Climate Impacts

Dyrehaugen Web Notebook

2023-12-09

Contents

1

Climate Change

The issue of Climate Change is treated across several web notebooks:

- Climate System (github) (geek) (loc)
- Climate Models (github) (geek) (loc)
- Climate Impacts (github) (geek) (loc)
- Climate Actions (github) (geek) (loc)

You are now visiting the **Climate Impacts** Web Notebook.

> **Climate is someone else's Weather**
>
> **Climate Crisis and Economic Development are one and the same problem**
>
> **The neoliberal solution to climate change is to hope that somehow it will become profitable to save the planet. This will not work.**

> **If warming reaches or exceeds 2°C this century, mainly richer humans will be responsible for killing roughly 1 billion mainly poorer humans.**

Part I

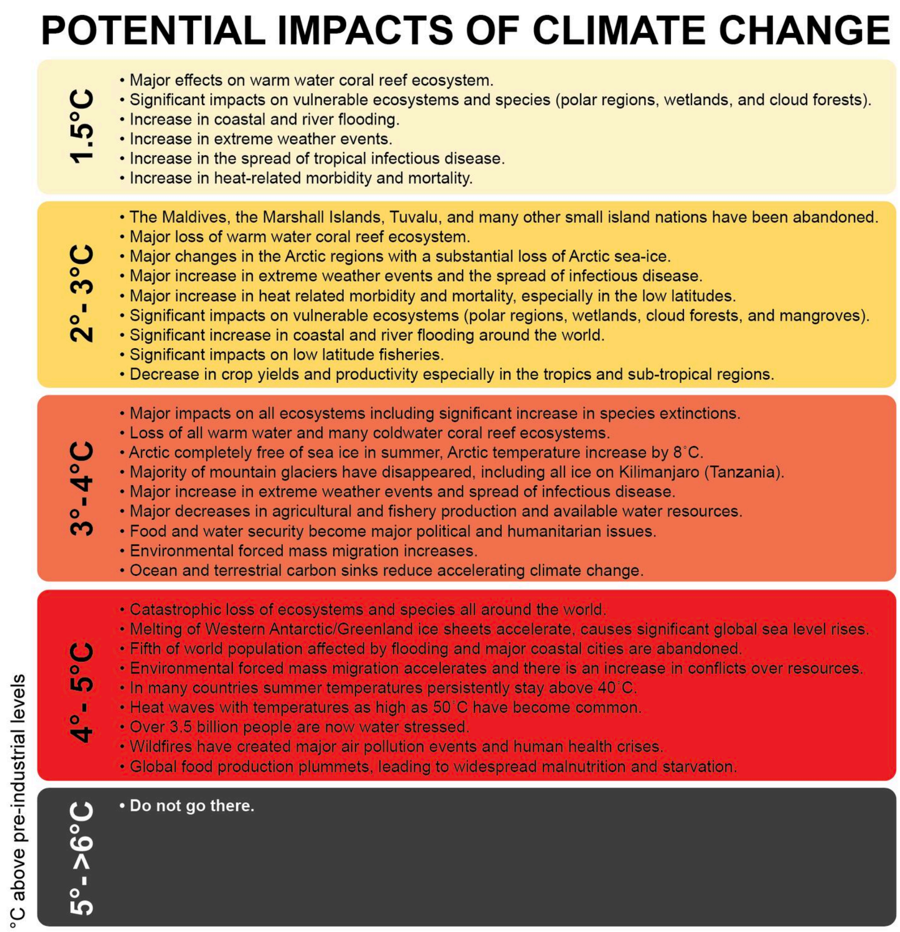
Impacts

2

Impacts

Overview of Nature Communications on Climate Change Impacts:

Nature Communications



The impacts of climate change are strongly non-linear.

3

Draught

3.0.1 European Draught Extremes

The series of severe droughts and heatwaves in Europe since 2014 is the most extreme for more than 2,000 years, research suggests.

The study analysed tree rings dating as far back as the Roman empire to create the longest such record to date. The scientists said global heating was the most probable cause of the recent rise in extreme heat.

The study also found a gradual drying of the summer climate in central Europe over the last two millennia, before the recent surge. The scientists ruled out volcanic activity and solar cycles as causes of this long-term trend and think subtle changes in Earth's orbit are the cause.

The scientists said changes in the position of the jet stream and the circulation of air over the continent caused the droughts, and that climate change was probably the underlying driver.

Previous climate reconstructions from tree rings used width and wood density to determine temperature. The Büntgen-led study used measurements of carbon and oxygen isotopes to show how much water was available to the trees, giving a record of droughts. This showed that the high frequency of recent European droughts was unprecedented, even compared with severe historical droughts such as the Renaissance drought in the early 16th century.

The wood samples come from the Czech Republic and Bavaria in Germany, and represent climate conditions across central Europe. High temperatures were the main cause of recent droughts, and these have been seen across Europe.

Guardian

Abstract Büntgen

Europe's recent summer droughts have had devastating ecological and economic consequences, but the severity and cause of these extremes remain unclear. Here we present 27,080 annually resolved and absolutely dated measurements of tree-ring stable carbon and oxygen (13C and 18O) isotopes from 21 living and 126 relict oaks (Quercus spp.) used to reconstruct central European summer hydroclimate from 75 bce to 2018 ce. We find that the combined inverse 13C and 18O values correlate with the June–August Palmer Drought Severity Index from 1901–2018 at 0.73 ($P < 0.001$). Pluvials around 200, 720 and 1100 ce, and droughts around 40, 590, 950 and 1510 ce and in the twenty-first century, are superimposed on a multi-millennial drying trend. Our reconstruction demonstrates that the sequence of recent European summer droughts since 2015 ce is unprecedented in the past 2,110 years. This hydroclimatic anomaly is probably caused by anthropogenic warming and associated changes in the position of the summer jet stream.

Büntgen (2021) European drought extremes - Nature (Paywall)

4

Rainfall

4.1 Decreased Globel Precipitation Area

Benestad

The total area with 24 hrs precipitation has shrunk by 7% between 50°S–50°N over the period 1998–2016, according to the satellite-based Tropical Rain Measurement Mission data. A decrease in the daily precipitation area is an indication of profound changes in the hydrological cycle, where the global rate of precipitation is balanced by the global rate of evaporation. This decrease was accompanied by increases in total precipitation, evaporation, and wet-day mean precipitation. If these trends are real, then they suggest increased drought frequencies and more intense rainfall. A linear dependency was also found between the global mean temperature and the 50°S–50°N daily precipitation area with a slope value of -17×106km2°C.

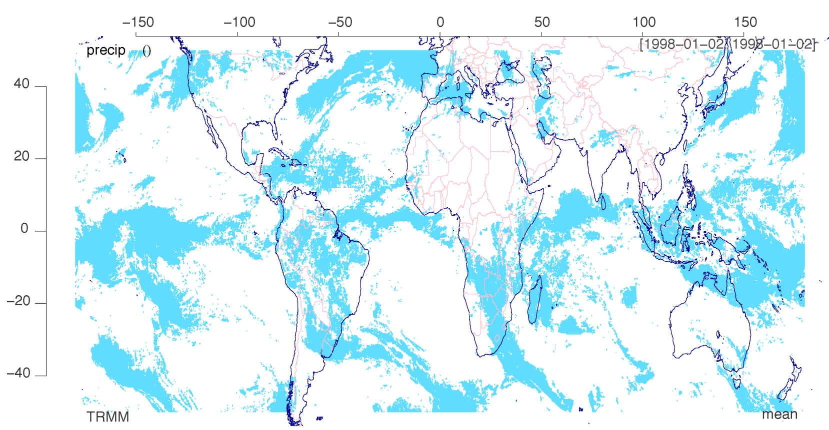


Figure: Global Rainfall Area on a random day.

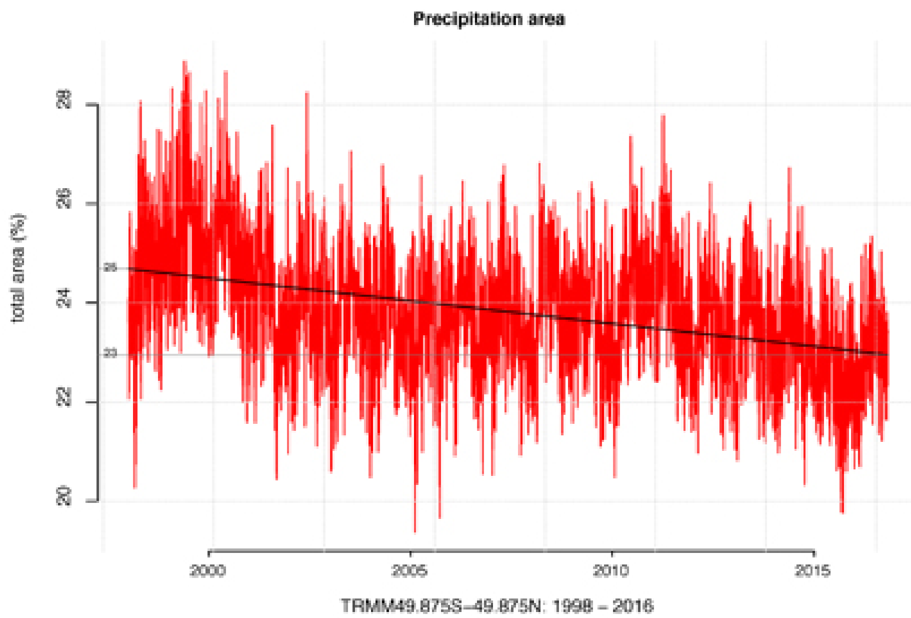


Figure: Time series of the rainfall area based on daily TRMM data expressed as the fraction of the total surface area between 50°S–50°N. A linear trend analysis indicates a change in the estimated rainfall area from 25% to 23% over the 1998–2016 period. The trend is statistically significant at the 1% level. (TRMM- Tropical Rainfall Measurement Mission).

The study of the precipitation area AP is both scientifically interesting and important in terms of our understanding of the hydrological cycle and climate change. A 7% decrease in AP over two decades is dramatic, especially if it reflects a real ongoing long-term change. The precipitation between 50°S–50°N dominates the water budget of the global hydrological cycle both because it represents 77% of the surface area and because the precipitation is most intense in the tropics (table 2). One plausible physical explanation for the observed decline may be that an increased rate of atmospheric overturning [7] may have resulted in more convection and precipitation from cumulonimbus type clouds rather than more spatially extensive stratonimbus clouds. Such changes will have consequences even if they only are due to slow natural variability.

A regression analysis suggested that the daily precipitation area diminishes with the global mean temperature, and used with global climate model simulations, crude projections for the future suggested a decrease in daily precipitation area by 28% by 2100. For monthly accumulated precipitation, however, the area appears to experience an increase over time, as the area of monthly precipitation is influenced by migratory phenomena and the area is estimated for amounts that are aggregated over longer time scales.

Benestad

4.2 Quasi-stationary Rainstorms

Kahraman Abstract

Under climate change, increases in precipitation extremes are expected due to higher atmospheric moisture. However, the total precipitation in an event also depends on the condensation rate, precipitation efficiency, and duration. Here, a new approach following an "ingredients-based methodology" from severe weather forecasting identifies important aspects of the heavy precipitation response to climate change, relevant from an impacts perspective and hitherto largely neglected. Using 2.2 km climate simulations, we show that a future increase in precipitation extremes across Europe occurs, not only because of higher moisture and updraft velocities, but also due to slower storm movement, increasing local duration. Environments with extreme precipitation potential are 7× more frequent than today by 2100, while the figure for quasi-stationary ones is 11× (14× for land). We find that a future reduction in storm speeds, possibly through Arctic Amplification, could enhance event accumulations and flood risk beyond expectations from studies focusing on precipitation rates.

Kahraman Plain language Summary

Intense rainstorms are expected to be more frequent due to global warming, because warmer air can hold more moisture. Here, using very detailed climate simulations (with a 2.2 km grid), we show that the storms producing intense rain across Europe might move slower with climate change, increasing the duration of local exposure to these extremes. Our results suggest such slow-moving storms may be 14× more frequent across land by the end of the century. Currently, almost-stationary intense rainstorms are uncommon in Europe and happen rarely over parts of the Mediterranean Sea, but in future are expected to occur across the continent, including in the north. The main reason seems to be a reduced temperature difference between the poles and tropics, which weakens upper-level winds in the autumn, when these short-duration rainfall extremes most occur. This slower storm movement acts to increase rainfall amounts accumulated locally, enhancing the risk of flash floods across Europe beyond what was previously expected.

Kahraman (2021) Quasi-Stationary Intense Rainstorms Spread Across Europe Under Climate Change (pdf)

Forskning.no

4.3 Landslides

The global landslide hotspot is located in South Asia, driven by the summer (SW) monsoon. The monsoon drives a period of intense and prolonged rainfall in the period centred on June to September. Rainfall levels can be high – in some cases the highest in the world. The monsoon also drives convective activity that can cause cloudbursts. Together, these effects trigger large numbers of landslides, with catastrophic outcomes.

Thus, one of the key elements in the understanding of future landslide patterns is to understand the dynamics of the monsoon with climate change – i.e. under future warming. If the monsoon is likely to intensify then we might see more landslides through time. And of course vice versa. The pattern is not simple of course; the monsoon could weaken but rainfall intensity could increase. So understanding the dynamics of the monsoon is key.

