

Chronic or Acute Climate Change?

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September 2026

1. Introduction

When applied to an illness, chronic means persisting for a long time or constantly recurring. Often this is contrasted with acute which means an unpleasant or unwelcome situation or phenomenon present or experienced to a severe or intense degree.

Most are familiar with diseases that are acquired by humans, other animals or possibly lower life-forms, but what about more complex life-forms, like Earth's environment. If we define Earth's environment as a life-form, human-caused climate change is definitely a disease (then would we definitely be germs?).

Rather than bantering with definitions, we should be looking for a cure to this disease, but, of course, we already know what this cure is: stop emitting greenhouse gasses. However, this is easier said than done, but we really need to do it.

If we don't fix human caused (or anthropogenic) climate change, the problems we currently having with global warming will pale in comparison with future problems, as described in the sections and subsections below.

2. Rising global temperatures

Rising temperatures are expected to increase the frequency and intensity of heatwaves, droughts, floods, and storms.¹ Heatwaves will cause more human-deaths, disrupt agriculture, and strain infrastructure.

2.1. Floods

Extreme rainfall will come with a warmer atmosphere, which can hold and release more humidity. Floods caused by this rain will overwhelm drainage systems, damage homes, and contaminate water supplies

2.2. Accelerated Sea Level Rise and Coastal Loss

A warmer atmosphere will also accelerate melting glaciers, ice sheets, and thermal expansion of seawater, which will continue to raise sea levels, threatening low-lying coastal cities, island nations, and wetlands.²

Secondary effects of this sea-level rise include:

2.2.1. More Frequent and Severe Flooding

Even small increases in sea level can push high-tide and storm water beyond flood thresholds that previously were not breached. For example, a 4-inch rise can turn a 12-inch high-tide event into a 16-inch event, flooding further inland.³

This leads to repeated "sunny day" flooding, damaging roads, sewers, and utilities.

¹ U.S. Environmental Protection Agency

² Wikipedia, mostly the article on "Climate change in the United States."
https://en.wikipedia.org/wiki/Climate_change_in_the_United_States

³ Earth.gov

2.3. Wildfires and Droughts

Warmer, drier conditions will expand the range and severity of wildfires, especially in forests and grasslands. Prolonged droughts will stress crops, reduce water availability, and increase the risk of desertification.⁴

3. Ocean Warming, Acidifying, & Biosystem Failure

Oceans are absorbing excess heat and carbon dioxide, leading to marine heatwaves, coral bleaching, deoxygenation, and shifts in marine species distributions. This threatens fisheries, biodiversity, and coastal economies.

Many marine species — including corals, oysters, clams, mussels, scallops, sea urchins, pteropods (sea butterflies), and shell-forming algae — rely on calcium carbonate for protection and structure. Acidification slows shell/skeleton growth, can cause dissolution, and weaken structures. For example, coral skeletons become less dense, making reefs more fragile and vulnerable to storms.¹

4. Habitat loss from Climate Change

Climate change speeds extinction rates, damaging ecosystem resilience.

4.1. Key mechanisms

Temperature shifts: Many species rely on specific temperature ranges for survival. Warming is pushing species like polar bears from Arctic hunting grounds (also, melting small ice bergs which are prime polar bear hunting sites), coral reefs from warm waters, and high-elevation animals like the American pika from their cool habitats (this also reduces cooler higher locations by exceeding the maximum mountain-tops' altitude).

Sea-level rise and coastal change: Rising seas are submerging mangroves, salt marshes, and wetlands, wiping out breeding and feeding grounds for fish, shellfish, and birds.

Extreme weather: Droughts, floods, and wildfires are destroying forests, grasslands, and wetlands. For example, prolonged droughts in Kenya have killed reticulated giraffes and elephants by depleting water and food sources

Altered seasonal cues: Warmer temperatures disrupt migration, breeding, and nesting timing, causing mismatches between wildlife and food availability.

Food scarcity: Earlier or absent emergence of insects, seeds, and flowering plants leaves migratory birds and other species without sustenance

4.2. Water Scarcity and Food Insecurity

Altered precipitation patterns and increased evaporation will reduce freshwater availability in many regions. This will strain agriculture, raise food prices, and increase competition for resources, potentially fueling conflict.⁵

⁴ National Aeronautics and Space Administration

⁵ The Science Times, Environment & Climate.

