

BALLARD BRIEF

June 2023

Impacts of Climate Change in the United States

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Summary

While every country both contributes to and feels the effects of climate change, the United States' heavy influence and high rates of contribution make this problem even more acute domestically. Climate change is primarily driven by human emission of greenhouse gases through the burning of fossil fuels and from mass-scale agriculture. Because climate change can be a polarizing issue, passing legislation to slow the harmful contributing factors has proven difficult. The effects of climate change have worsened in the past few decades, with increased instances of wildfires and extreme shifts in weather patterns. These negative consequences disproportionately affect vulnerable people groups including ethnic minorities and people with lower levels of income. In order to avoid the detrimental aftereffects of climate change like mental health challenges, floods, and food insecurity, solutions have emerged including shifting the US power dependence to electrical sources

rather than fossil fuels; this shift towards electrification has been successful in other countries. This shift of dependence ultimately starts with policy change.

Key Terms

Anthropocene—The current geologic time period that started in the mid-1900s when human activity became a primary driver of the Earth's great cycles.⁷

Anthropogenic—Human-originated impacts on nature.⁸

Carbon sequestration—The process of removing carbon from the atmosphere for storage in plants, soil, ocean, or other long-term locations.⁹

Climate crisis—The combination of climate change consequences on people and ecosystems worldwide.¹⁰

Climate feedback—Something that can accelerate or slow the rate of climate change.¹¹

Environmental justice—The distribution of the benefits and consequences of society's

environmental actions ought to be equal.¹²

Food security—The state where everyone can access sufficient, safe food that meets their needs.¹³

Holocene—The geologic time period representing the past 11,650 years before the Earth was so impacted by

anthropogenic activity.¹⁴

Polar vortex—A mass of very cold air that originates in the Arctic or Antarctica that occasionally travels out of those regions and causes plummeting temperatures in other areas.¹⁵

Context

Q: What is climate change?

A: To understand the impacts of climate change on people living in the United States and around the world, it is important to differentiate between climate and weather. Climate involves long-term trends in temperature patterns in a general area.¹⁶ Weather, conversely, comprises localized, short-term atmospheric patterns.¹⁷ Climate change is a shift in climate patterns.¹⁸ These shifts are caused by increases in the abundance of various gases in the atmosphere such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). These gases contribute to what is known as the

greenhouse effect, which is when the gases act as a blanket around Earth that traps heat inside.¹⁹ This greenhouse effect results in an increase in average global temperatures. Throughout Earth's history, global temperatures have fluctuated from hot to cold many times due to natural variations in greenhouse gases.²⁰ Without human interference, the Earth's temperature would be roughly the same as several hundred years ago.²¹ The Earth's temperature is rising because of large quantities of anthropogenic greenhouse gases in the atmosphere.²² When temperatures rise, all other earth systems—for example, the water cycle, carbon cycle, and various

nutrient cycles—are impacted. Due to higher temperatures, precipitation patterns change, hurricanes become more destructive, and wildfires become more prevalent.²³ The greenhouse gases that lead to this rising temperature come from a wide variety of sources, but in general, they come from burning fossil fuels, agriculture, and land degradation.²⁴ These sources of greenhouse gases will be discussed in more detail later on in this brief.

Q: How is climate change measured?

A: The impacts of climate change can be complicated to measure because of how widespread they are. In addition, because of how connected all of Earth's systems are, it is difficult to predict future consequences. However, scientists are working to measure and predict the impacts of climate change. The US Global Change Research Program prepares a large Climate Assessment Report every four years in the United States. This report analyzes the current scientific literature on