A new open access paper has just been published in the journal Earth System Dynamics (Katzenberger et al. 2021) that examines the dynamics of the Indian monsoon under future warming scenarios. To do so it examines the 32 global climate models within the Coupled Model Intercomparison Project Phase 5 (CMIP5) under a range of emission scenarios.

The results are really interesting. As the authors put it:

All of these models show a substantial increase in June-to-September (JJAS) mean rainfall under unabated climate change (SSP5-8.5) and most do also for the other three Shared Socioeconomic Pathways analyzed (SSP1-2.6, SSP2-4.5, SSP3-7.0). Moreover, the simulation ensemble indicates a linear dependence of rainfall on global mean temperature with a high agreement between the models independent of the SSP if global warming is the dominant forcing of the monsoon dynamics as it is in the 21st century; the multi-model mean for JJAS projects an increase of $0.33\,\mathrm{mm\,d}{-1}$ and $5.3\,\%$ per kelvin of global warming.

These are fascinating results. Under most likely scenarios for future warming the monsoon will strength, with more rainfall on average. In graphical form the figure below displays the outcomes:

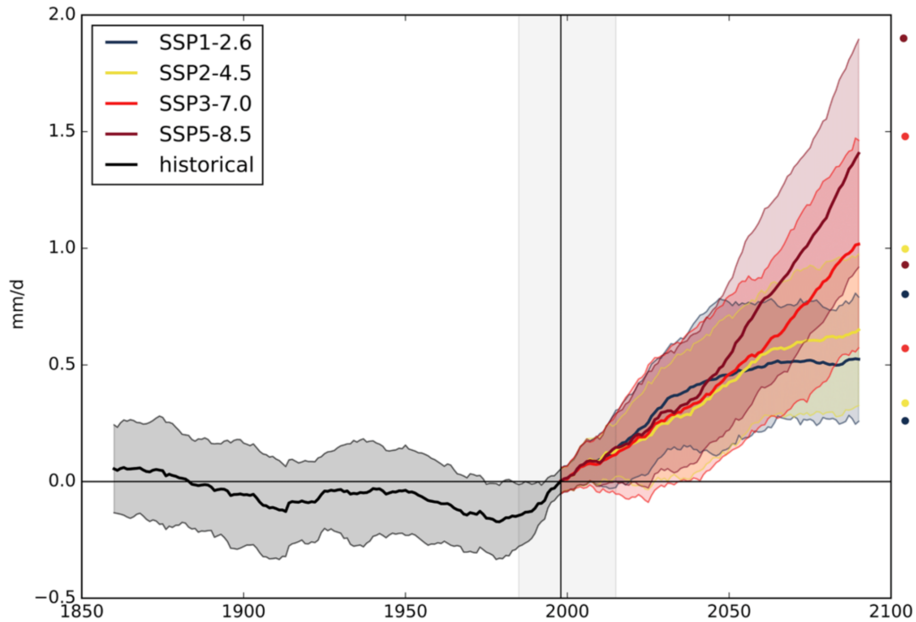


Figure: Multi-model mean of Indian summer monsoon rainfall (mm d−1) for the Indian summer monsoon for 1860–2090 relative to the mean (horizontal black line) in 1985–2015 (grey background) for the four scenarios (SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5). The 20-year smoothed time series of one ensemble member per model was used to calculate the multi-model mean. Shading in the time series represents the range of mean plus/minus 1 standard deviation marked with circles on the right side of the figure. Image and caption (lightly edited) from Katzenberger et al. (2021).

Interestingly, the models project that both the west coast of India and the Himalaya region will show substantial increases in monsoon precipitation. These are the areas most affected by landslides. The models also suggest greater interannual variability, indicating that some years will be exceptionally wet.

Studies like this provide a general expectation for future behaviour. There will be nuances of course that require further investigation, such as the impacts on cloudburst rainfall and the interaction between the atmosphere and the topography. But in general terms, the models suggest that we might expect to see increased landslide activity driven by the summer monsoon with time. Coupled with the ongoing environmental degradation in the Himalayas, especially through haphazard road construction, the picture for future landslide impacts is poor. Strategies to adapt to future warming are urgently required.

Petley: Indian Monsoon

4.4 Water availability

Abstract Konapala

Accessibility of water resources for human consumption and ecosystems largely depends on the spatio-temporal distribution of both precipitation and evaporation. As a result, changes in characteristics of precipitation and evaporation due to human-caused climate change in the 21st century may result in changes in water availability (WA) that have implications for both humans and the biosphere. Previous studies have elucidated trends in precipitation in terms of both annual mean, seasonal variation, and the distribution of extreme events. Studies have also examined the corresponding changes in evaporation characteristics. Though the combined monthly distribution of precipitation and evaporation have widespread implications for regional hydrology, crop yield, and ecology, few studies have examined the concomitant changes in both annual mean and seasonal variation in these variables. Moreover, the existing global climate classifications that form the basis for WA studies rarely consider seasonal variation characteristics from a non-parametric standpoint, even though they vary in a complex manner across global land regions.

Konapala (2021) Water Availability (pdf)

4.4.1 Energy Crops takes away Water

Billions more people could have difficulty accessing water if the world opts for a massive expansion in growing energy crops to fight climate change, research has found.

The idea of growing crops and trees to absorb CO2 and capturing the carbon released when they are burned for energy is a central plank to most of the Intergovernmental Panel on Climate Change's scenarios for the negative emissions approaches needed to avoid the catastrophic impacts of more than 1.5°C of global warming.

But the technology, known as bioenergy with carbon capture and storage (BECCS), could prove a cure worse than the disease, at least when it comes to water stress.

Fabian Stenzel at the Potsdam Institute for Climate Impact Research in Germany and his colleagues project that the water needed to irrigate enough energy crops to stay under the 1.5°C limit would leave 4.58 billion people experiencing high water stress by 2100 – up from 2.28 billion today. That is 300 million more people than a scenario in which BECCS isn't used at scale and warming spirals to a devastating 3°C.

"I was a little bit shocked. The takeaway message is, so far, we haven't looked at side effects enough. To limit all the trade-offs that we might face in terms of climate change and climate change mitigation, it's really important to look at the holistic Earth system," says Stenzel.

New Scientist

Stenzel

Bioenergy with carbon capture and storage (BECCS) is considered an important negative emissions (NEs) technology, but might involve substantial irrigation on biomass plantations. Potential water stress resulting from the additional withdrawals warrants evaluation against the avoided climate change impact. Here we quantitatively assess potential side effects of BECCS with respect to water stress by disentangling the associated drivers (irrigated biomass plantations, climate, land use patterns) using comprehensive global model simulations. By considering a widespread use of irrigated biomass plantations, global warming by the end of the 21st century could be limited to 1.5 °C compared to a climate change scenario with 3 °C. However, our results suggest that both the global area and population living under severe water stress in the BECCS scenario would double compared to today and even exceed the impact of climate change. Such side effects of achieving substantial NEs would come as an extra pressure in an already water-stressed world and could only be avoided if sustainable water management were implemented globally.

Stenzel in Nature (pdf)

4.5 Agricultural Productivity

Despite important agricultural advancements to feed the world in the last 60 years, a Cornell-led study shows that global farming productivity is 21% lower than it could have been without climate change. This is the equivalent of losing about seven years of farm productivity increases since the 1960s.

The future potential impacts of climate change on global crop production has been quantified in many scientific reports, but the historic influence of anthropogenic climate change on the agricultural sector had yet to be modeled.

The scientists and economists developed an all-encompassing econometric model linking year-to-year changes in weather and productivity measures with output from the latest climate models over six decades to quantify the effect of recent human-caused climate change on TFP.

The results show clearly that adaption efforts must look at the whole supply chain, including labor and livestock. Even as agriculture becomes more mechanized and sophisticated, the sensitivity to weather does not go away.

This study is a big leap beyond the traditional focus on a few major grain crops. By looking at the whole system – the animals, the workers, the specialty crops – we can see that the entire agricultural economy is quite sensitive to weather. It seems that in agriculture, practically everything gets harder when it's hotter.

Ortiz-Bobea Cornell News

Agricultural research has fostered productivity growth, but the historical influence of anthropogenic climate change (ACC) on that growth has not been quantified. We develop a robust econometric model of weather effects on global agricultural total factor productivity (TFP) and combine this model with counterfactual climate scenarios to evaluate impacts of past climate trends on TFP. Our baseline model indicates that ACC has reduced global agricultural TFP by about 21% since 1961, a slowdown that is equivalent to losing the last 7 years of productivity growth. The effect is substantially more severe (a reduction of ~26–34%) in warmer regions such as Africa and Latin America and the Caribbean. We also find that global agriculture has grown more vulnerable to ongoing climate change.

Nature (Paywall)

A third of global food production will be at risk by the end of the century if greenhouse gas emissions continue to rise at their current rate, new research suggests.

Many of the world's most important food-growing areas will see temperatures increase and rainfall patterns alter drastically if temperatures rise by about 3.7C, the forecast increase if emissions stay high.

Researchers at Aalto University in Finland have calculated that about 95% of current crop production takes place in areas they define as "safe climatic space", or conditions where temperature, rainfall and aridity fall within certain bounds.

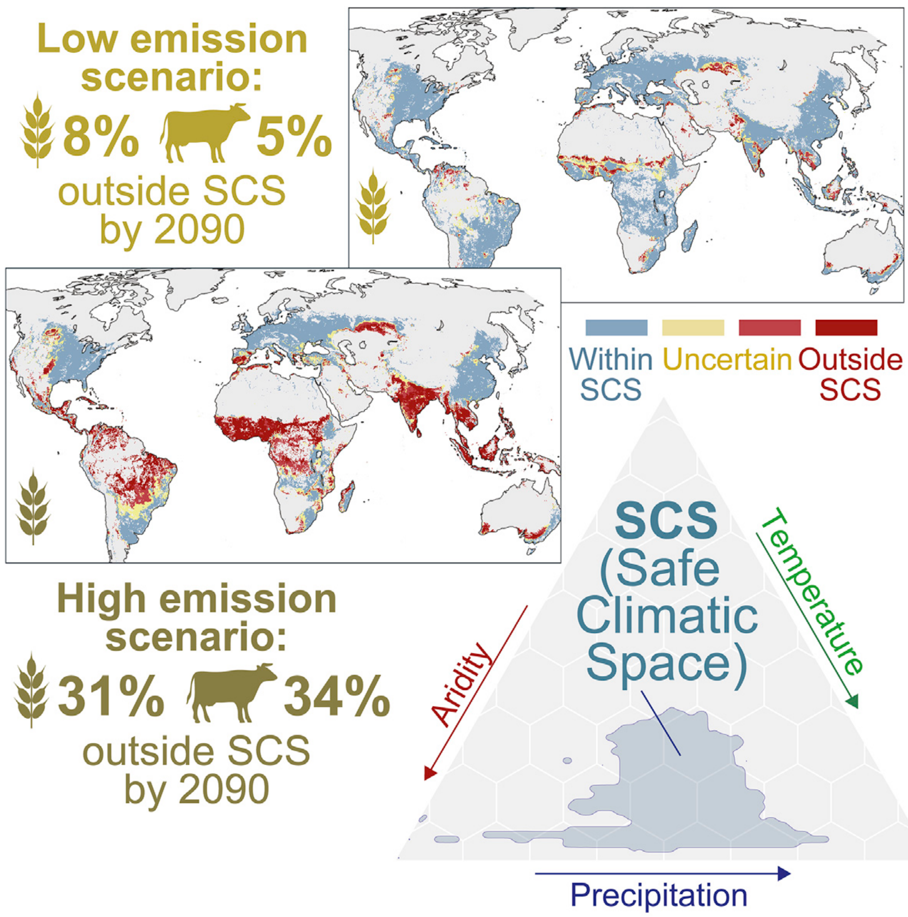
If temperatures were to rise by 3.7C or thereabouts by the century's end, that safe area would shrink drastically, mostly affecting south and south-eastern Asia and Africa's Sudano-Sahelian zone, according to a paper published in the journal One Earth on Friday.

Guardian

Climate change risks pushing 1/3 of food production outside safe climatic space.

Kummu

We developed the novel concept of safe climatic space, which allows us, for the first time, to identify the climatic conditions under which food production developed during the stable Holocene climate conditions. We show that nearly one-third of global food crop production and over one-third of livestock production could be forced beyond these suitable conditions by 2081–2100 if we cannot limit the warming to 1.5–2 C. The most vulnerable areas would be South and Southeast Asia and Africa's Sudano- Sahelian Zone.



Kummu (2021) (pdf)

Jägermeyr Abstract

Potential climate-related impacts on future crop yield are a major societal concern. Previous projections of the Agricultural Model Intercomparison and Improvement Project's Global Gridded Crop Model Intercomparison based on the Coupled Model Intercomparison Project Phase 5 identified substantial climate impacts on all major crops, but associated uncertainties were substantial. Here we report new twenty-first-century projections using ensembles of latest-generation crop and climate models. Results suggest markedly more pessimistic yield responses for maize, soybean and rice compared to the original ensemble. Mean end-of-century maize productivity is shifted from +5% to −6% (SSP126) and from +1% to −24% (SSP585)—explained by warmer climate projections and improved crop model sensitivities. In contrast, wheat shows stronger gains (+9% shifted to +18%, SSP585), linked to higher CO2 concentrations and expanded high-latitude gains. The 'emergence' of climate impacts consistently occurs earlier in the new projections—before 2040 for several main producing regions. While future yield estimates remain uncertain, these results suggest that major breadbasket regions will face distinct anthropogenic climatic risks sooner than previously anticipated.

