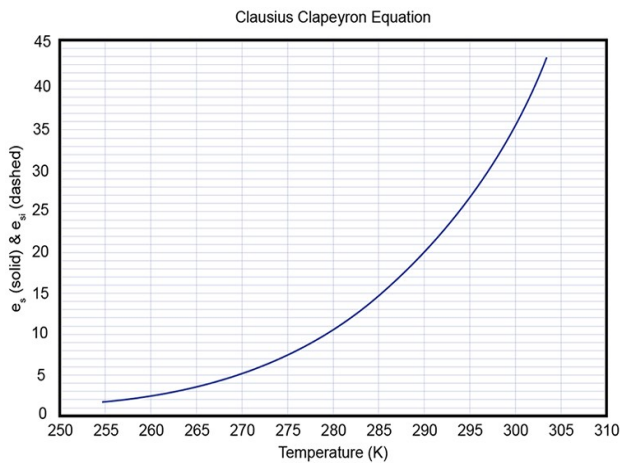


Climate Science and Policy for Nonscientists

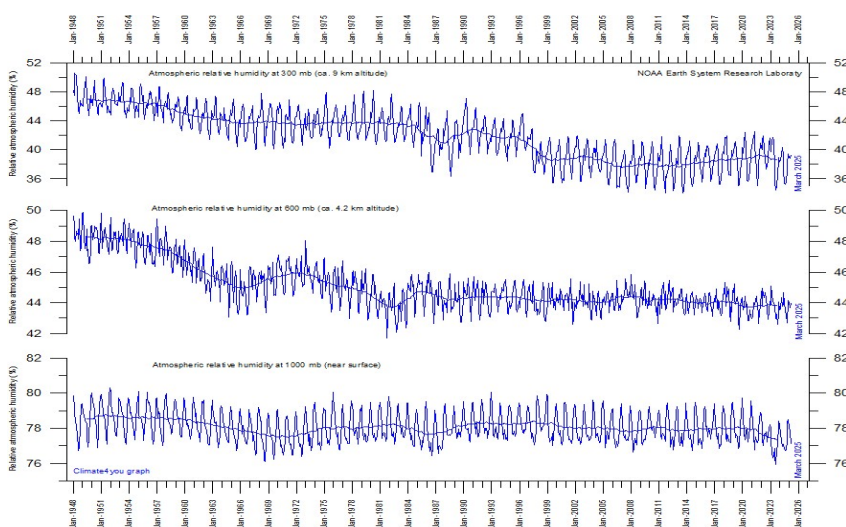
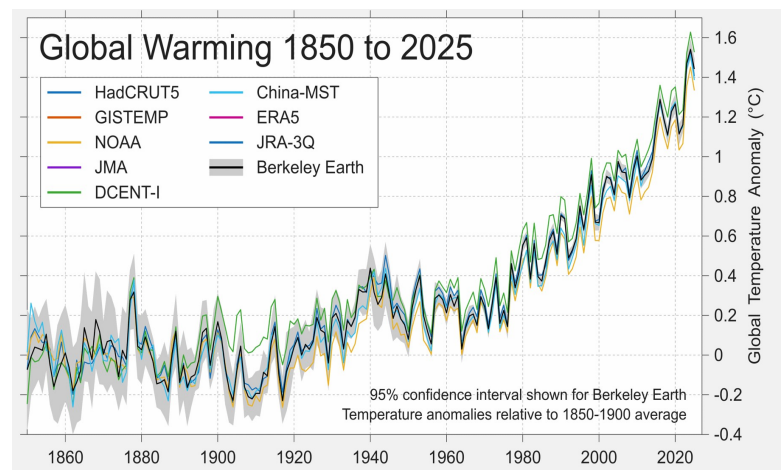
One Picture is Worth a Thousand Words.



The world has warmed over the last century and a half. The IPCC found the amount of warming to have been, as a best estimate, 1.07°C from the pre-industrial period (1850-1900) to 2010-2020. (AR6 p.5). In a warmer world more water should evaporate into the air, and hence precipitation should be expected to increase. The IPCC concludes on a theoretical basis that precipitation will increase around 1-3% per 1°C of warming. (AR6 ps.615, 1057).

RAIN, DROUGHT, SNOW, FLOODS

Rain, drought, snow, and floods are all related. Drought is the prolonged absence of rain. Snow is frozen rain. Heavy rain or rapid snow melt may cause floods. It is generally agreed that, if air temperature in the laboratory is raised by 1°C, then the maximum amount of water that can be carried in the air as vapor increases by 7%. (IPCC AR6 p.1057). Present world average temperature is 15°C or 287K, which falls roughly in the middle of the curve shown.



According to this theory, relative humidity will remain the same. But actual measurements of relative humidity show that, in the actual atmosphere, relative humidity has been declining, and more so at higher altitudes (the two upper lines in the graph).

Actual world rainfall has not increased as much as expected. The data 1901-2021 shows only a “very weak” upward trend with significant year-to-year variability.