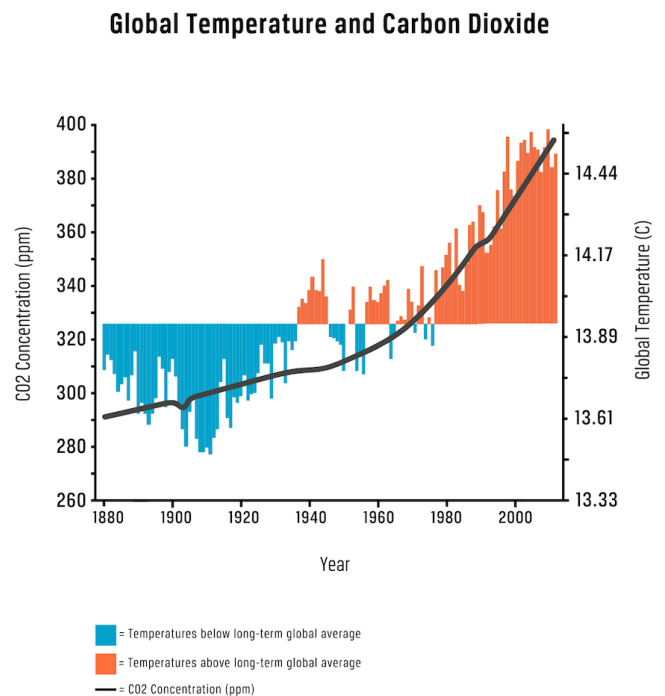
climate change in the US and discusses the natural and economic current consequences or those that may occur in the future.²⁵ This brief pulls much of its data from this report. In addition to this report from the United States, the United Nations Intergovernmental Panel on Climate Change (IPCC) produces an Assessment Report every few years. Their most recent report was from 2021 and contained updated information on climate projections.²⁶ The European Union also produces an annual report on the impacts of climate change worldwide. It contains information similar to the US and IPCC reports and emphasizes the pressing need to reduce greenhouse gas emissions to prevent the climate crisis from worsening.²⁷

The most basic measurements of climate change are global temperature and greenhouse gas concentration in the atmosphere. Scientists generally measure temperature compared to 1850 because this is when the industrial revolution began, and factories started emitting greenhouse gases.²⁸ The global average

temperature has risen around 1.2°C (~2°F).²⁹ That may sound like a minor change, especially considering that throughout the United States, one can experience a 30° change in temperature over the course of a day.³⁰ However, this small difference makes more sense when Earth is compared to the human body. The human internal temperature is generally around 37°C (98.6°F).³¹ When body temperature increases even by just a couple of degrees, it is called a fever resulting from illness. Earth is in a very similar situation. The consequences of climate change could be compared to if the Earth had a fever that was continuing to worsen. This brief will address the consequences of this one-degree change.

In 1850, CO₂ levels were around 280 ppm (parts per million).³² Today, CO₂ levels in the atmosphere are around 419 ppm.³³ This means that atmospheric concentrations of greenhouse gases have nearly doubled in the past 170 years. This rate of change is faster than has been observed in the past. For example,

from 1880 to 1978, the Earth warmed around 0.4°C, but from 1978 until 2023, Earth warmed an additional 0.5°C.³⁴ Thus, the warming that used to take 100 years now has only taken 50.



Q: Where is climate change impacting people?

A: People all across the globe are negatively impacted by the climate crisis in some way.³⁵ However, geographically, climate change impacts developing countries and coastal regions the most. This is mostly because these countries have limited

access to resources, and those living there are often unable to relocate in the case of disaster.

In the United States, people living near the coast are more impacted by climate change because sea-level rise force them to relocate, and more intense hurricanes destroy people's homes.³⁶ In addition to the negative impacts experienced along the coast, people living in the western United States are more vulnerable to increased drought and fires due to climate change.³⁷ In the eastern half of the United States, flooding from heavy rains is a more serious problem.³⁸ This brief will examine the major consequences of climate change for people all over the US.

Q: Who is impacted by climate change?