Jägermeyr (2021) Climate impacts on global agriculture emerge earlier in new generation of climate and crop models

4.5.1 Synchronized Low Yields

Kornhuber Abstract

Simultaneous harvest failures across major crop-producing regions are a threat to global food security. Concurrent weather extremes driven by a strongly meandering jet stream could trigger such events, but so far this has not been quantified. Specifically, the ability of state-of-the art crop and climate models to adequately reproduce such high impact events is a crucial component for estimating risks to global food security. Here we find an increased likelihood of concurrent low yields during summers featuring meandering jets in observations and models. While climate models accurately simulate atmospheric patterns, associated surface weather anomalies and negative effects on crop responses are mostly underestimated in bias-adjusted simulations. Given the identified model biases, future assessments of regional and concurrent crop losses from meandering jet states remain highly uncertain. Our results suggest that model-blind spots for such high-impact but deeply-uncertain hazards have to be anticipated and accounted for in meaningful climate risk assessments.

Kornhuber (2023) Risks of synchronized low yields are underestimated in climate and crop model projections

4.5.2 Crop Yield Draught Sensitivity

Leng Abstract

Understanding the potential drought impacts on agricultural production is critical for ensuring global food secu- rity. Instead of providing a deterministic estimate, this study investigates the likelihood of yield loss of wheat, maize, rice and soybeans in response to droughts of various intensities in the 10 largest producing countries. We use crop-country specific standardized precipitation index (SPI) and census yield data for 1961–2016 to build a probabilistic modeling framework for estimating yield loss risk under a moderate (−1.2 b SPI b −0.8), severe (−1.5 b SPI b −1.3), extreme (−1.9 b SPI b −1.6) and exceptional (SPI b −2.0) drought. Results show that there is N80% probability that wheat production will fall below its long-term average when experiencing an exceptional drought, especially in USA and Canada. As for maize, India shows the highest risk of yield reduc- tion under droughts, while rice is the crop that is most vulnerable to droughts in Vietnam and Thailand. Risk of drought-driven soybean yield loss is the highest in USA, Russian and India. Yield loss risk tends to grow faster when experiencing a shift in drought severity from moderate to severe than that from extreme to the exceptional category, demonstrating the non-linear response of yield to the increase in drought severity. Sensitivity analysis shows that temperature plays an important role in determining drought impacts, through reducing or amplifying drought-driven yield loss risk. Compared to present conditions, an ensemble of 11 crop models simulated an increase in yield loss risk by 9%–12%, 5.6%–6.3%, 18.1%–19.4% and 15.1%–16.1 for wheat, maize, rice and soybeans by the end of 21st century, respectively, without considering the benefits of CO 2 fertilization and adaptations. This study highlights the non-linear response of yield loss risk to the increase in drought severity. This implies that adaptations should be more targeted, considering not only the crop type and region but also the specific drought severity of interest.

Leng Memo

Global agricultural productivity has exhibited substantial variations during the past decades, and crop yield reductions are often observed when dry conditions occurred. Overall, crop yield variability can be explained by the drought index (i.e. SPI) for the study period.

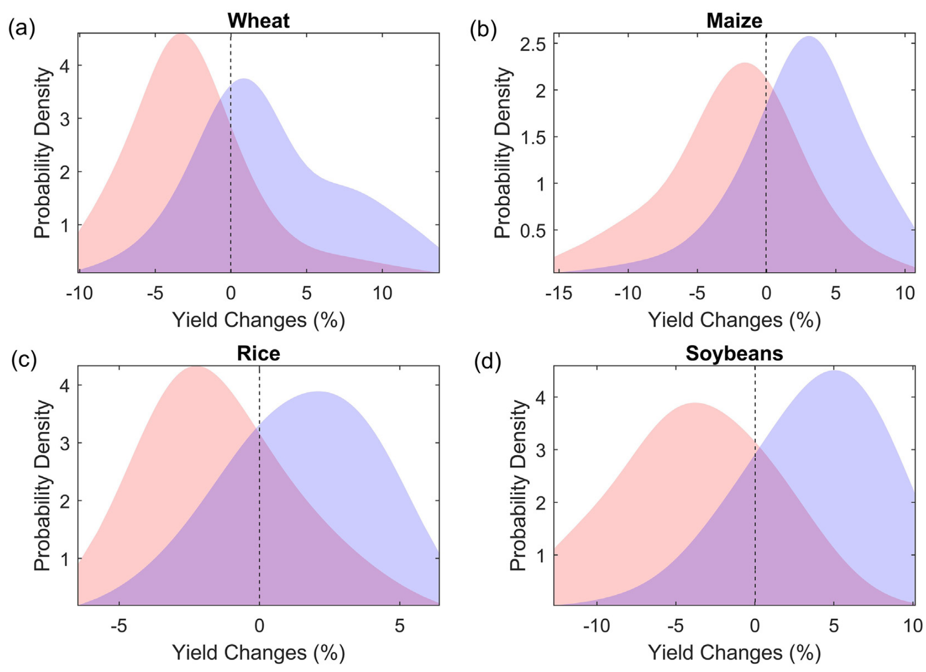


*Fig: Conditional probability distribution of yield changes (%) relative to its long-term mean under moderate drought (red) and wet (blue) conditions for (a) wheat, (b) maize, (c) rice and (d) soybeans.

Results show a significant association between droughts and yield reductions during the past decades. When experiencing an excep- tional drought, the probability of yield loss could exceed 70% for soy- bean and maize, while the risk for wheat and rice is up to 68% and 64%, respectively. This prediction represents an increase of yield loss risk by 24%, 21%, 18% and 20% for soybean, maize, rice and wheat, re- spectively, when drought severity grows from moderate to the excep- tional category. Notably, the rate of risk growth tends to become slower with increase in drought severity, suggesting the non-linear response of yields to droughts. Regionally, the risk of drought-driven wheat reduction is the highest in USA and Canada, where there is N80% probability that wheat reduction may fall below its long-term av- erage given an exceptional drought. As for maize, India shows the highest risk of yield reduction, while rice yield in Vietnam and Thailand are most vulnerable to droughts. Risk of soybean yield reduc- tion is the highest in USA, Russian and India, while relatively low risk is observed in other regions. Further analysis based on 11 process- based model simulations shows that yield loss risk will increase in the future, with the largest growth found for rice followed by soybeans, wheat and maize.

Leng (2018) Crop yield sensitivity of global major agricultural countries to droughts and the projected changes in the future (pdf)

> Big yield losses for all 4 major crops expected in our hot, dry new world, while food demand is forecast to double by 2050. During heat and drought, plants close their pores to prevent dehydration. Doing so also means they can't absorb CO_2 for photosynthesis. Tsakraklides (2023) Twiiter Comment

5

Human Health

5.1 Morbidity and Mortality

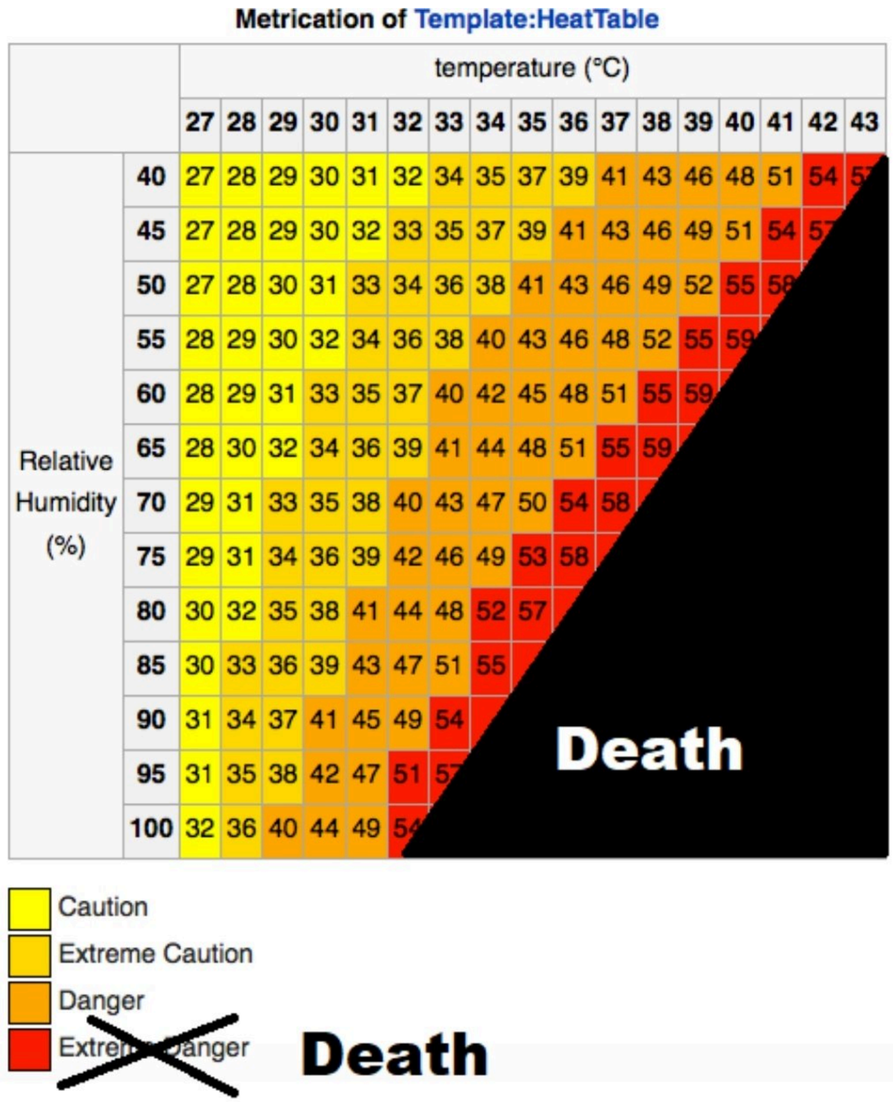
5.2 Humid Heat Bulbs

Foster on Raymond

In the article “The Emergence of Heat and Humidity Too Severe for Human Tolerance,” published in Science Advances, Colin Raymond, Tom Matthews, and Radley M. Horton explain that what are called dry-bulb temperatures, measurements obtained from an ordinary thermometer, are not adequate in ascertaining the dangers to human health associated with heat stress.68 Instead, it is necessary to measure the wet-bulb temperature—heat and humidity. This is obtained by placing a wet cloth on the thermometer and blowing air on it. Human beings cool themselves or shed their metabolic heat at high temperatures via sweat-based latent cooling. But once the wet-bulb temperature reaches 35°C (or 95°F), this cooling mechanism ceases to be effective. Under such conditions, human beings are not able to cool themselves by sweating, even if they are in the shade, wearing little clothing, and drinking plenty of water. When outside and exposed to such wet-bulb temperatures for six hours, even young, healthy individuals will perish from this heat stress. In humid regions, and for populations whose physical conditions are less than optimal, it is possible for lives to be threatened even with lower wet-bulb temperatures, between 26°C and 32°C, as was the case in the heatwaves that hit Europe in 2003 and Russia in 2010, killing thousands of people, especially the elderly and other vulnerable populations.69

Raymond and his colleagues stress that “extreme heat remains one of the most dangerous natural hazards” and “a wet-bulb temperature…of 35°C marks our upper physiological limit.” Thus, it is not possible simply to adapt to progressively warmer temperature, when heat and humidity surpass the point of what is survivable. These worrying wet-bulb temperature conditions are occurring a few hours at a time in coastal and major river regions of South Asia, the Middle East, Mexico, and Central America. Such conditions are likely to become more regular and to last longer in these regions over the next few decades, or even years, with even more deadly consequences, while spreading across larger terrestrial stretches, rendering parts of the world uninhabitable. In the second half of the century, if "business-as-usual" trends continue, the likely consequences are too horrific to imagine.70

Foster (2022) On Raymond (Monthly Review July/August 2022)



Metrication of Template:HeatTable

Relative Humidity (%)	temperature (°C) 27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
40	27	28	29	30	31	32	34	35	37	39	41	43	46	48	51	54	
45	27	28	29	30	32	33	35	37	39	41	43	46	49	51	54		
50	27	28	30	31	33	34	36	38	41	43	46	49	52	55	58		
55	28	29	30	32	34	36	38	40	43	46	48	52	55	59			
60	28	29	31	33	35	37	40	42	45	48	51	55	59				
65	28	30	32	34	36	39	41	44	48	51	55	59					
70	29	31	33	35	38	40	43	47	50	54	58						
75	29	31	34	36	39	42	46	49	53	58							
80	30	32	35	38	41	44	48	52	57								
85	30	33	36	39	43	47	51	55									
90	31	34	37	41	45	49	54										
95	31	35	38	42	47	51											
100	32	36	40	44	49												

Abstract Raymond:

Humans' ability to efficiently shed heat has enabled us to range over every continent, but a wet-bulb temperature (TW) of 35°C marks our upper physiological limit, and much lower values have serious health and productivity impacts. Climate models project the first 35°C TW occurrences by the mid-21st century. However, a comprehensive evaluation of weather station data shows that some coastal subtropical locations have already reported a TW of 35°C and that extreme humid heat overall has more than doubled in frequency since 1979. Recent exceedances of 35°C in global maximum sea surface temperature provide further support for the validity of these dangerously high TW values. We find the most extreme humid heat is highly localized in both space and time and is correspondingly substantially underestimated in reanalysis products. Our findings thus underscore the serious challenge posed by humid heat that is more intense than previously reported and increasingly severe.