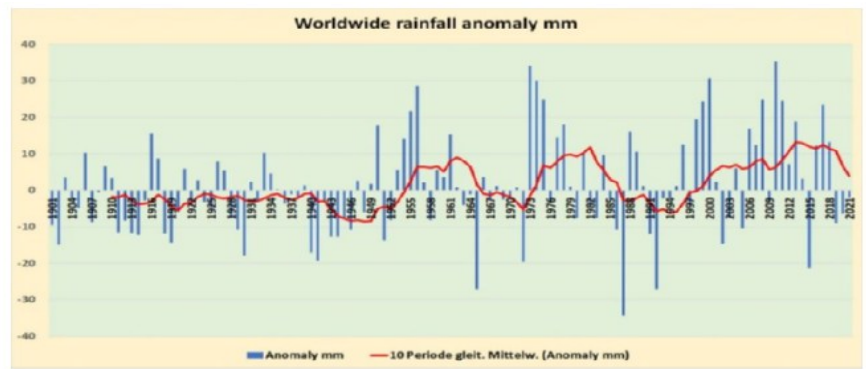


Fig. 6. The worldwide rainfall anomaly from 1901 to 2021 shows only a very weak upward trend of about 1 mm per year. Data: EPA 14) (Note that this graph shows only anomalies, not the full quantities as would be preferable. Given that the source

7. Global precipitation

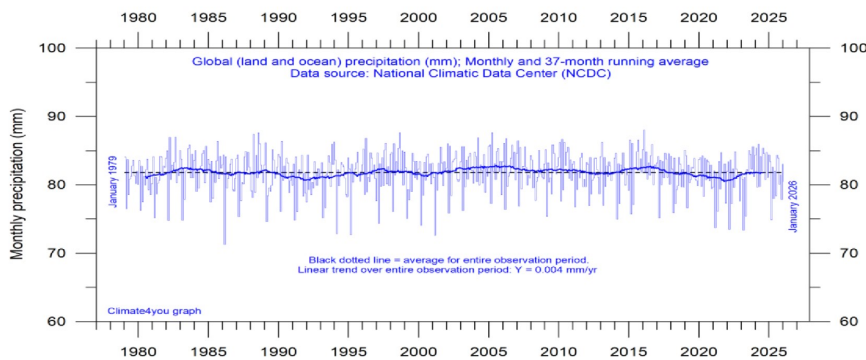
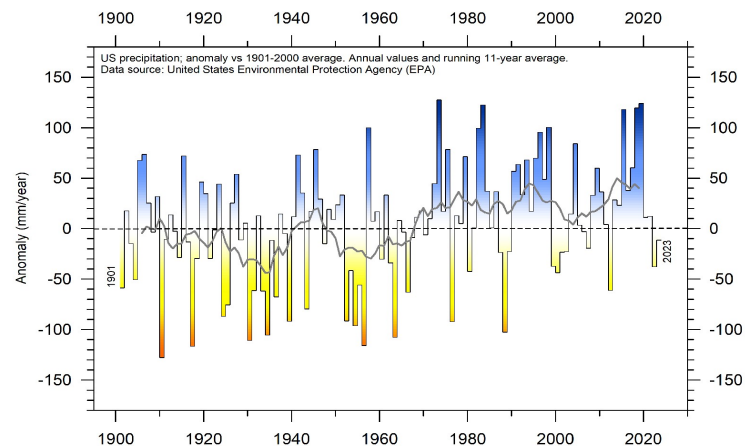


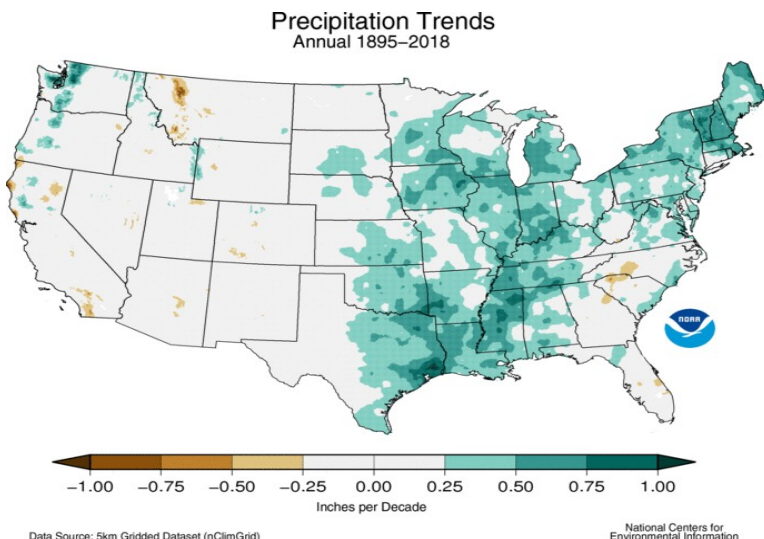
Figure 9: Global precipitation 1979 - 2026.

World precipitation 1979-2026 shows virtually no trend and less year-to-year variability.

Particularly since around 1930, the US shows more of an upward trend. It also shows significant year-to-year variability. The IPCC has acknowledged that natural variability is a “major” source of uncertainty for scientists trying to understand and predict water cycles. (AR6 p.1059).

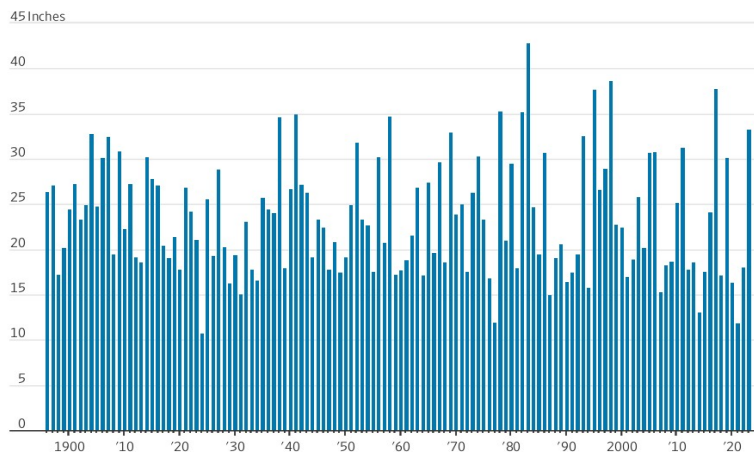


But the data for the US as a whole conceals an important regional difference. Virtually all of the increase has been in the Eastern half of the US. The IPCC acknowledges “substantial” regional differences in precipitation. (AR6 p.10).