A: In the United States, certain groups of people are more vulnerable to the impacts of climate change. People living in areas hit by natural disasters with family members nearby are more likely to evacuate than those who do not, while low-income, minority

households and households with disabled or elderly people do not have the resources to evacuate.³⁹ Poorer individuals are more likely to be negatively impacted by climate change for several reasons. They often have access to fewer resources to help them recuperate after climate disasters. Their livelihoods are more likely to be based on climate-dependent jobs, such as in the agricultural or fishing sectors, or they may not be protected from climate-related work disruption.^{40,41} In addition to those who are poor, children are also among the most vulnerable groups. They are especially prone to experience the mental consequences of climate change, such as fear, anxiety, depression, or even PTSD.^{42,43} One study found that around 82% of children in the United States experienced “strong feelings of fear, sadness, and anger” when discussing environmental problems.⁴⁴

Q: Who is responsible for climate change?

A: Climate change is primarily driven by countries and corporations that

consume large quantities of fossil fuels.⁴⁵ However, individuals also play a role in contributing to the climate crisis. Each person is responsible for and impacted by climate change in the United States and worldwide. This brief will look at those who are most impacted and the most responsible industries. In their most recent assessment report, the Intergovernmental Panel on Climate Change (IPCC) ran an analysis comparing all of the possible causes of the increase in temperature. They concluded that human-generated emissions are the reason for this warming.⁴⁶ They reported in 2021, “It is unequivocal that human influence has warmed the atmosphere, ocean, and land.”⁴⁷ Humans emit greenhouse gases by burning fossil fuels and from mass-scale agriculture.⁴⁸ Climate change impacts every country, including the United States. Because the United States is one of the major contributors to global climate change, having produced over 20% of global emissions since 1850 (more than any other country), it is critical to

understand how this crisis affects those living there.⁴⁹ Currently, only 47% of Americans believe that they will personally be affected by climate change,⁵⁰ compared to 60% of Chinese people and 57% of people in India.^{51,52} In Great Britain, a country with a comparable economy to the US, nearly 75% of people are worried about climate change negatively impacting them.⁵³ The United States’ comparatively low number is one of the primary reasons this brief will specifically address the impacts of climate change on those living in the United States rather than people in other countries.

Q: How long has climate change been happening in this region and with this demographic?

A: Scientists have known about climate change for over 150 years. In 1856, Eunice Foote was the first scientist to demonstrate the warming effect of CO₂.⁵⁴ Foote concluded that if there were higher concentrations of

these warming gases in the atmosphere—CO₂ being one of the specific gases she worked with—the Earth could experience higher temperatures.

Industrial sources have emitted excess greenhouse gases into the atmosphere since the mid-1800s, and these greenhouse gases have been contributing to an average warming of global temperatures ever since.⁵⁵

These emissions primarily came from burning coal and wood in trains, factories, and homes.⁵⁶ In addition, most of the major land-use change, specifically from agriculture, happened in the mid-1800s and contributed to the start of anthropogenic climate change.⁵⁷ Most of the emissions and warming have been since the 1970s.⁵⁸

The United States has decreased greenhouse gas emissions over the past few decades primarily due to shifts to cleaner energy sources such as natural gas, wind, and solar.⁵⁹ Since 1990, there has been a 7% decrease in emissions in the US.⁶⁰ Even though US emissions have decreased over a longer timeframe, throughout 2022,

US emissions increased by around 0.8%. This increase is primarily due to using more indoor heating or cooling in response to extreme weather, including heat waves and polar vortexes.⁶¹ This increased use in furnace and air conditioning means more fossil fuels are burned, and more greenhouse gases are emitted. Globally, emissions are still increasing, though that upward trend is starting to level out.⁶²

In the United States, climate change has been understood as a major national threat for over half a century. In 1965, President Lyndon B. Johnson stated, “[t]his generation has altered the composition of the atmosphere on a global scale through... a steady increase in carbon dioxide from the burning of fossil fuels.”⁶³ In 1988, James Hansen, then director of the NASA Goddard Institute, commented in the US Senate Energy Committee: “The greenhouse effect has been detected, and it is changing our climate now.”⁶⁴ For a time, the discussion on climate change became increasingly politically divided. Fortunately, that

divide has been shrinking and there is now almost no difference in understanding of climate change between parties for people under the age of 40. Even though many Americans don't believe that climate change will directly impact them, most—nearly three-quarters—believe that it is a major problem in the world.⁶⁵