Raymond (2020) The emergence of heat and humidity too severe for human tolerance (pdf)

Inside

While scientists warn with increasing urgency that global warming is sharply increasing the likelihood of deadly heat waves, many regions are doing little to protect vulnerable populations.

Recent research shows that the global death toll from extreme heat is rising, but still, "Large parts of society don't think of heat as a threat," said University of Oxford University climate scientist Fredi Otto after researchers unveiled a series of new extreme heat studies at the European Geosciences Union online conference last month.

The research discussed at the conference suggests that many models are underestimating the short-term threat to the most vulnerable areas—densely populated tropical regions—and that the threats aren't clearly communicated. And a study released in late April showed that, in the U.S., the risk of power failures during such heatwaves could increase the death toll.

Last week's updates to the U.S. Environmental Protection Agency's Climate Indicators website, which had been delayed for years by the Trump administration, showed that major U.S. cities experienced three times as many heat waves—four or more days with temperatures that should only occur every 10 years—in the 2010s as during the 1960s. The season in which heat waves occur has lengthened by 47 days. In addition to heat exhaustion, recent research also showed that extreme heat dramatically increases the chances of pre-term births.

Inside

Mann on US Heat Dome 2021

he science is clear on how human-caused climate change is already affecting heat waves: Global warming has caused them to be hotter, larger, longer and more frequent. What were once very rare events are becoming more common.

Heat waves now occur three times as often as they did in the 1960s — on average at least six times a year in the United States in the 2010s. Record-breaking hot months are occurring five times more often than would be expected without global warming. And heat waves have become larger, affecting 25 percent more land area in the Northern Hemisphere than they did in 1980; including ocean areas, heat waves grew 50 percent.

Extreme heat is the deadliest form of extreme weather in the United States, causing more deaths on average than hurricanes and floods combined over the past 30 years. Recent research projects that heat stress will triple in the Pacific Northwest by 2100

The heat wave afflicting the Pacific Northwest is characterized by what is known as an omega block pattern, because of the shape the sharply curving jet stream makes, like the Greek letter omega (Ω). This omega curve is part of a pattern of pronounced north-south wiggles made by the jet stream as it traverses the Northern Hemisphere. It is an example of a phenomenon known as wave resonance, which scientists (including one of us) have shown is increasingly favored by the considerable warming of the Arctic.

Mann (2021) US heat Dome

5.2.1 Urban Heat Exposure

Tuholske Significance

Increased extreme heat exposure from both climate change and the urban heat island effect threatens rapidly growing urban settlements worldwide. Yet, because we do not know where urban population growth and extreme heat intersect, we have limited capacity to reduce the impacts of urban extreme heat exposure. Here, we leverage fine-resolution temperature and population data to measure urban extreme heat exposure for 13,115 cities from 1983 to 2016. Globally, urban exposure increased nearly 200%, affecting 1.7 billion people. Total urban warming elevated exposure rates 52% above population growth alone. However, spatially heterogeneous exposure patterns highlight an urgent need for locally tailored adaptations and early warning systems to reduce harm from urban extreme heat exposure across the planet's diverse urban settlements.

Tuholske Abstract

Increased exposure to extreme heat from both climate change and the urban heat island effect—total urban warming—threatens the sustainability of rapidly growing urban settlements worldwide. Extreme heat exposure is highly unequal and severely impacts the urban poor. While previous studies have quantified global exposure to extreme heat, the lack of a globally accurate, fine-resolution temporal analysis of urban exposure crucially limits our ability to deploy adaptations. Here, we estimate daily urban population exposure to extreme heat for 13,115 urban settlements from 1983 to 2016. We harmonize global, fine-resolution (0.05°), daily temperature maxima and relative humidity estimates with geolocated and longitudinal global urban population data. We measure the average annual rate of increase in exposure (person-days/year−1) at the global, regional, national, and municipality levels, separating the contribution to exposure trajectories from urban population growth versus total urban warming. Using a daily maximum wet bulb globe temperature threshold of 30 °C, global exposure increased nearly 200% from 1983 to 2016. Total urban warming elevated the annual increase in exposure by 52% compared to urban population growth alone. Exposure trajectories increased for 46% of urban settlements, which together in 2016 comprised 23% of the planet's population (1.7 billion people). However, how total urban warming and population growth drove exposure trajectories is spatially heterogeneous. This study reinforces the importance of employing multiple extreme heat exposure metrics to identify local patterns and compare exposure trends across geographies. Our results suggest that previous research underestimates extreme heat exposure, highlighting the urgency for targeted adaptations and early warning systems to reduce harm from urban extreme heat exposure.

Tuholske Memo

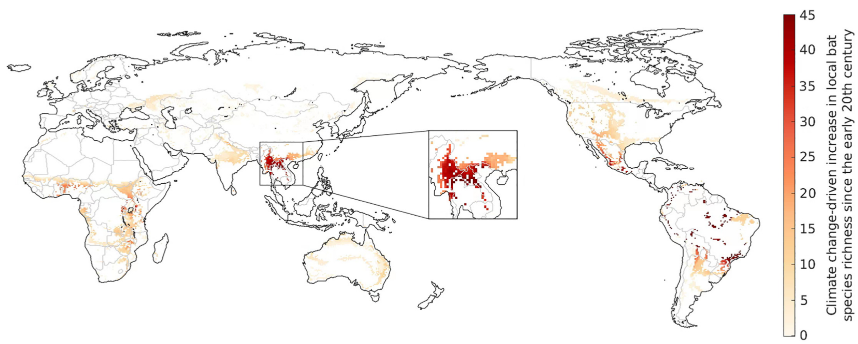
Our main findings use an extreme heat exposure threshold defined as WBGT max > 30 °C, the International Standards Organization (ISO) occupational heat stress threshold for risk of heat-related illness among acclimated persons at low metabolic rates (100 to 115 W). WBGT max is a widely used heat stress metric that captures the biophysical response of hot temperature–humidity combinations that reduce labor output, lead to heat-related illness, and can cause death. In using a threshold WBGT max > 30 °C, which has been associated with higher mortality rates among vulnerable populations, we aim to identify truly extremely hot temperature–humidity combinations that can harm human health and well-being. We recognize, however, that strict exposure thresholds do not account for individual-level risks and vulnerabilities related to acclimatization, socio-economic, or health status or local infrastructure. We also note that there are a range of definitions of exposure, and we provide further analysis identifying 2-d or longer periods during which the maximum heat index (HI max) exceeded 40.6 °C following the US National Weather Service's definition for an excessive heat warning.

Tuholske (2021) Global urban population exposure to extreme heat (pdf)

5.3 COVID

Abstract Beyer

Bats are the likely zoonotic origin of several coronaviruses (CoVs) that infect humans, including SARS-CoV-1 and SARS-CoV-2, both of which have caused large-scale epidemics. The number of CoVs present in an area is strongly correlated with local bat species richness, which in turn is affected by climatic conditions that drive the geograph- ical distributions of species. Here we show that the southern Chinese Yunnan province and neighbouring regions in Myanmar and Laos form a global hotspot of climate change-driven increase in bat richness. This region coin- cides with the likely spatial origin of bat-borne ancestors of SARS-CoV-1 and SARS-CoV-2. Accounting for an es- timated increase in the order of 100 bat-borne CoVs across the region, climate change may have played a key role in the evolution or transmission of the two SARS CoVs.



Beyer (2021) Climate Change -> Bats -> Covid (pdf)

5.4 Metabolism

Global temperature rises threaten food chains and the survival of larger animals. Warmer conditions result in less efficient energy transfer, ultimately causing reductions in biomass.

Temperature rises due to the global climate crisis are putting growing pressure on food chains, ultimately threatening the survival of larger animals. New research examined the transfer of energy from tiny single celled organisms up to large mammals. 4C of warming reduced the energy transfer by up to 56 per cent - posing a grave risk to animals higher up the food chain.

Scientists from the University of Exeter and Queen Mary University of London measured the transfer of energy from phytoplankton - a kind of single-celled algae, to small animals which eat them - (zooplankton). Warmer conditions increase the “metabolic cost” of growth, meaning there was less efficient energy flow through the food chain, and consequently a reduction in overall biomass.

Phytoplankton and zooplankton are the foundation of food webs that support freshwater and marine ecosystems that humans depend on.

The study is the first direct evidence that the cost of growth increases in higher temperatures, limiting the transfer of energy up a food chain.

Independent

Abstract Barneche:

In natural ecosystems, the efficiency of energy transfer from resources to consumers determines the biomass structure of food webs. As a general rule, about 10% of the energy produced in one trophic level makes it up to the next. Recent theory suggests this energy transfer could be further constrained if rising temperatures increase metabolic growth costs, although experimental confirmation in whole ecosystems is lacking. We quantified nitrogen transfer efficiency (a proxy for overall energy transfer) in freshwater plankton in artificial ponds exposed to 7 years of experimental warming. We provide the first direct experimental evidence that, relative to ambient conditions, 4 °C of warming can decrease trophic transfer efficiency by up to 56%. In addition, both phytoplankton and zooplankton biomass were lower in the warmed ponds, indicating major shifts in energy uptake, transformation and transfer. These new findings reconcile observed warming-driven changes in individual-level growth costs and carbon-use efficiency across diverse taxa with increases in the ratio of total respiration to gross primary production at the ecosystem level. Our results imply that an increasing proportion of the carbon fixed by photosynthesis will be lost to the atmosphere as the planet warms, impairing energy flux through food chains, with negative implications for larger consumers and the functioning of entire ecosystems.

Barneche (2020) Warming impairs trophic transfer

5.5 Melting Glacier Viral Spillovers

Geddes

Genetic analysis of soil and lake sediments from Lake Hazen, the largest high Arctic freshwater lake in the world, suggests the risk of viral spillover – where a virus infects a new host for the first time – may be higher close to melting glaciers.

The findings imply that as global temperatures rise owing to climate change, it becomes more likely that viruses and bacteria locked up in glaciers and permafrost could reawaken and infect local wildlife, particularly as their range also shifts closer to the poles.

Geddes (2022) Next pandemic may come from melting glaciers

6

Societal Collapse

6.1 Deep Adaptation

(More unde 'Actions')

Bendell (2018) Deep Adaption: A Map for Navigating Climate Tradegy (pdf)

7

Coastal Flooding

Climate Impact Lab

According to new data on the Human Climate Horizons platform, a collaboration between the Climate Impact Lab and UNDP, increased coastal flooding this century will put over 70 million people in the path of expanding floodplains. Latin America, the Caribbean, the Pacific, and Small Island Developing States (SIDS) are at the forefront, projected to lose significant land and critical infrastructure to permanent inundation.

The extent of coastal flooding has increased over the past 20 years as a result of sea level rise, meaning 14 million more people worldwide now live in coastal communities with a 1-in-20 annual chance of flooding, new data reveals. Continuing our current course of global greenhouse gas emissions (SSP2-4.5) is projected by the end of the century to expand this 1-in-20 floodplain to areas today populated by nearly 73 million people.

New hyperlocal data released today by Human Climate Horizons, a collaboration between the United Nations Development Programme (UNDP) and the Climate Impact Lab (CIL), maps in detail this fivefold increase in susceptibility to flood damage along the world's densely populated coastlines. The data platform makes it possible to see where sea-level rise impacts may most threaten homes and infrastructure.

Hundreds of highly populated cities will face increased flood risk by midcentury, relative to a future without climate change. This includes land home to roughly 5 percent of the population of coastal cities such as Santos, Brazil, Cotonou, Benin, and Kolkata, India. Flood risk exposure is anticipated to double to 10 percent of the population by the end of the century.

Many low-lying regions along the coasts of Latin America, Africa, and Southeast Asia may face a severe threat of permanent inundation, part of an alarming trend with the potential to trigger a reversal in human development in coastal communities worldwide. By 2100, climate change is expected to cause the submergence of a significant share of land (>5 percent) in the following Small Island Developing States (SIDS) and Associate Members of United Nations Regional Commissions: Bahamas, British Virgin Islands, Cayman Islands, Maldives, Marshall Islands, Turks and Caicos, Tuvalu, and Seychelles.

At the highest levels of global warming (SSP5-8.5), approximately 160,000 square kilometers of coastal land (an area larger than the territory of Greece or Bangladesh) would be inundated by 2100, compared to a future with no climate change. This includes vast stretches of coastal cities in Ecuador, India, Saudi Arabia, Vietnam, and the United Arab Emirates—host of COP28. With concerted action to reduce global emissions and put the world on track to limit warming below 2 degrees Celsius (SSP1-2.6), 70,000 square kilometers of that at-risk land is projected to remain above sea level.