Natural cycles can drive dramatic differences in yearly precipitation in particular places. For example, the El Nino/La Nina cycle causes California to flip flop from years of heavy precipitation to years of drought, which greatly aggravates the wildfire problem in the state. And the same cycle dramatically changes precipitation from Australia to India, where in the past El Ninos have caused droughts that caused famines killing millions.

California Annual Precipitation, 1895-2023



Source: State of California

FAQ 8.3: Climate change and droughts

In some regions, drought is expected to increase under future warming.

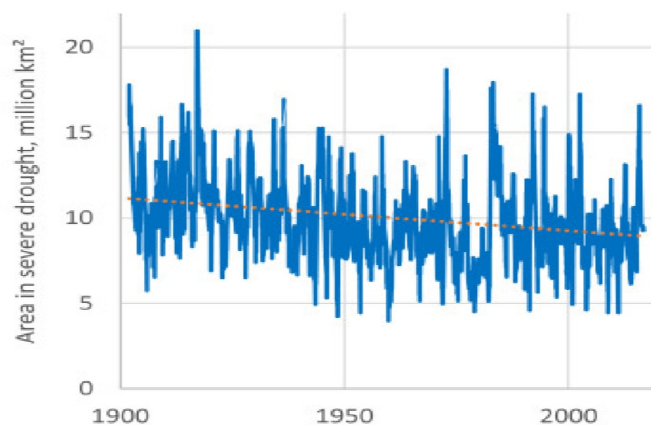


FAQ 8.3, Figure 1 | Schematic map highlighting in brown the regions where droughts are expected to become worse as a result of climate change. This pattern is similar regardless of the emissions scenario; however, the magnitude of change increases under higher emissions.

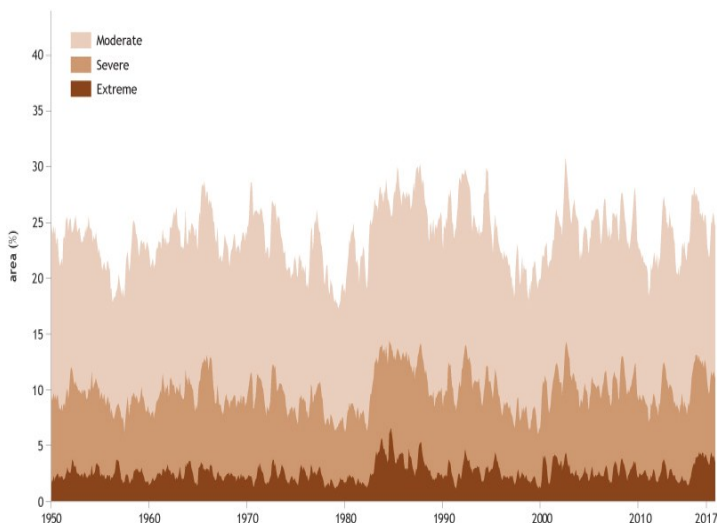
DROUGHT

The IPCC predicts that a warmer climate will intensify both very wet and very dry weather in particular regions. (AR6 ps.19, 24). The IPCC has noted heavy precipitation increases in 19 of 45 regions and drought increases in 12 of the 45. (AR6 p.10). The map shows the areas where the IPCC predicts drought will increase. (AR6 p.1158)

Lomborg reports that actually the area of the world under severe drought as measured by the gold-standard Standardized Precipitation Index (SPI) has been declining over the past century, as shown in this chart:

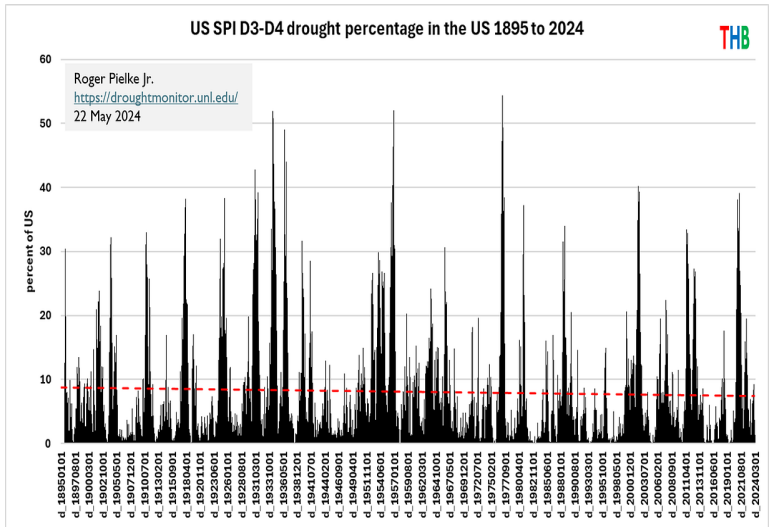


The Standardized Precipitation Index shows that world severe drought declined from 1900 to 2022.