5. Permafrost Thaw

Permafrost (from perma- 'permanent' and frost) is soil or underwater sediment which continuously remains below 32 °F for two years or more; the oldest permafrost has been continuously frozen for around 700,000 years. While the shallowest permafrost has a vertical extent of below 3 ft, the deepest is greater than 4,900 ft. Similarly, the area of individual permafrost zones may be limited to narrow mountain summits or extend across vast Arctic regions.²

5.1. Methane Release

Thawing Arctic permafrost could release large amounts of stored methane, a potent greenhouse gas, creating a feedback loop that accelerates warming.

6. Air Quality and Public Health Impacts

Climate change can worsen air pollution by increasing wildfires and heat-related respiratory stress, contributing to millions of premature deaths annually.⁵

6.1. Photo-Chemical Smog

Photochemical smog is a type of smog produced when ultraviolet light from the sun reacts with nitrogen oxides in the atmosphere. It is visible as a brown haze, and is most prominent during the morning and afternoon, especially in densely populated, warm cities. Cities that experience this smog daily include Los Angeles, Sydney, Mexico City, Beijing, and many more.⁶

Photochemical smog forms from a complex process, however the source of it is quite apparent. The largest contributor is automobiles, while coal-fired power plants and some other power plants also produce the necessary pollutants to facilitate its production. Due to its abundance in areas of warmer temperatures, photochemical smog is most common in the summer.

It forms in the morning when a tremendous number people are driving their vehicles to work. Nitrogen oxides produced in the car engine are introduced into the atmosphere, which may combine with water to form nitric acid or react with sunlight to produce monatomic oxygen atoms, which then combine with molecular oxygen to produce ozone. The nitric acid may precipitate to the Earth resulting in acid rain, or remain in the smog. Due to the direct production of it by vehicles, the smog forms over cities where many people may encounter its adverse health effects.

Hotter days mean more photochemical smog, especially in the densely populated cities such as those mentioned above. As more and more urban populations arise around the globe, this problem is only expected to increase.

Composition: Nitric oxide (NO) and nitrogen dioxide (NO₂) are emitted by burning fossil fuels, along with being naturally emitted from things such as volcanos and forest fires (it is the concentration of these pollutants within cities as described above that is of the most concern however, as natural emissions tend to spread out over larger areas). When exposed to ultraviolet radiation, NO₂ goes through a complex series of reactions with hydrocarbons to produce components of photochemical smog—a mixture of ozone, nitric acid, aldehydes, peroxyacyl nitrates (PANs) and other secondary pollutants.

⁶ Energy Education article on “Photochemical smog,”

NO₂, ozone and PANs are called photochemical oxidants because they can react and oxidize certain compounds in the atmosphere or within a person's lungs that are not normally oxidized. Even small traces of these chemicals can affect the respiratory tract of humans and animals, and damage crops and trees.

7. Environmental Migration and Social Disruption

Sea level rise, extreme weather, and resource scarcity will force mass migration, thus straining both urban and rural infrastructure and increasing social tensions.⁷

8. Long-Term Climate Instability

Some changes & secondary effects may be irreversible for centuries, including:

8.1. Permafrost Loss

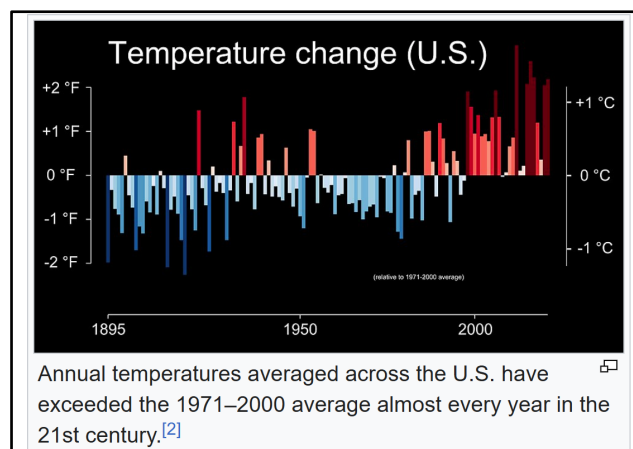
See sections 4 and 4.1 above. Once the additional humidity (water vapor), methane and water vapor (both water vapor and methane are greenhouse gasses) are released in the atmosphere this will result in a positive feedback loop that increases global warming further.