Climate Impcat Lab (2023) Climate change's impact on coastal flooding

8

Costs

8.1 EEA Extreme Event Attribution

- Newmann & Noy Abstract*

Extreme weather events lead to significant adverse societal costs. Extreme Event Attribution (EEA), a methodology that examines how anthropogenic greenhouse gas emissions had changed the occurrence of specific extreme weather events, allows us to quantify the climate change-induced component of these costs. We collect data from all available EEA studies, combine these with data on the socio-economic costs of these events and extrapolate for missing data to arrive at an estimate of the global costs of extreme weather attributable to climate change in the last twenty years. We find that **US$ 143 billion per year of the costs of extreme events is attributable to climatic change.** The majority (63%), of this is due to human loss of life. Our results suggest that the frequently cited estimates of the economic costs of climate change arrived at by using Integrated Assessment Models may be substantially underestimated.

- Newmann & Noy Memo*

The EEA methodology compares the probability of an event that occurred with the probability or intensity of the same event occurring in a counterfactual world without anthropogenic emissions. From a probabilistic perspective, a Fraction of Attributable Risk (FAR) metric is calculated to describe what portion of the risk of an extreme weather event occurring is the result of climate change. Methodologically, these probabilistic methods have been approached from both a frequentist or a Bayesian perspective5, with possibly important consequences for the results thus obtained. We do not distinguish between these in our work here, given the relative paucity of Bayesian attribution work. The attri- bution approach based on FAR is known as the risk-based approach6. The alternative intensity approach calculates what share of a specific aspect of the risk (e.g., rainfall) was due to climate change. For instance, the 2017 Hurricane Harvey's climate change-induced economic costs were analyzed by both risk-based7 and intensity-based8 approaches.

The economic costs associated with extreme weather events can be measured in two ways: First, these include direct economic damage, which occurs during or immediately after the event. Using flooding as an example, where the hazard is heavy precipitation, direct economic damage may include destroyed housing and roads, or lost crops. However, an extreme weather event can also cause indirect economic losses. These are declines in economic value-added because of the direct economic damage. Examples of these indirect losses are wide- ranging. For the flood example, they could include microeconomic impacts such as revenue loss for businesses when access routes are inundated by floodwater, meso-economic impacts such as temporary unemployment in the affected area, or even wider-ranging macroscale supply-chain disruptions. These indirect economic losses can often spill out beyond the affected area, and indeed even beyond the affected country/region's borders. Indirect losses may also have long time lags, making them difficult to quantify. Generally, events that cause more damage will also lead to more losses, ceteris paribus. However, this relationship between direct damage and indirect loss is nonlinear, with high-damage events causing disproportionately many more losses as well. Because of these difficulties in quantifying indirect (flow) losses over a large variety of extreme weather phenomena in a large diversity of countries/regions and economies (thereafter refer- red to as countries for ease of exposition) and affected regions, this paper only focuses on the more easily quantified stock of direct damages.

By combining the data on direct economic damages, with the attributable share of the risk, we can quantify the climate change- attributable cost of these events. This attribution-based method for calculating the costs of climate change (from extreme weather events) differs fundamentally from other approaches to climate change cost estimation. Those other approaches use macroeconomic modeling embedded within climate models in various types of Integrated Assessment Models (IAM).

Aim is to demonstrate the use-value of the methodology, rather than reach an unimpeachable set of estimates.

Most IAMs are substantially under- estimating the current economic costs of climate change.

Newmann & Noy (2023) The global costs of extreme weather that are attributable to climate change (pdf)

Carrington on Newmann & Noy

The damage caused by the climate crisis through extreme weather has cost $16m (£13m) an hour for the past 20 years, according to a new estimate. It found average costs of $140bn (£115bn) a year from 2000 to 2019, although the figure varies significantly from year to year. The latest data shows $280bn in costs in

2022. The researchers said lack of data, particularly in low-income countries, meant the figures were likely to be seriously underestimated. Additional climate costs, such as from crop yield declines and sea level rise, were also not included.

The researchers produced the estimates by combining data on how much global heating worsened extreme weather events with economic data on losses. The study also found that the number of people affected by extreme weather because of the climate crisis was 1.2 billion over two decades.

Hundreds of "attribution" studies have been done, calculating how much more frequent global heating made extreme weather events. This allows the fraction of the damages resulting from human-caused heating to be estimated.

The researchers applied these fractions to the damages recorded in the International Disaster Database, which compiles available data on all disasters in which 10 people died, or 100 were affected, or the country declared a state of emergency or requested international assistance.

The central estimate was an average climate cost of $140bn a year, with a range from $60bn to $230bn. These estimates are much higher than those from computer models, which are based on changes in average global temperature rather than on the extreme temperatures increasingly being seen in the world.

The analysis used a statistical value of a life lost of $7m, an average of the figures used by the US and UK governments.

Only considering the economic damage caused to infrastructure would heavily skew the cost estimates to rich countries, despite much of the damage from extreme weather hitting poorer ones.

This study looks at the attribution for the physical event – it's much simpler, robust, and it provides a convincing case. It is an emerging field and uncertainties are really large. One lesson of the study is that global research centres – mostly located in rich countries – need to work more on what is happening in poorer countries.

Carrington (2023) Climate crisis costing $16m an hour in extreme weather damage

8.2 Insurance

Keen

Flawed economic thinking on climate has put your pension at risk

Investment consultants to pension funds have relied upon peer-reviewed economic research to provide advice to pension funds on the damages to pensions that will be caused by global warming.

Following the advice of investment consultants, pension funds have informed their members that global warming of 2-4.3 oC will have only a minimal impact upon their portfolios.

The economics papers informing the models used by investment consultants are at odds with the scientific literature on the impact of these levels of warming.

The economics of climate change is an interdisciplinary subject, but papers on the economics of climate damages were refereed by economists alone. Properly refereeing these papers required knowledge of the science of global warming that economists typically did not have. Consequently, economic referees approved the publication of papers that made claims about global warming that are seriously at odds with the scientific literature.

These claims have been fundamental to the predictions by economists of minimal impacts on the economy from global warming.

Economists have claimed, in refereed economics papers, that 6oC of global warming will reduce future global GDP by less than 10%, compared to what GDP would have been in the complete absence of climate change.

In contrast, scientists have claimed, in refereed science papers, that 5oC of global warming implies damages that are "beyond catastrophic, including existential threats," while even 1oC of warming—which we have already passed—could trigger dangerous climate tipping points.

This results in a huge disconnect between what scientists expect from global warming, and what pensioners/investors/financial systems are prepared for.

Consequently, a wealth-damaging correction or "Minsky Moment" cannot be ruled out, and is virtually inevitable. Pension funds have a fiduciary duty to correct the erroneous predictions they have given their members.

Similarly, financial regulators, who have used the same erroneous and misleading economic damage predictions to stress test the exposure of financial institutions to climate change, must drastically revise their stress test studies.

This report calls on all stakeholders, from governments, regulators, investment professionals, all the way to civil society groups and individuals, to ensure that climate change policy is based upon the work of scientists.

Climate change must be treated as a potentially existential threat to the economy, rather than an issue which is suitably addressed by economic cost-benefit analysis.

Keen (2023) Loading the DICE against Pension Funds

Parshley

Insured losses from natural disasters in the U.S. now routinely approach $100 billion a year, compared to $4.6 billion in 2000. As a result, the average homeowner has seen their premiums spike 21 percent since 2015. Perhaps unsurprisingly, the states most likely to have disasters — like Texas and Florida — have some of the most expensive insurance rates. That means ever more people are forgoing coverage, leaving them vulnerable and driving prices even higher as the number of people paying premiums and sharing risk shrinks.

Reinsurers globally raised prices for property insurers by 37 percent in 2023, contributing to insurance companies pulling back from risky states like California and Florida.

In a worse-case scenario, this all leads to a massive stranded asset problem: Premiums get so high that property values plummet, families' investments dissipate, and banks are stuck holding what's left.

The global process for handling life's risks is breaking down, leaving those who can least afford it unprotected.

In the last decade, the frequency of global natural catastrophes jumped by 28 percent. On a single day in July, 60 percent of the U.S. population faced an extreme weather alert. Costs have catapulted too: Since 1970, losses from disasters increased an average 5 percent a year, particularly in the United States. Tragically, the fastest-growing counties also face some of the highest risks. It doesn't have to be one of these huge events. It's [also] successive events, back-to-back - like the 12 atmospheric rivers that hit California this winter.

The reinsurance industry has paid dearly for much of the last decade; underwriting losses drove $115 billion in global reinsurance losses in 2022. There's a tension over a business model that's retrospective, with a risk that's emerging. The financial foundation of insurance, in other words, is cracking.

Unlike insurers, who face political pressures from state regulators to keep rates affordable, reinsurance is much more of a free market. Reinsurers are reacting by raising their rates, limiting their coverage, and even deciding to reduce their exposure in places like Florida.

Because getting risk wrong is now so costly, there's been a race in the private sector to model future odds. This rush to fine-tune risk predictions may potentially accelerate skyrocketing premiums.

The economic implications of all this are troubling. A new report by the U.S. Treasury Department, released at the end of June, found major gaps in the supervision and regulation of insurers. The report advised much closer attention to "the risks the insurance industry may pose to the overall financial sector."

As disasters continue surging, what they call the "growing climate bubble in the housing market" will pop — leaving millions of homes uninsurable and destroying their value. If the value of their home plummets or if the credit agencies downgrade their communities we will have a lot of people trapped in places that are unsafe, economically trapped.

Insurers have played a major role in emissions for decades: Without insurance, fossil fuel companies have difficulty obtaining financing. Insurers have been slower to move away from oil and gas, in part because it's a larger part of many companies' business.

It is difficult to understand how the industry can carefully price and manage climate risk in some areas of its business while simultaneously having no apparent plan to phase out its underwriting of and investment in the projects and companies generating the emissions that are causing these very harms.

The economic and insured losses over time are a clear indicator that the past is not a representation of the future. With insurers themselves running out of insurance options, the stability of financial systems is far shakier than many realize.

Science is the easy part. Getting people to change their behavior, on the other hand, is difficult.

Parshley (2023) As climate risks mount, the insurance safety net is collapsing

8.3 Climate Change Inflation

Epp

Climate change is going to cost us, said Kenneth Gillingham, a professor of environmental and energy economics at Yale. It will create an upward force on prices in many sectors. Some will affect us over the long term, but we're already feeling them now. For example, air pollution and hotter temperatures.

We are more likely to have, say, ground-level ozone, which will lead to asthma cases and hospital admissions.

That could inflate health care costs.

Epp (2023) Climate change effects likely to include long-term inflation

9

Health

9.1 Death

Lancet

Heat-related deaths of people older than 65 years increased by 85% compared with 1990– 2000.

Lancet (2023) The 2023 report of the Lancet Countdown on health and climate change

9.2 Amazonas degradation sourcing pandemics

Romano

Home to the greatest biodiversity on the planet, the Amazon is also a ticking time bomb for the emergence or resurgence of diseases with pandemic potential. This is because environmental degradation and altered landscapes are important factors in this process, which are exacerbated during periods of extreme drought, such as the one now affecting the region.

In the Amazon in particular, the paving of the BR-319 highway, linking Porto Velho to Manaus, is a significant source of concern. Conservative estimates predict that deforestation around the road will triple in the next 25 years, mainly due to land speculation. This is made worse by the fact that 90% of the area directly affected consists of untouched forest.

And deforestation is not a static situation, but dynamic and unpredictable, resulting in the fragmentation of forests, increasing the risk of fires and reducing the biodiversity of the affected areas. The association between human action in the Amazon, climate change, disorganised migration and precarious social development creates a favourable environment for the emergence and resurgence of diseases, it has been shown. Known diseases…

This process can happen in different ways. The degradation of conserved areas and the diversion of rivers and extreme drought, can, for example, lead to water and food shortages. And this poses a direct threat of malnutrition, affecting the health of local populations and leaving them more vulnerable to known diseases.

Lack of clean water and poor hygiene in drought conditions also increase the risk of diseases transmitted by contaminated water and food, such as cholera and hepatitis, and viruses that cause severe diarrhoea, such as rotavirus. Making matters worse, the incidence of diseases associated with poor fish preservation, such as rhabdomyolysis (black urine disease) - which is not infectious - also rises during extreme droughts.

Global warming is also a critical factor in this process, allowing an increased presence of mosquitoes that transmit diseases such as malaria and dengue fever. An increase of just a few degrees in the planet's average temperature can allow them to colonise areas that were previously inaccessible. In regions where they are present, environmental degradation can increase or decrease rainfall periods, favouring flooding and the maintenance of standing water, and facilitating their proliferation.

Not surprisingly, vector-borne diseases are classic cases of outbreaks due to environmental imbalance. The recent humanitarian crisis of the Yanomami, a tragedy caused by illegal mining, land grabbing and lack of access to health services, is a case in point. In addition to the contamination of water and the environment by mercury, mining activity has created a favourable environment for the reproduction and spread of mosquito species of the genus Anopheles, the transmitter of the protozoan that causes malaria.

This is because digging ravines to extract gold and minerals creates pools of water that act as artificial breeding sites. In addition, mining activity increases the human population in these remote regions, which facilitates the spread of malaria. In numerical terms, while between 2008-2012 around 20% of malaria cases occurred in Yanomami territory, between 2018-2022 almost 50% of cases affected this population. … and new diseases

Zoonotic diseases (transmitted from animals to people) present an even greater potential problem. While some pathogens (disease-causing agents such as viruses and bacteria) are capable of infecting one or a few host species, others are more generalised and can, if there is contact and opportunity, infect a wide variety of animals.