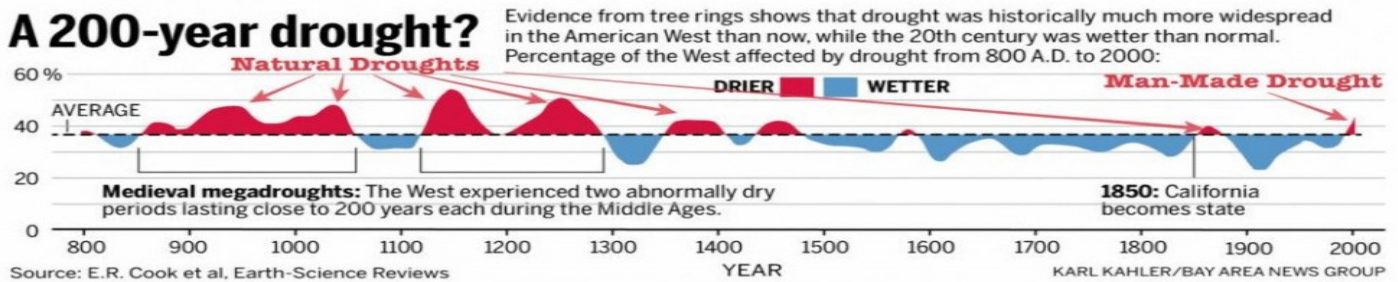


The US NOAA dataset on worldwide mild, severe, and extreme drought from 1950 to 2018 shows no significant trend. Curiously, it shows that all three types of drought kicked up noticeably about 1983 and have slightly declined since then.

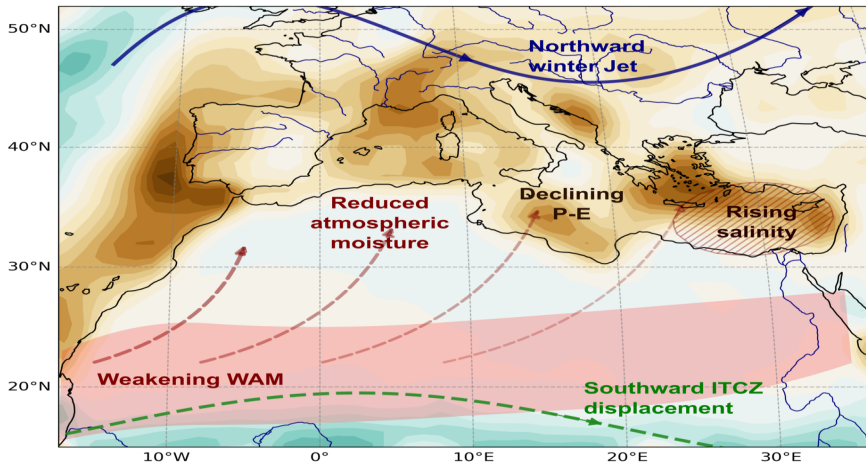
This data set shows no upward trend in extreme drought for the US from 1895-2024 and also shows very high year-to-year variability.



A 200-year drought?



The US Southwest is presently experiencing a significant drought and has a history of extreme droughts, caused by natural variability, going back over a thousand years.

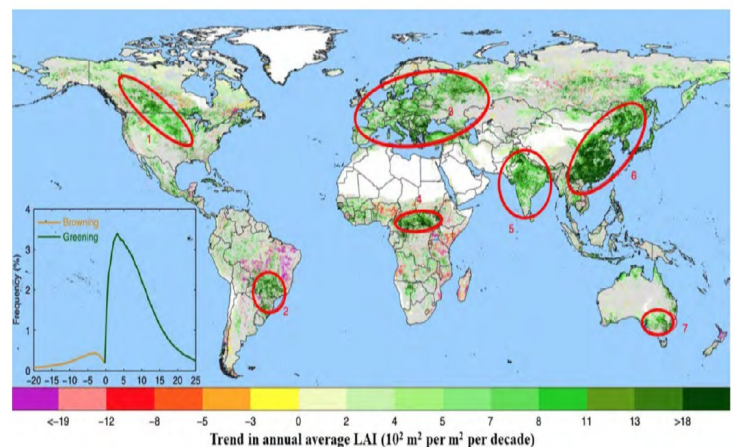


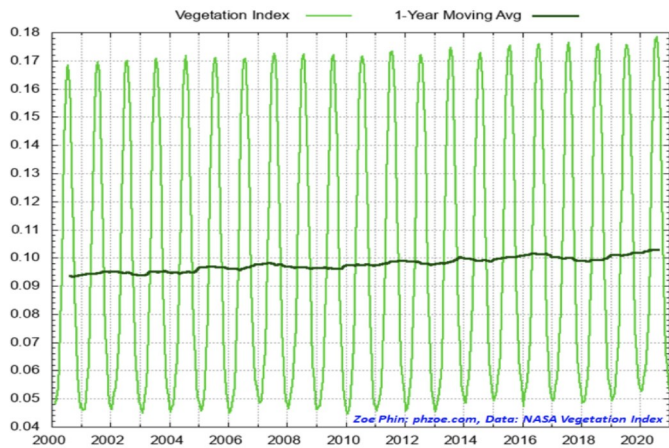
Historians are identifying megadroughts that have caused societal collapses in the past. For example, a recent study proposes that such a drought at the end of the Bronze Age (about 1200 BC) caused the collapse of the Mycenaean, the Minoan, and the Hittite Empires. This megadrought is believed to have been caused by the coincidence of three natural climate cycles, each operating over different time scales.