8.2. Compounded Climate Warming in the US

The relentless advance of climate change brought more drought, flooding and heatwaves to communities around the world last year, compounding threats to people's lives and livelihoods, per the UN's World Meteorological Organization (WMO).²

In the US, the climate is shifting in ways that are widespread and varied between regions. From 2010 thru 2019, the United States experienced its hottest decade on record (see chart below). Extreme weather events, invasive species, floods and droughts are increasing. Climate change's impacts on tropical cyclones and sea level rise also affect regions of the country.

Cumulatively since 1850, the U.S. has emitted a larger share than any country of the green-house gases causing current climate change, with some 20% of the global total of carbon dioxide alone. Current US emissions per person are among the largest in the world. Various state and federal climate change policies have been introduced, and the US has ratified the Paris Agreement despite temporarily withdrawing. In 2021, the country set a target of halving its annual greenhouse gas emissions by 2030, however oil and gas companies still get tax breaks.



⁷ United Nations: UN News, Global perspective Human stories: Human, economic, environmental toll of climate change on the rise: WMO, April 21, 2023, <https://news.un.org/en/story/2023/04/1135852> . Note that this is the parent-site of the site where the above content was found.

Climate change is having considerable impacts on the environment and society of the United States. This includes implications for agriculture, the economy (especially the affordability and availability of insurance), human health, and indigenous peoples, and it is seen as a national security threat. US States that emit more carbon dioxide per person and introduce policies to oppose climate action are generally experiencing greater impacts.

8.3. Record Year

2020 was an extraordinary year for extreme weather and climate events in the United States, breaking multiple records for the number and cost of disasters.

8.3.1. Record Number of Events

NOAA's National Centers for Environmental Information confirmed 22 billion-dollar weather and climate disasters in 2020, surpassing the previous annual record of 16 set in 2011 and tied in 2017. Damage from these events exceeded \$95 billion.

8.3.2. Types of Disasters

Tropical cyclones: 7 billion-dollar events, including hurricanes Hanna, Isaias, Laura, Sally, Delta, Zeta, and Eta — a record for one year.

Severe storms: 13 billion-dollar events, including the August 10 Midwest derecho, Texas hailstorms, and tornado outbreaks

Drought/heatwave: 1 billion-dollar event affecting the Western and Central U.S.

8.3.3. Other Seasonal extremes

Hurricanes/Tropical storms: 30 named storms in the Atlantic, a record, with 12 making landfall in the U.S.

8.3.4. California Wildfires

Five of the six largest wildfires in California's history occurred in 2020. The 2020 wildfire season was unprecedented in modern California history, with over 9,900 fires burning approximately 4.3 million acres, more than four percent of the state's land area, and causing 33 fatalities and billions in damages (estimated \$7–13 billion).

The August Complex fire became the first "gigafire," burning over 1 million acres across seven counties, surpassing the size of Rhode Island. Other notable fires included the LNU Lightning Complex and the SCU Lightning Complex, which caused widespread destruction in Northern California. The extreme severity of the 2020 fires was driven by a combination of climate change, prolonged drought, high temperatures, and strong winds such as Diablo and Santa Ana winds, which accelerated fire spread.

Human factors, including downed power lines and accumulated forest fuels due to over a century of fire suppression, also contributed to the intensity.

The season was further complicated by COVID-19 restrictions and a historic heatwave, which challenged evacuation and firefighting efforts.

8.3.5. Derecho

A powerful inland hurricane-like storm on August 10 caused widespread damage across the Midwest. The derecho formed in eastern Nebraska and South Dakota shortly after sunrise on August 10, 2020, and traveled eastward across Iowa, northern Illinois, Wisconsin, and Indiana, eventually reaching the Ohio River Valley. The storm carved a path approximately 700–770 miles long and lasted about 14 hours, with sustained damaging winds in some areas lasting 30–60 minutes, far longer than typical derechos, which usually produce 10–20 minutes of high winds. The storm moved at an average speed of 55 mph, with the strongest winds concentrated in Iowa

8.3.6. Historical Context

Adding 2020 to the record since 1980, the U.S. has experienced 285 billion-dollar disasters costing over \$1.875 trillion in total.