This type of "jump" from one host to another occurs constantly among animals in their natural habitat, for example from bats to non-human primates, small rodents and other mammals. However, there is usually a balance in the circulation of these agents.

But when habitats are destroyed, for whatever reason (human or otherwise), local species migrate to more conserved areas in search of food and shelter. And this can lead them to areas close to human settlements – and facilitate contact between wild animals and people. Impossible to predict, but possible to monitor

Unfortunately, preventing zoonoses is not an easy task – is no effective method that can predict what the next emerging disease will be, or from where it will emerge.

But it is possible to keep an eye on it. To do this, we monitor the circulation of resistant viruses and bacteria in samples of water, animals and vectors, as well as humans. Animals such as bats, rodents and primates are subjected to next-generation sequencing technologies for early detection of circulating agents that could pose a threat to human health.

And yet it's not enough. To be effective, surveillance must be constant and cover local and national levels. Although Brazil has the capacity and basic technical infrastructure for this, few actions are actually implemented. In addition to surveillance, we need investments in faster and more accurate diagnostic methods that can help contain the spread of potential new diseases with pandemic potential.

Romano (2023) Amazon a time bomb for the emergence of diseases with pandemic potential – due to deforestation and climate change

10

Risk Tipping Points (RTP)

> These are different from climate system tipping points: Risk tipping points are crossed when impacts on us humans pass critical limits.
>
> We are changing the entire risk landscape and losing our tools to manage risk.

Carrington

> The risk tipping points are different from the climate tipping points the world is on the brink of, including the collapse of Amazon rainforest and the shutdown of a key Atlantic Ocean current. The climate tipping points are large-scale changes driven by human-caused global heating, while the risk tipping points are more directly connected to people's lives via complex social and ecological systems.

Humanity is moving dangerously close to irreversible tipping points that would drastically damage our ability to cope with disasters, UN researchers have warned, including the withdrawal of home insurance from flood-hit areas and the drying up of the groundwater that is vital for ensuring food supplies.

These "risk tipping points" also include the loss of the mountain glaciers that are essential for water supplies in many parts of the world and accumulating space debris knocking out satellites that provide early warnings of extreme weather.

Carrington (2023) Earth close to 'risk tipping points' that will damage our ability to deal with climate crisis, warns UN

UNU-EHS

For Mountain glaciers, the risk tipping point is called *"peak water"* — it is when a glacier produces the maximum volume of water run-off due to melting. After this point, freshwater availability will steadily decline. Peak water has already passed or is expected to occur within the next 10 years for many of the small glaciers in Central Europe, western Canada or South America. In the Andes, where peak water has already passed for many glaciers, communities are now grappling with the impacts of unreliable water sources for drinking water and irrigation.

For *Uninsurable future*, the risk tipping point is reached when increasingly severe hazards such as storms, floods or fires drive up the costs of insurance until it is no longer accessible or affordable. Once insurance is no longer offered against certain risks, in certain areas or at a reasonable price, these areas are considered "uninsurable". In Australia, for example, approximately 520,940 homes are predicted to be uninsurable by 2030, primarily due to increasing flood risk. Once this point is passed, people are left without an economic safety net when disasters strike, opening the door to cascading socioeconomic impacts in high-risk areas.

These diverse examples illustrate that risk tipping points extend beyond the single domains of climate, ecosystems, society or technology, but rather are inherently interconnected across them. They share similar root causes and drivers which are embedded in our behaviours and actions that increasingly put pressure on our systems until they change and stop supporting human lives and livelihoods. The impacts of these risk tipping points are not isolated to the places where tipping points are crossed but, through their interconnections with other systems, cascade through to other places around the world, influencing those to tip as well. For example, Unbearable heat threatens not only human lives and health, but also wildlife, which is increasing the risk of Accelerating extinctions, putting the ecosystems we depend on in peril.

More and more risk tipping points on the horizon

The six risk tipping points analysed in this report offer some key examples of the numerous risk tipping points we are approaching. If we look at the world as a whole, there are many more systems at risk that require our attention. Each system acts as a string in a safety net, keeping us from harm and supporting our societies. As the next system tips, another string is cut, increasing the overall pressure on the remaining systems to hold us up. Therefore, any attempt to reduce risk in these systems needs to acknowledge and understand these underlying interconnectivities. Actions that affect one system will likely have consequences on another, so we must avoid working in silos and instead look at the world as one connected system.

UNU-EHS (2023) Risk tipping points

11

Vegetation

Harvey on Yuan

Declining plant growth is linked to decreasing air moisture tied to global warming

The world is gradually becoming less green, scientists have found. Plant growth is declining all over the planet, and new research links the phenomenon to decreasing moisture in the air—a consequence of climate change.

The study published yesterday in Science Advances points to satellite observations that revealed expanding vegetation worldwide during much of the 1980s and 1990s. But then, about 20 years ago, the trend stopped.

Since then, more than half of the world's vegetated landscapes have been experiencing a "browning" trend, or decrease in plant growth, according to the authors.

Climate records suggest the declines are associated with a metric known as vapor pressure deficit—that's the difference between the amount of moisture the air actually holds versus the maximum amount of moisture it could be holding. A high deficit is sometimes referred to as an atmospheric drought.

Since the late 1990s, more than half of the world's vegetated landscapes have experienced a growing deficit, or drying pattern.

The declines challenge an argument often presented by skeptics of mainstream climate science to downplay the consequences of global warming: the idea that plants will grow faster with larger amounts of carbon dioxide. The argument hinges on the idea that food supplies will increase.

It's largely a red herring, as climate scientists have patiently explained for years. Rising CO2 does benefit plants, at least up to a point, but it's just one factor. Plants are also affected by many other symptoms of climate change, including rising temperatures, changing weather patterns, shifts in water availability and so on.

Harvey (2023) Earth Stopped Getting Greener 20 Years Ago

Yuan Abstract

Atmospheric vapor pressure deficit (VPD) is a critical variable in determining plant photosynthesis. Synthesis of four global climate datasets reveals a sharp increase of VPD after the late 1990s. In response, the vegetation greening trend indicated by a satellite-derived vegetation index (GIMMS3g), which was evident before the late 1990s, was subsequently stalled or reversed. Terrestrial gross primary production derived from two satellite-based models (revised EC-LUE and MODIS) exhibits persistent and widespread decreases after the late 1990s due to increased VPD, which offset the positive CO2 fertilization effect. Six Earth system models have consistently projected continuous increases of VPD throughout the current century. Our results highlight that the impacts of VPD on vegetation growth should be adequately considered to assess ecosystem responses to future climate conditions.

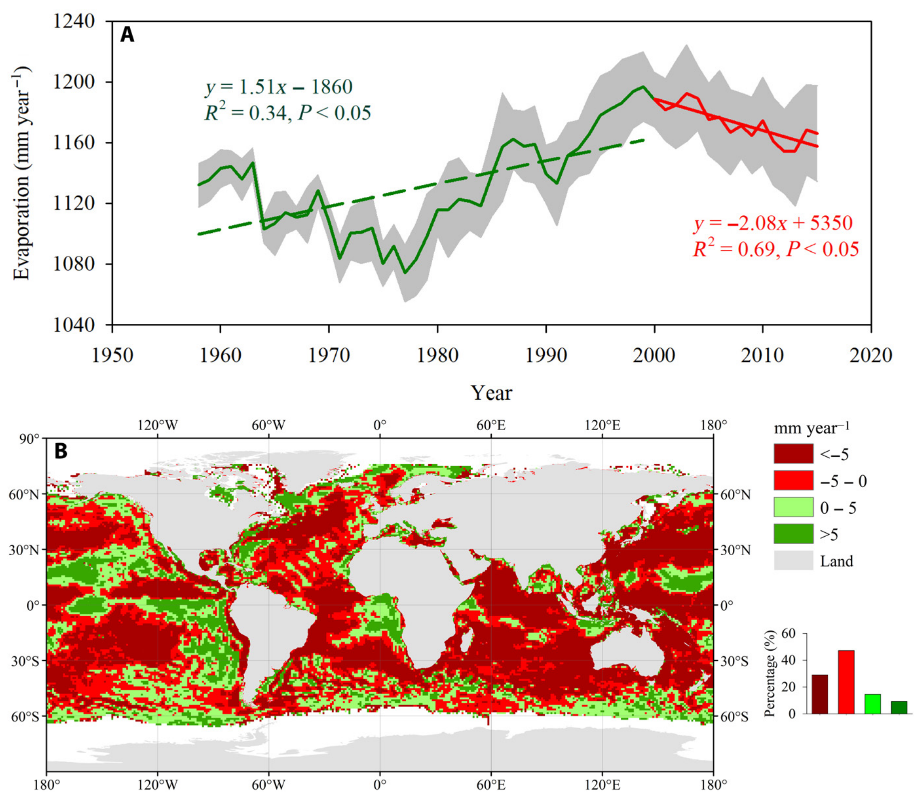


Figure: Comparison of oceanic evaporation (Eocean) trends during the two periods of 1957–1998 and 1999–2015. (A) Time series of globally averaged oceanic *evaporation. (B) Spatial pattern on differences of oceanic evaporation trends between 1999–2015 and 1957–1998. Gray shaded area in (A) indicates ±1 SD. The inset in (B) shows the frequency distributions of the corresponding differences.*

Our results support increased VPD being part of the drivers of the widespread drought-related forest mortality over the past decades, which has been observed in multiple biomes and on all vegetated continents. Increased VPD may trigger stomatal closure to avoid excess water loss due to the high evaporative demand of the air leading to a negative carbon balance that depletes carbohydrate reserves and results in tissue-level carbohydrate starvation. In addition, reduced soil water supply coupled with high evaporative demand causes xylem conduits and the rhizosphere to cavitate (become air-filled), stopping the flow of water, desiccating plant tissues, and leading to plant death. Enhanced VPD limits tree growth even before soil moisture begins to be limiting.

Most terrestrial ecosystem models cannot capture vegetation responses to VPD. Thus, problems reproducing the observed long-term vegetation responses to climate variability may challenge their ability to predict the future evolution of the carbon cycle.

The results of our analysis suggest that this projected increased VPD might have a substantially negative impact on vegetation.

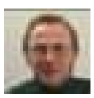
[Yuan (2023) Increased atmospheric vapor pressure deficit reduces global vegetation growth](

Part II

Appendices

Appendix A

About



Dyre Haugen and *Dyrehaugen* are Webians for *Jon Martin* - self-owned Globian, Webian, Norwegian and Canarian with a background from industrial research policy, urban planning and economic development consulting on global, regional and urban scales. I am deeply concerned about the (insane) way humanity (i.e. capitalism) interfere with nature. In an effort to gain insights in how and why this happens stuff is collected from around the web and put together in a linked set of web-sites. The sites are operated as personal notebooks. However, these days things can be easily published to the benefit of others concerned with the same issues. But be aware - this is not polished for presentation or peer-reviewed for exactness. I offer you just to have a look at my 'work-desk' as it appears in the moment. Any comment or suggestion can be mailed to dyrehaugen@pm.me Currently migrating from twitter (@dyrehaugen) to Mastodon (@dyrehaugen@mastodon.online) Thanks for visiting!

Appendix B

History

In Norwegian Allerede på 1950-tallet oppdaget en gruppe amerikanske forskere tegn på at menneskelig aktivitet kunne gjøre jorda varmere.

Prinsippene bak global oppvarming hadde da vært kjent siden slutten av 1800-tallet.

Det skulle likevel ta lang tid før temaet fikk stor oppmerksomhet her i landet.

I 1959 dukket for første gang ordet «drivhuseffekt» opp i en norsk avis. Men vi skal langt inn på 1980-tallet før den norske offentligheten fikk et forhold til det som senere blir omtalt som klimaendringer eller global oppvarming.

Klimaforskerne varslet ikke (Lars Sandved Dalen i Forskning.no)

Replikk til Dalen

Appendix C

Links

Current Dyrehaugen Sites:

- rcap - On Capitalism (loc)
- rclm - On Climate Change (loc)
- recs - On Economics (loc)
- rfin - On Finance (loc)
- rngy - On Energy (loc)
- renv - On Environment (loc)
- rsts - On Statistics (loc)
- rurb - On Urbanization (loc)
- rvar - On Varia (loc)
- rwsd - On Wisdom (loc)

Blogs:

- rde - Blog in English (loc)
- rdn - Blog in Norwegian (loc)

Discontinued:

- jdt - Collection (Jekyll) (loc)
- hdt - Collection (Hugo) (loc)

Not listed:

- (q:) dhe dhn jrw56
- (z:) rcsa rpad rstart

Appendix D

NEWS

D.1 231011 Global economic losses from extreme weather $5 trillion

Global economic losses could reach $5 trillion under a "plausible increase" in extreme weather events linked to climate change that cause crop failures and food and water shortages, insurance marketplace Lloyd's of London said on Wednesday.

Lloyd's, which carried out the research alongside the Cambridge Centre for Risk Studies, stressed that its "systemic risk scenario", which models the global economic impact of extreme weather, was hypothetical. But it said the work would improve business and policymaker understanding of their exposure to critical threats such as extreme weather.