Figure 20: Trend in annual average leaf area

The Wet/Dry Balance

Studies of recent changes in world plant growth provide insight into the ratio of land benefitting (greening) and land suffering (browning) from climate change. The weight of the evidence shows that the world is greening. (See CliSciPol Science Topic: Greening World). This graph came from a particular study, which concluded that 55% of the world land area was greening and only 7% was browning.



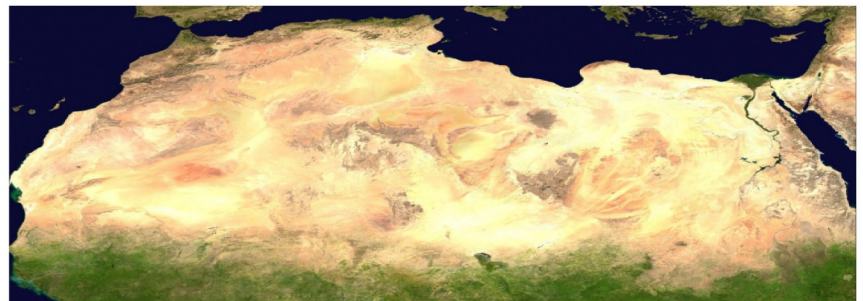


NASA's Vegetation Index has risen from 0.0936 to 0.1029, which is a 9.94% increase. Chart by [Zoe Phin](#)

NASA's world greening index increased over 9% from 2000 to 2020.

A study of the Sahara has found that its entire Southern edge is greening, and that the desert area shrank by 8% over the 30 years of the study from 1990 to 2020

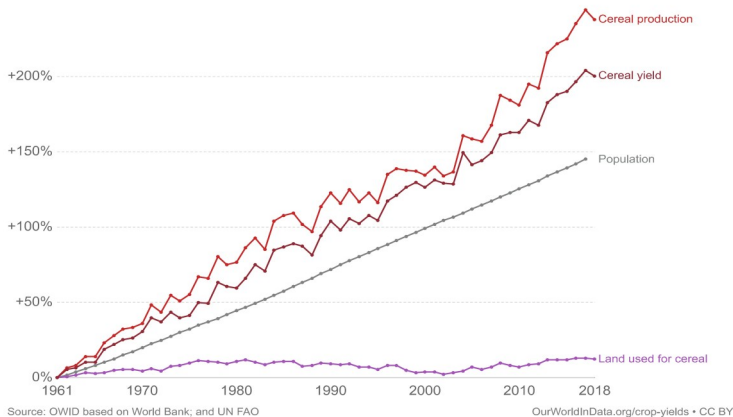
Using satellite images, Venter et al. 2018 found an eight percent increase in woody vegetation in sub-Saharan Africa over the last three decades, underscoring the global "greening trend".



Recent study by Venter et al finds that the Sahara has shrunk by 8% over the past three decades. NASA image, public domain.

Change in cereal production, yield and land use, World

Population and cereal production, yield and land use figures are indexed to the year 1961 (i.e. 1961 = 0).

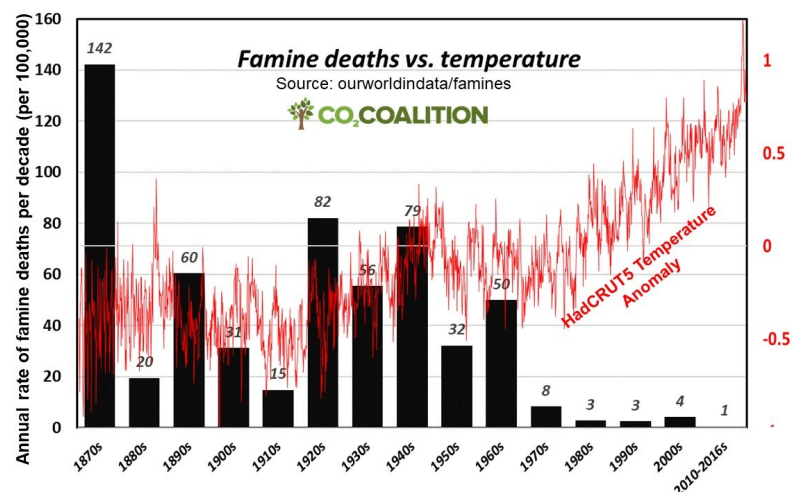


Source: OWID based on World Bank; and UN FAO

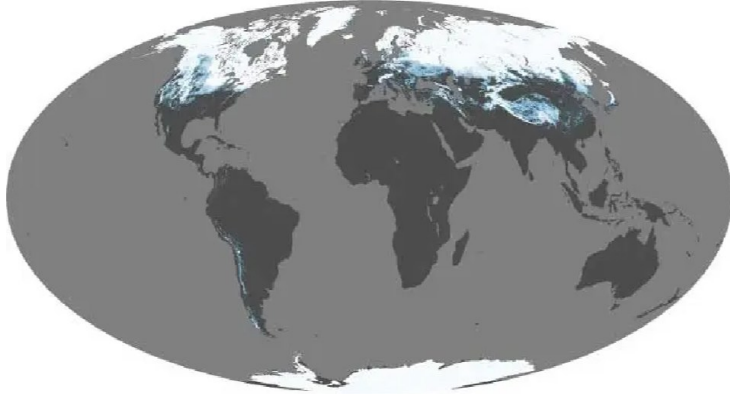
OurWorldInData.org/crop-yields • CC BY

The favorable changes in the world climate have allowed food production to grow at a faster rate than the rapid rate of population growth. Rising temperatures extend the length of the growing season. CO₂ acts both as plant food and plant fertilizer. The present atmospheric CO₂ level is about 425 ppm. The optimal level for plant growth is believed to be between 1,000 and 1,500 ppm, which is the level at which many greenhouses operate to realize the resulting extra growth.