Contributing Factors

Greenhouse Gases

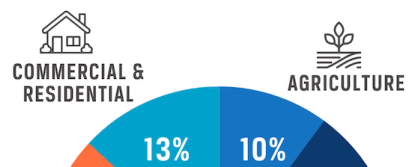
The emission of greenhouse gases is the primary cause of climate change in the United States and worldwide. These gases are produced by fossil fuels, agriculture production, and ecological disturbance such as deforestation and wetland destruction. Over the past 30 years, the United States has seen a decrease in greenhouse gas emissions of around 7%.⁶⁶ In addition, per capita usage has decreased by 18%.⁶⁷ This means that, on balance, the United States has been

increasing the efficiency of vehicles, buildings, and agriculture while still scaling production to meet a growing population. While this is a positive change, the consequences of climate change will continue to worsen if more substantial preventative measures are not taken.⁶⁸

Fossil Fuels

Fossil fuels are commonly used across all economic sectors, emitting greenhouse gases contributing to climate change. Fortunately, the reliance on fossil fuels in the United States is decreasing as renewable energy becomes more prevalent in energy generation.⁶⁹ In the US, the transportation sector is the largest consumer of fossil fuels, accounting for approximately 31%. At 28%, electricity generation is the next leading cause of fossil fuel consumption.⁷⁰ The huge demand for fossil fuels in the United States translates to greater production of these limited and polluting resources.

Sources of Greenhouse Emissions in the US



When fossil fuels are used in a combustion process—such as in cars or power plants—gases such as carbon dioxide are leftover as a byproduct of the reaction. These gases dissipate and accumulate in the atmosphere.⁷¹ The states that burn the most fossil fuels per capita are Wyoming, North Dakota, and Alaska.⁷² This is because these states extract a great deal of these fuels, and there are few people living there. When looking at the total amount of fossil fuels burned, states like Texas, California, and Florida take the lead by a wide margin due to their large populations.⁷³ These states also have many more people living in them. There are many sources of greenhouse gases, but burning fossil fuels contributes the largest portion. The proportional distribution of fossil fuel consumption and greenhouse gas emissions is different in the US compared to the rest of the world. Globally, the transportation sector only contributes to 14% of greenhouse

emissions, while the US contributes to 27%.^{74,75} Because the transportation sector is large in the United States, they produce more greenhouse gases than other countries worldwide. This sector is so large because of how integral transportation is to all other sectors in the US and because public transportation is not well developed in the United States.⁷⁶ Europe only emits 775 million metric tons of CO₂ from transportation annually, while the United States emits over double that with around 1600 million metric tons.^{77,78}

Agriculture

Agriculture in the United States accounts for 11% of all greenhouse gases.⁷⁹ Agriculture may not contribute to climate change as much as burning fossil fuels, but it still plays a role. While agriculture occurs across the United States, California, Iowa, Texas, and Nebraska has the most agriculture (and thus the most contributions to this issue).⁸⁰ In 2020, 53% of US agriculture's greenhouse gas emissions came from crop

cultivation, 40% from livestock, and 6% from fuel combustion.⁸¹ This diversity of greenhouse gas sources from agriculture is important to break down to understand how each contributes to the problem of climate change.