When adjusting the estimated $5 trillion in losses over a five-year period for the probability of those extreme weather events occurring, the expected global economic losses were $711 billion, Lloyd's said.

"The global economy is becoming more complex and increasingly subject to systemic threats," said Trevor Maynard, Executive Director of Systemic Risks at the Cambridge Centre for Risk Studies.

He added that the research would "help businesses and policymakers explore the potential impacts of these scenarios".

Lloyd's modelled global economic losses of extreme weather events by estimating the impact of food and water shocks on global gross domestic product over a five-year period.

The weighted average loss across the three severities it modelled - major, severe and extreme - was $5 trillion over the five years, ranging from $3 trillion in the lowest severity scenario up to $17.6 trillion in the most extreme.

Lloyd's also modelled for events concentrated in regions - it said extreme weather events centred in Greater China would lead to the biggest losses, of $4.6 trillion.

The Caribbean region would lose 19% of its GDP over five years if the extreme weather events were concentrated there, Lloyd's estimated.

Reuters

D.2 230908 Antarctica Polar Amplification

Antarctica is likely warming at almost twice the rate of the rest of the world and faster than climate change models are predicting, with potentially far-reaching implications for global sea level rise.

Scientists analysed 78 Antarctic ice cores to recreate temperatures going back 1,000 years and found the warming across the continent was outside what could be expected from natural swings.

In West Antarctica, a region considered particularly vulnerable to warming with an ice sheet that could push up global sea levels by several metres if it collapsed, the study found warming at twice the rate suggested by climate models.

Climate scientists have long expected that polar regions would warm faster than the rest of the planet – a phenomenon known as polar amplification – and this has been seen in the Arctic.

Antarctica was warming at a rate of between 0.22C and 0.32C per decade, compared to 0.18C per decade predicted by climate models.

Part of the warming in Antarctica is likely being masked by a change in a pattern of winds – also thought to be linked to global heating and the loss of ozone over the continent – that has tended to reduce temperatures.

Guardian (2023) Antarctica warming much faster than models predicted in 'deeply concerning' sign for sea levels

D.3 230116 No US Green Monetary Policy - but EU?

Jay Powell has said the Federal Reserve will not become a "climate policymaker", as he mounted a full-throated defence of the US central bank's independence from political influence.

In a speech delivered on Tuesday, the Fed chair said the central bank must steer clear of issues outside its congressionally mandated purview and instead maintain a narrow focus on keeping consumer prices stable, fostering a healthy labour market and ensuring the safety of the country's banking system.

"It is essential that we stick to our statutory goals and authorities, and that we resist the temptation to broaden our scope to address other important social issues of the day," he said at a conference hosted by Sweden's central bank. "Without explicit congressional legislation, it would be inappropriate for us to use our monetary policy or supervisory tools to promote a greener economy or to achieve other climate-based goals." He added: "We are not, and will not be, a 'climate policymaker'."

At the same event, Isabel Schnabel, a member of the six-person executive board of the European Central Bank, advocated greater action to address climate change.

The German economist pledged to "ensure that all of the ECB's policies are aligned with the objectives of the Paris Agreement to limit global warming to well below 2C". The ECB's position is clear. It worries that high interest rates to control inflation will undermine the green transition by raising the cost of investing in wind, solar, hydrogen and other clean energies necessary for moving to a net zero carbon world.

But ECB and Fed are aligned on two important issues:

First, that the primary role of green intervention lies not with independent central banks but with governments. Powell said that "in a well-functioning democracy, important public policy decisions should be made, in almost all cases, by the elected branches of government". Schnabel concurred, saying, "governments must remain in the lead in accelerating the green transition".

Second, they agree central banks have a role when supervising the banking system in ensuring commercial banks understand and manage financial risks from global warming. These include weather-related risks to infrastructure that banks have financed or fossil fuel assets that might become near-worthless in future.

ESG on a Sunday

D.4 211104 Global CO2 emissions have been flat for a decade, new data reveals

Global carbon dioxide (CO2) emissions from fossil fuels and cement have rebounded by 4.9% this year, new estimates suggest, following a Covid-related dip of 5.4% in 2020.

The Global Carbon Project (GCP) projects that fossil emissions in 2021 will reach 36.4bn tonnes of CO2 (GtCO2), only 0.8% below their pre-pandemic high of 36.7GtCO2 in 2019.

The researchers say they "were expecting some sort of rebound in 2021" as the global economy bounced back from Covid-19, but that it was "bigger than expected”.

While fossil emissions are expected to return to near-record levels, the study also reassesses historical emissions from land-use change, revealing that global CO2 output overall may have been effectively flat over the past decade.

The 2021 GCP almost halves the estimate of net emissions from land-use change over the past two years – and by an average of 25% over the past decade.

These changes come from an update to underlying land-use datasets that lower estimates of cropland expansion, particularly in tropical regions. Emissions from land-use change in the new GCP dataset have been decreasing by around 4% per year over the past decade, compared to an increase of 1.8% per year in the prior version.

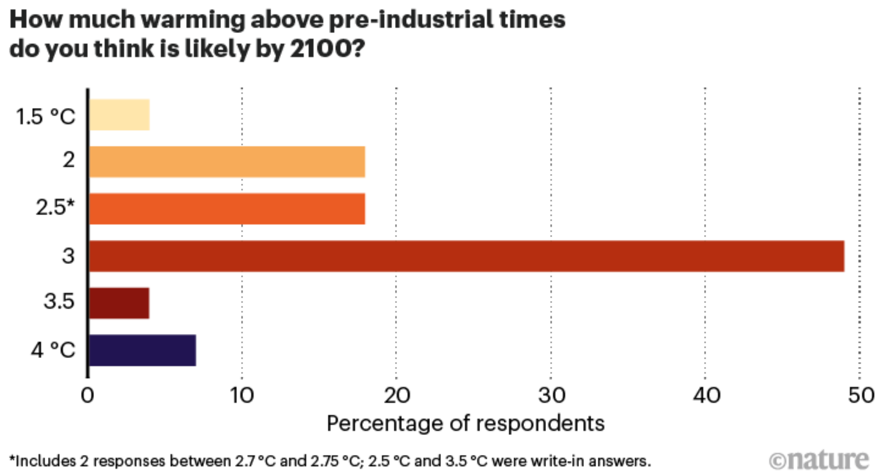
However, the GCP authors caution that uncertainties in land-use change emissions remain large and “this trend remains to be confirmed”.

CarbonBrief

D.5 211104 Top climate scientists are sceptical that nations will rein in global warming

Nature conducted an anonymous survey of the 233 living IPCC authors last month and received responses from 92 scientists — about 40% of the group. Their answers suggest strong scepticism that governments will markedly slow the pace of global warming, despite political promises made by international leaders as part of the 2015 Paris climate agreement.

Six in ten of the respondents said that they expect the world to warm by at least 3 °C by the end of the century, compared with what conditions were like before the Industrial Revolution. That is far beyond the Paris agreement’s goal to limit warming to 1.5–2 °C.



Most of the survey's respondents — 88% — said they think global warming constitutes a 'crisis', and nearly as many said they expect to see catastrophic impacts of climate change in their lifetimes.

Nature

D.6 210921 Microsoft CO2-removal

In January this year, Microsoft made a major announcement: it had paid for the removal of 1.3 million tonnes of carbon dioxide from the atmosphere. Among its purchases were projects to expand forests in Peru, Nicaragua and the United States, as well as initiatives to regenerate soil across US farms. Microsoft will pay the Swiss firm Climeworks to operate a machine in Iceland that pulls CO2 from the air and injects it into the ground, where it mineralizes and turns to stone. The amount of CO2 to be removed is equivalent to about 11% of the annual emissions from Microsoft's value chain; of this, the company will count less than half as being certified to officially compensate for its emissions. It is the largest corporate procurement of carbon removal so far.

Microsoft did this as part of its 2020 commitment to slash its greenhouse-gas emissions to 'net zero' — as one of more than 120 nations and 1,500 companies to set such goals1. By 2030, the company will reduce its emissions by half or more, and will have 100% of its electricity consumption matched by zero-carbon energy purchases. It will electrify its vehicle fleet, stop using diesel for backup energy and reduce emissions across its value chain. Emissions that are harder to abate, including historical emissions, will be compensated for by withdrawing carbon from the atmosphere. The firm is levying an internal carbon tax across all types of greenhouse-gas emission. It has set up a US$1-billion fund to invest in carbon reduction and removal technologies, and partnerships to provide social and environmental benefits. The aim is that, by 2030, the company will be carbon negative. By 2050, it will have removed all of its emissions since it was founded in 1975.

Here we summarize the lessons learnt from Microsoft's carbon-removal efforts, along with those from another early corporate procurement — the $9-million purchases of carbon removal in 2020 and 2021 by the US–Irish financial-infrastructure company Stripe. Although these are just two companies' efforts, they are the first significant open solicitations focused exclusively on carbon removal. We write as a team composed of Microsoft staff working on the company's carbon-negative programme and research scientists who analyse carbon reduction and removal strategies.

We highlight three 'bugs' in the current system: inconsistent definitions of net zero, poor measurement and accounting of carbon, and an immature market in CO2 removal and offsets. These challenges need to be overcome if the world is to reach net zero by mid-century.

Nature

D.7 210909 ORCA turned on - Iceland

The world's largest plant designed to suck carbon dioxide out of the air and turn it into rock has started running, the companies behind the project said on Wednesday.

The plant, named Orca after the Icelandic word "orka" meaning "energy", consists of four units, each made up of two metal boxes that look like shipping containers.

Constructed by Switzerland's Climeworks and Iceland's Carbfix, when operating at capacity the plant will draw 4,000 tonnes of carbon dioxide out of the air every year, according to the companies. The climate crisis requires a new culture and politics, not just new tech Peter Sutoris Read more

According to the US Environmental Protection Agency, that equates to the emissions from about 870 cars. The plant cost between US$10 and 15m to build, Bloomberg reported.

To collect the carbon dioxide, the plant uses fans to draw air into a collector, which has a filter material inside.

Once the filter material is filled with CO2, the collector is closed and the temperature is raised to release the CO2 from the material, after which the highly concentrated gas can be collected.

The CO2 is then mixed with the water before being injected at a depth of 1,000 metres into the nearby basalt rock where it is mineralised.

Guardian

D.8 210715 Arctic Sea Ice at Record Low

ARCTIC SEA ICE AT RECORD LOW for this time of year. This is an enormous source of amplifying feedback. Losing the remaining Arctic sea ice and its reflection of solar energy back to space would be equivalent to another one trillion tons of CO2.

Peter Carter (twitter)

D.9 210526 Dutch Court against Shell

This is a real ruling: it includes Scope 3 emissions.

Rechtspraak

De rechtbank Den Haag beveelt Royal Dutch Shell (RDS) om via het concernbeleid van de Shell-groep de CO2-uitstoot eind 2030 terug te brengen tot netto 45% ten opzichte van het niveau van 2019.

Rechtsspraak (Dutch) English Translation

D.10 210509 NDCs need 80% increase to 2°C

On current trends, the probability of staying below 2 °C of warming is only 5%

Liu (2021) Nature (pdf)

D.11 210508 Young Legal Action

The young people taking their countries to court over climate inaction

Children and young adults around the world are demanding action from governments on global heating and the ecological crisis,

Guardian

D.12 210424 Earth's Axis tilted by Melting Glaciers

Since the 1990s, the loss of hundreds of billions of tonnes of ice a year into the oceans resulting from the climate crisis has caused the poles to move in new directions.

The direction of polar drift shifted from southward to eastward in 1995 and that the average speed of drift from 1995 to 2020 was 17 times faster than from 1981 to 1995.

Since 1980, the position of the poles has moved about 4 metres in distance.

The accelerated decline [in water stored on land] resulting from glacial ice melting is the main driver of the rapid polar drift after the 1990s.

Guardian

D.13 210410 CO2 and Methane surged in 2020

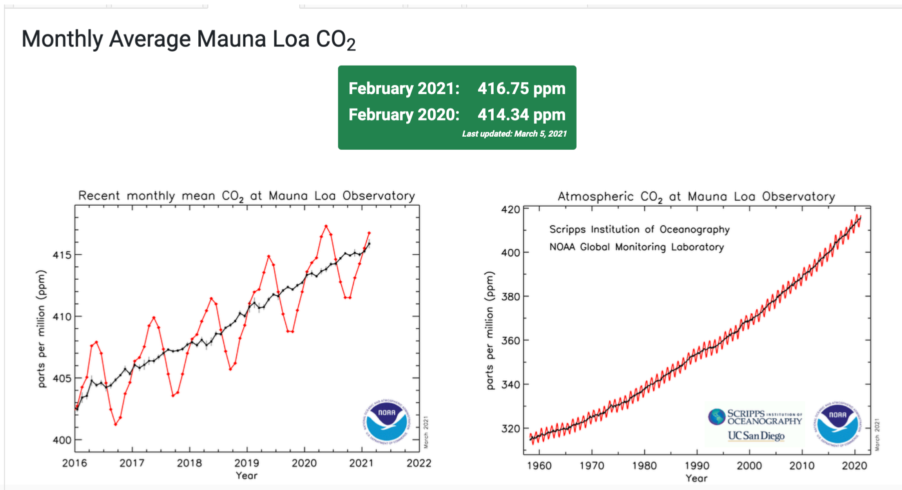
Levels of the two most important anthropogenic greenhouse gases, carbon dioxide and methane, continued their unrelenting rise in 2020 despite the economic slowdown caused by the coronavirus pandemic response.