Since the Great Famine in India-Pakistan 1876-1878, when over seven million died, there has been extraordinary progress made in reducing famine deaths at the same time that world temperatures have been rising.



Snow cover map per NASA MODIS

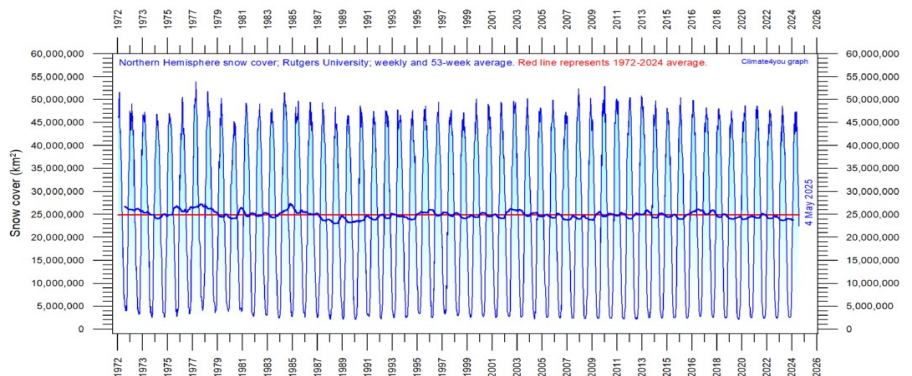


Animation @ https://earthobservatory.nasa.gov/global-maps/MOD10C1_M_SNOW

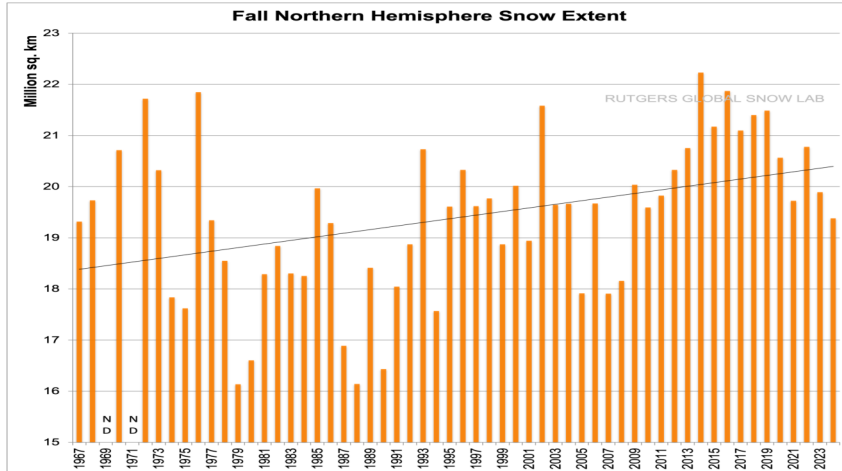
SNOW

Aside from Antarctica, most all snowfall occurs in the Northern Hemisphere, so data on snowfall usually is NH only. Rising world temperatures might reduce snowfall, but increasing world precipitation might increase it. The IPCC concludes that it is “very likely” that some high-latitude regions will have increased snow, because increased snowfall will prevail over warming-induced increased snow melt.” (AR6 p.134).

Despite the rising temperatures overall NH snowfall was remarkably constant from 1972 to 2025. The IPCC notes “low confidence” in most regions of future change in heavy snowfall. (AR6 p.25). But the IPCC also states that in Africa snowfall has decreased in the past and will continue to decrease. (AR6 p.135).

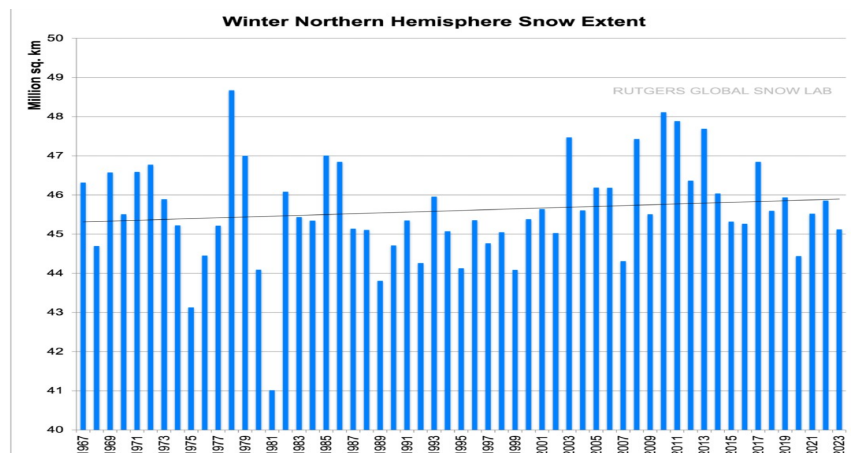


Northern hemisphere weekly snow cover since January 1972 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53-week average (approximately 1 year). The horizontal red line is the 1972-2024 average.