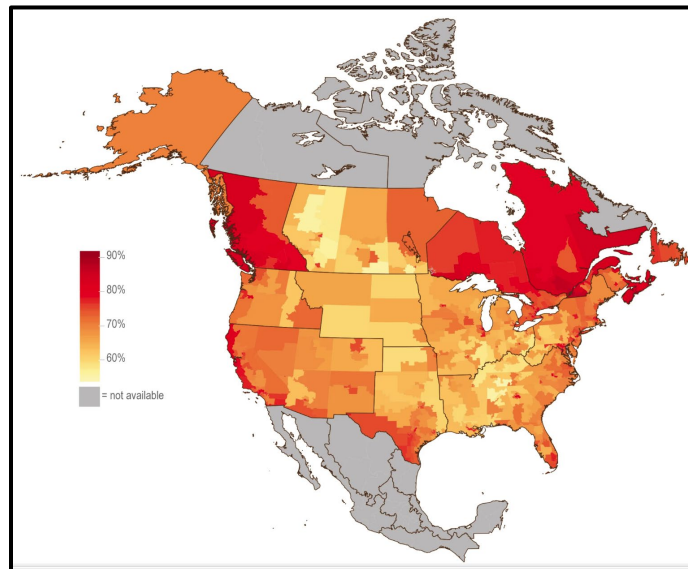
The year also marked the sixth consecutive year with 10 or more billion-dollar disasters, above the 1980–2019 average of 6.6.

In summary, 2020 stands as one of the most extreme and costly years in U.S. disaster history, with record storm activity, unprecedented wildfire burning, and severe weather events that collectively reshaped the nation's climate risk profile.

However, according to the American government's Climate Change Science Program, "With continued global warming, heat waves and heavy downpours are very likely to further increase in frequency and intensity. Substantial areas of North America are likely to have more frequent droughts of greater severity. Hurricane wind speeds, rainfall intensity, and storm surge levels are likely to increase. The strongest cold season storms are likely to become more frequent, with stronger winds and extreme wave heights.

8.4. US Public Perception

The map below is the regional-distribution of public perception that 'the Earth is getting warmer' as a surrogate for public acceptance that climate change is happening (percent of population).⁸



⁸ reddit.com

Note that, although the areas that are more liberal, and thus both trust scientific judgement more and are more likely to support government intervention, are stronger believers, people in many areas that will be most heavily impacted by human-caused climate change (like parts of the desert southwest), not so much.

9. Book Review

The above post ended-up being rather long, but it is very informative, so I am proud of it. But synchronously with writing this post I have been reading an awesome book (not used as a source in the above post, but see below).

I am approaching completion of the reviewed book, but this was not an easy read. The “not easy” has nothing to do with the quality of the writing nor the information-content, both were high in the extreme. However, I need to be careful in who I recommend to purchase and attempt to read the book detailed below:

Climate Change, Biological and Human Aspects, Second Edition: Author, Jonathan Cowie, Cambridge University Press, © 2013 (second edition).

Excerpt: *Finally, what of (sea level rise) beyond the 21st century? Whereas the 6 m (appx. 20 ft.) during the last interglacial may arguably be a very ... worst-case scenario for the 21st century, it is not so in the longer term. Conversely, it is most unlikely... for **all** Antarctic, Greenland and glacier ice to melt by the end of the 21st century or even the next few centuries: so unlikely, in fact, that it can be discounted. However, unless greenhouse gas emissions are curbed considerably in the near future, and indefinitely, on the scale of many centuries, if not millennia hence, a significant proportion of such melt becomes more probable. If the Earth warmed sufficiently over the next millennia sea levels could rise by more than 80 m (appx 260 ft.) This would have a profound effect on the global civilization. All current ports and many capital cities would be under water...*

When I read a book, I put small Post-It-Notes on any likely excerpts. I must have 20 or 30 of these in this book. This book is over 500 pages long, and it is NOT a quick read.

I have read many books about climate change, but none like this one.