CO2

The global surface average for carbon dioxide (CO2), calculated from measurements collected at NOAA's remote sampling locations, was 412.5 parts per million (ppm) in 2020, rising by 2.6 ppm during the year. The global rate of increase was the fifth-highest in NOAA's 63-year record, following 1987, 1998, 2015 and 2016. The annual mean at NOAA's Mauna Loa Observatory in Hawaii was 414.4 ppm during 2020.

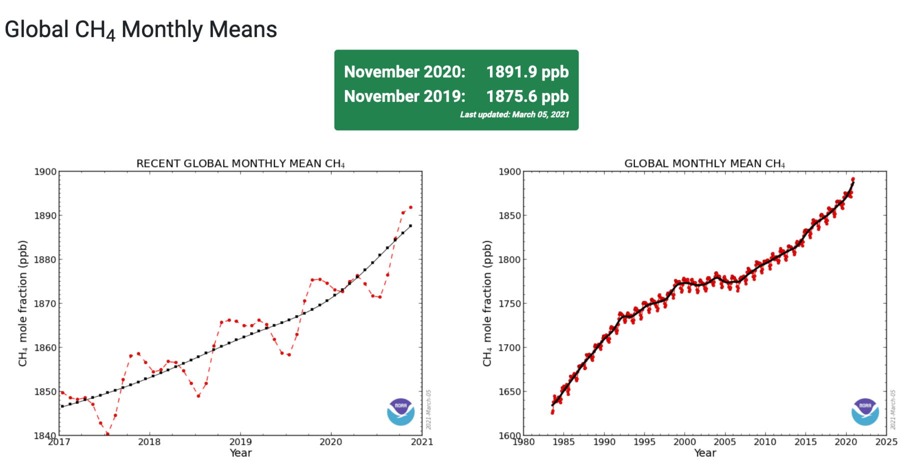
The economic recession was estimated to have reduced carbon emissions by about 7 percent during 2020. Without the economic slowdown, the 2020 increase would have been the highest on record, according to Pieter Tans, senior scientist at NOAA's Global Monitoring Laboratory. Since 2000, the global CO2 average has grown by 43.5 ppm, an increase of 12 percent.

The atmospheric burden of CO2 is now comparable to where it was during the Mid-Pliocene Warm Period around 3.6 million years ago, when concentrations of carbon dioxide ranged from about 380 to 450 parts per million. During that time sea level was about 78 feet higher than today, the average temperature was 7 degrees Fahrenheit higher than in pre-industrial times, and studies indicate large forests occupied areas of the Arctic that are now tundra.



Methane

Analysis of samples from 2020 also showed a significant jump in the atmospheric burden of methane, which is far less abundant but 28 times more potent than CO2 at trapping heat over a 100-year time frame. NOAA's preliminary analysis showed the annual increase in atmospheric methane for 2020 was 14.7 parts per billion (ppb), which is the largest annual increase recorded since systematic measurements began in 1983. The global average burden of methane for December 2020, the last month for which data has been analyzed, was 1892.3 ppb. That would represent an increase of about 119 ppb, or 6 percent, since 2000.



NOAA

D.14 210404 Gas Sustainability

**Scientifically Sustainable*

The European Commission is attempting to finish its sustainable finance taxonomy, a landmark regulation that from next year will define what can be labelled as a sustainable investment in the EU.

A leaked proposal for the rules, shared with EU states last week, would label as sustainable some gas plants that generate power and also provide heating or cooling. That came after the Commission's original proposal – which denied natural gas-fuelled power plants a green label, following the recommendation of the bloc's expert advisers – faced resistance from some EU countries.

Nine members of the expert group advising the European Union on its sustainable finance rules have threatened to step down if Brussels pushes ahead with plans that they say would discredit its efforts to fight climate change.

EU countries disagree on what role natural gas should play in meeting climate goals. Gas emits roughly half the CO2 of coal when burned in power plants, but gas infrastructure is associated with leaks of methane, a potent greenhouse gas.

"The concept of what is scientifically sustainable, that's really not for politicians to decide," said Andreas Hoepner, a professor at University College Dublin who signed the letter.

Reuters

D.15 210220 US SCC Update in Progress

In its 2013 revision of the SCC, the Obama IWG arrived at a central value of around US$50 per tonne of CO2 emitted in 2020 (all values expressed in today's dollars). It also established a range for the SCC ($15–75) and presented an estimate at the 95th percentile ($150). The time is ripe for this update,

That IWG did a careful job, but devastating storms and wildfires are now more common, and costs are mounting. Advances in attribution science mean that researchers can now link many more extreme weather events directly to climate change, and new econometric techniques help to quantify the dollar impacts. The monetary losses exceed the predictions of early models. The same goes for sea-level rise and many other types of damage.

Plenty of scientific and economic judgements need to be made. These include how to deal with endemic uncertainties, including sudden and irreversible 'tipping points', such as ice-sheet collapses. Ethical questions must be considered, including the consequences for vulnerable communities and future generations.

Revising the SCC will take extensive research. A 2017 study by the US National Academies of Sciences, Engineering, and Medicine proposed building a new climate-economy model based on modules — separate components that handle climate change, socio-economic projections, damages, valuation and discounting

Other nations use widely different SCC values or overall approaches2. Germany's 2020 guidance presented two values: €195 (US$235) and €680 ($820). Some countries instead establish a goal for emissions reductions (such as the United Kingdom's 68% reduction by 2030 compared to 1990 levels) and then focus on minimizing the costs of achieving it, estimated at $20–100 per tonne of CO2. This is called a target-consistent approach.

Wagner (Nature)

D.16 210215 Focus on Steel, Meat and Cement

Bill Gates has written about Climate Change.

His assessment is that there is not the time, money or political will to reconfigure the energy sector in 10 years, and encouraging an impossible goal dooms the world to short-term measures that prove insufficient.

Crucially, people need to radically change how they produce the worst climate offenders: steel, meat and cement. Making steel and cement accounts for roughly 10% of all global emissions, and beef alone 4%.

Bill Gates

D.17 210127 10 New Insights in Climate Science 2020

Someof which are:

Earth's temperature response to doubling the levels of carbon dioxide in the atmosphere is now better understood. While previous IPCC assessments have used an estimated range of 1.5–4.5°C, recent research now suggests a narrower range of 2.3–4.5°C.

Emissions of greenhouse gases from permafrost will be larger than earlier projections because of abrupt thaw processes, which are not yet included in global climate models.

Global plant biomass uptake of carbon due to CO 2 fertilization may be limited in the future by nitrogen and phosphorus.

Rights-based litigation is emerging as a tool to address climate change.

Moving forward, the latest research calls for innovative, imaginative, and transformative approaches to building sustainable and resilient human societies. For instance, by strengthening global cooperative frameworks and building new governance arrangements that can include bottom-up community initiatives. In the short term, we have a one-off opportunity to get on the right path by directing post-pandemic recovery spending to green investments. If the focus is instead on economic growth, with sustainability as an afterthought, it would jeopardize our ability to deliver on the Paris Agreement. Alarmingly, governments do not yet seem to be seizing the opportunity to shift towards low-carbon, healthier, and more resilient societies.

futureearth (pdf)

D.18 210130 Adaptation Summit

Climate change adaptation seems to be a fairly new concept to many leaders. It were sometimes mix-ups with mitigation during the high-level talks. Mitigation and adaptation are both important and sometimes they overlap, so mix-ups are understandable. Climate adaptation involves many communities and disciplines (e.g. weather forecasting, climate services, regional climate modelling, “distillation“, disaster risk reduction).

Financing is clearly needed for climate change adaptation. To ensure progress and avoid lofty visions without results on the ground, there may also be a need for tangible results and to show examples and demonstrations. One specific type discussed at the summit was “Early warning systems” which play an important role.

But early warning systems, the way I understand them, don’t provide information about climate risks on longer timescales. Weather and climate – short and long timescales – are of course connected but nevertheless different

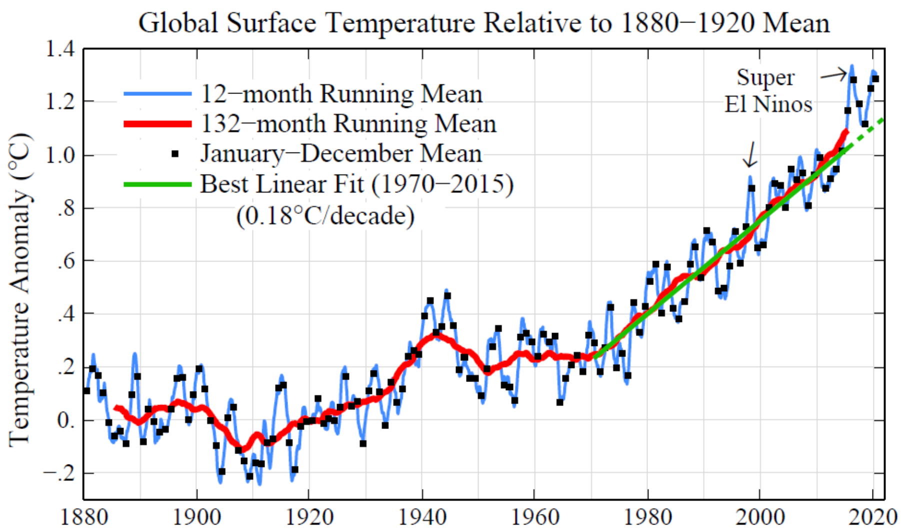
Rasmus (2021) Adaptation Summit

D.19 210118 Warming all anthropogenic

Parties to the Paris Agreement agreed to holding global average temperature increases “well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels”. Monitoring the contributions of human-induced climate forcings to warming so far is key to understanding progress towards these goals. Here we use climate model simulations from the Detection and Attribution Model Intercomparison Project, as well as regularized optimal fingerprinting, to show that *anthropogenic forcings caused 0.9 to 1.3 °C of warming in global mean near-surface air temperature in 2010–2019 relative to 1850–1900, compared with an observed warming of 1.1 °C.* Greenhouse gases and aerosols contributed changes of 1.2 to 1.9 °C and −0.7 to −0.1 °C, respectively, and *natural forcings contributed negligibly.* These results demonstrate the substantial human influence on climate so far and the urgency of action needed to meet the Paris Agreement goals.

Nature (paywall)

D.20 21014 Globale Temperature 1880-2020



The rate of global warming has accelerated in the past several years. The 2020 global temperature was +1.3°C (~2.3°F) warmer than in the 1880-1920 base period; global temperature in that base period is a reasonable estimate of 'pre-industrial' temperature. The six warmest years in the GISS record all occur in the past six years, and the 10 warmest years are all in the 21st century. Growth rates of the greenhouse gases driving global warming are increasing, not declining.

[GISSTEMP 2020 Update] (https://mailchi.mp/caa/global-temperature-in-2020?e=96d59a909f)

D.21 210104 Not so long lag?

> Until recently, Mann explained in The Guardian, scientists believed the climate system—a catch-all term for the interaction among the Earth's atmosphere, oceans, and other parts of the biosphere—carried a long lag effect. This lag effect was mainly a function of carbon dioxide remaining in the atmosphere and trapping heat for many decades after being emitted. So, even if humanity halted all CO2 emissions overnight, average global temperatures would continue to rise for 25 to 30 years, while also driving more intense heat waves, droughts, and other climate impacts. Halting emissions

> will take at least twenty years, under the best of circumstances, and so humanity was likely locked in to at least 50 more years of rising temperatures and impacts.
>
> Research over the past ten years, however, has revised this vision of the climate system. Scientists used to "treat carbon dioxide in the atmosphere as if it was a simple control knob that you turn up" and temperatures climb accordingly, "but in the real world we now know that's not what happens," Mann said. Instead, if humans "stop emitting carbon right now … the oceans start to take up carbon more rapidly." The actual lag effect between halting CO2 emissions and halting temperature rise, then, is not 25 to 30 years but, per Mann, "more like three to five years." (October 2020)

Guardian article

Covering Climate Now article

D.22 210102 Climate Finance Shadow Report 2020

Oxfam has released this report with subtitle *Asessing progress towards the $100 billion commitment* Progress is NOT in line with need or pledges.

> Climate change could undo decades of progress in development and dramatically increase global inequalities. There is an urgent need for climate finance to help countries cope and adapt. Over a decade ago, developed countries committed to mobilize $100bn per year by 2020 to support developing countries to adapt and reduce their emissions. The goal is a critical part of the Paris Agreement. As 2020 draws to a close, Oxfam's Climate Finance Shadow Report 2020 offers an assessment of progress towards the $100bn goal.
>
> Based on 2017–18 reported numbers, developed countries are likely to claim they are on track to meet the $100bn goal. And on their own terms, they may be. But how the goal is met is as important as whether it is met. The dubious veracity of reported numbers, the extent to which climate finance is increasing developing country indebtedness, and the enduring gap in support for adaptation, LDCs and SIDS, are grave concerns. Meeting the $100bn goal on these terms would be cause for concern, not celebration.

Oxfam Report (pdf)

Appendix E

Sitelog

Latest Additions