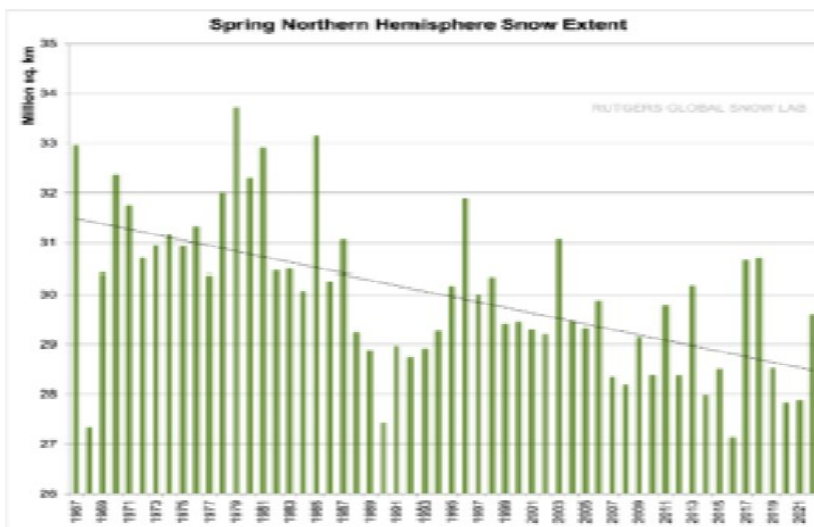


But there has been significant changes in snowfall in the 3 different snow seasons. Fall snowfall has significantly increased. (1967-2023)

Winter snowfall has slightly increased over the same period.



How odd... it's sloping (slightly) up. We thought children weren't going to know what snow is anymore. Spring and fall meanwhile are following opposite trends:



But spring snowfall fell so much that it negated the increases in the other two seasons.

**THE DAILY TELEGRAPH,
FRIDAY, AUGUST 21, 1931**

30 MILLIONS HUNGRY

TERRIFIC FLOOD IN CHINA

(Special Service)

SHANGHAI, Thursday.
THIRTY-ONE millions of Chinese are on the verge of starvation through the Yang-tse flood, which affects an area 1000 miles long and 50 miles wide.

Homes and crops in the flood belt have been destroyed. Hankow is inundated, and the horrors of the disaster have been augmented by disease resulting from floating corpses.

A shortage of drinking water and of food is causing alarm.

Damage running into millions has been done to property, while undermined buildings have collapsed, killing the inmates.

HIDEOUS PROSPECT

Hankow streets lie under seven feet of swirling water, which will take months to subside. Unless the city is rebuilt, it may go off the map.

The Government and foreigners in Shanghai are raising relief funds. Nanking proposes the purchase of 30,000,000 bushels of American wheat on 20 years' credit, by way of anticipating the inevitable winter famine.

This famine, it is feared, will be the greatest calamity that the nation has ever experienced.

FLOODS

The world has suffered horrendous floods in the recent past, such as the great China flood of 1931.

These are usually caused by rivers overflowing their banks.

Pittsburgh Post-Gazette

MONDAY MORNING, AUGUST 24, 1931.

2,000,000 FEARED DEAD IN CHINA

Famine, Pestilence Pushing Flood Toll Higher.

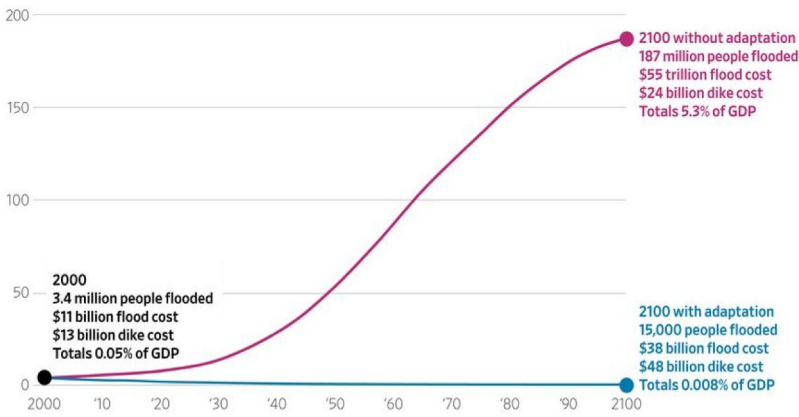
HANKOW, Aug. 23.—(P)—Relief was rushed to the flooded Yangtse river valley today but with the knowledge that many more thousands will die before any measures can prove effective for the homeless, starving and pestilence ridden millions.

Careful surveys reveal that at least 1,000 persons are dying each day in the district which centers around Wuchang, Hanyang and Hankow. Sixty thousand square miles of Hupeh and Hunan provinces are covered by water five to 20 feet deep. Seven million people were homeless and destitute in those provinces.

It was a physical impossibility to estimate the number of deaths but there was little doubt they would reach 2,000,000 in Hupeh and Hunan provinces before the floods abate and ravages of disease and famine end.

The Climate Changes but So Can We

Annual global coastal flooding costs, with and without adaptation (2005 dollars)

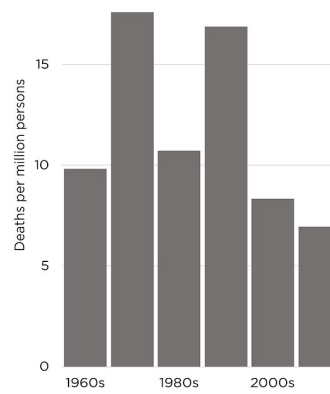


Source: Proceedings of the National Academy of Sciences of the United States of America

Fortunately the risks of floods can be hugely reduced by appropriate adaptation. One study has concluded that by adequate adaptations strategies flood damage can be reduced by 95%. (AR6 WGIII p.607). For example, one of the principal reasons for dam construction is to protect down-river areas from flooding.

Flood death rates have declined significantly both worldwide and in the G7. The death rate is much lower in wealthy countries that can afford to build dams and other mitigation projects, which can be expensive.

World death rate from floods



G7 death rate from floods

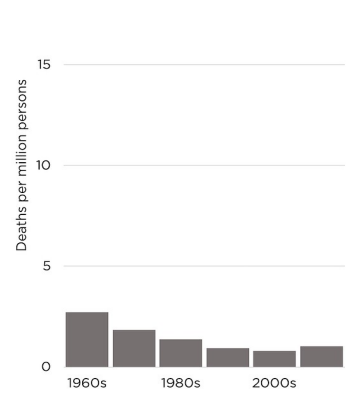


Figure 1. Annual Cost of U.S. Flood Damage, 1903–2019

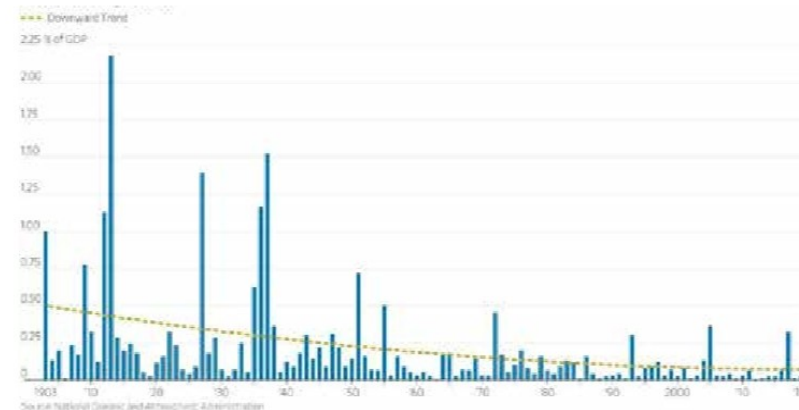


Figure 1. U.S. flood damage as a proportion of U.S. gross domestic product. Data plotted by Bjorn Lomborg. Data Source: National Oceanic and Atmospheric Administration.

In the US flood damages as a percentage of GDP have declined significantly since 1903.

The authors of AR6 were not able to link climate change to changes in flood frequency or intensity, nor were they able to attribute changes in flood frequency to human activity.

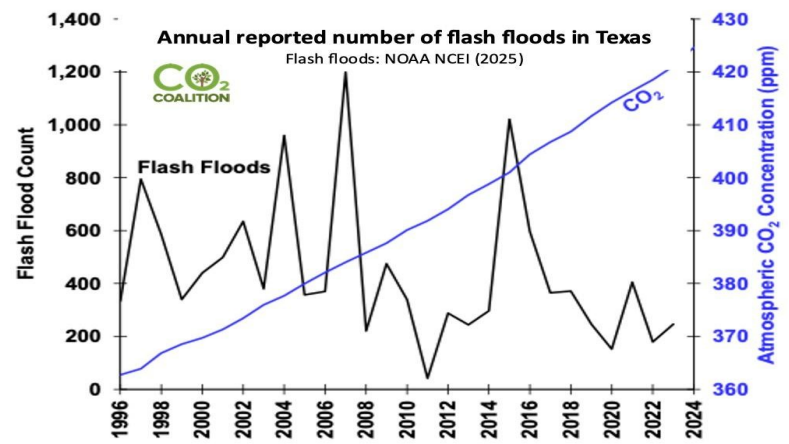
IPCC AR6 CONCLUSIONS ON FLOODING

1. There is low confidence in how the frequency of flooding will change regionally as it is strongly dependent on catchment characteristics, antecedent conditions, and how atmospheric circulation systems respond to climate change. (p.1073)
2. Heavier rainfall does not always lead to greater flooding. (p.1155)
3. Floods are affected by many factors in addition to heavy precipitation. (p.1567)
4. There is low confidence in the human influence on the changes in high river flows on the global scale. (p.1569)
5. There is limited evidence and low agreement on observed climate change influences for river floods in North America. (p.1830)



Nevertheless, flooding remains a serious problem in particular areas. For example, parts of Texas are exposed to frequent flash floods that can be lethal and cause much damage, as did the flood of July 4, 2025. (See CliSciPol Newsletter: July 2025).

Fortunately, the number of Texas flash floods is declining, but the number is highly variable from year to year.



And tidal flooding is an increasing problem in some low-lying coastal cities such as Charleston. (See CliSciPol Policy Topic: Coastal Cities Exposure)

CONCLUSION

The slight world increase in rain is beneficial. Substantially more areas of the world are growing greener while arid areas are growing smaller. Food production is growing and famine deaths have decreased dramatically. Snowfall is remaining roughly the same. Climate change has not resulted in any detectable increase in the number or intensity of floods, and adaptive measures, such as the construction of dams, have reduced flood deaths and adjusted flood damages worldwide.



All footnote citations are to the Intergovernmental Panel on Climate Change's publication, Climate Change 2021 The Physical Science Basis, the first part of the Sixth Assessment Report (AR6).