Crop cultivation contributes to climate change primarily because of nitrous oxide (N₂O) emissions from chemical processes in the soil as plants and microbes use nitrogen from the soil.⁸² Nitrous oxide is a greenhouse gas 273 times more potent at warming than CO₂.⁸³ All forms of livestock contribute to climate change because they emit greenhouse gases from gastrointestinal activity.⁸⁴ Beef production around the world is the cause of 40% of methane emissions from human activities.⁸⁵ This accounts for 14.5% of total greenhouse gas emissions worldwide. The United States produces around 20% of the world's beef supply.⁸⁶ About .006 gigatonnes of methane are produced from cows in the US or approximately 0.1% of global greenhouse gas emissions.^{87,88} Methane is more potent

at warming the climate than carbon dioxide. Because the United States produces a large portion of global beef, which is a major source of methane, it means that the United States is contributing to a problem that will negatively impact people domestically and globally.

Land-Use Change and Deforestation

Land-use change and climate change affect one another. For example, when humans change the land by clearing trees for farming, greenhouse gases previously stored in the soil are released.⁸⁹ As the Earth warms, more areas experience deforestation which causes a positive feedback loop.⁹⁰ This means that the more deforestation occurs, the more warming the Earth will experience. Additionally, the more warming the Earth experiences, the more deforestation will happen. This will be discussed in more detail in the section on negative consequences.

Land-use change is a major problem in the United States, with around 50% of the land used for agriculture.⁹¹ The other major change in land use is

urbanization, which has increased over 11% over the past 2 decades.⁹² This land-use change, in combination with shifts in rainfall patterns due to climate change,⁹³ has led to a 16% decrease in tree cover since 2000.⁹⁴ A decline in tree cover results in two major consequences. First, as mentioned earlier, the soil degrades, and carbon trapped in the soil is released into the atmosphere.⁹⁵ Second, trees absorb carbon dioxide through photosynthesis, decreasing greenhouse gases in the atmosphere.⁹⁶ Fewer trees mean less carbon dioxide drawdown, which exacerbates the greenhouse effect.

Human misuse of land leads to major shifts in precipitation trends, such as more precipitation in the Midwest and more rain later in the year.⁹⁷ If forests were regenerated worldwide, as much as 70 billion tons (77.16 tons) of carbon would be captured from the atmosphere by 2050. This is the equivalent of 7 years of global greenhouse gas emissions requiring at least 25% regeneration of forests worldwide.^{98,99,100} Because of how

enormous fossil fuel emissions are, reforestation is not a viable solution. Since 1990, land use change and deforestation have contributed around 44% of global carbon emissions since 1850.¹⁰¹ As humans degrade the land through cutting down trees and poor farming practices (such as over-tilling, failing to rotate crops, and overgrazing), greenhouse gases are released back into the atmosphere. In addition, these gases will no longer be drawn back into the soil because the vegetation sequestering them is gone. For example, studies have shown a 34% decrease in carbon sequestration in tilled soils versus no-till soils.¹⁰² While many of these are global statistics, they can be applied to the United States on a smaller scale.

Social Resistance

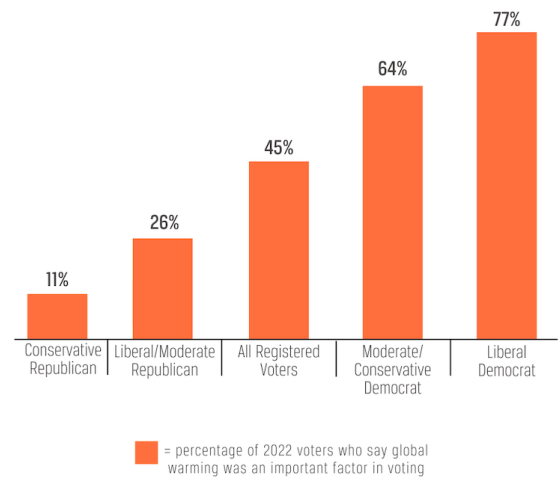
Ideological Division

Social resistance to climate change plays a major role in preventing the United States from solving this issue because of ideological division and psychological distance. As of 2020, 88% of adults who aligned more

closely with the Democratic party felt that climate change is a major threat to the US versus 31% of adults who aligned more closely with the Republican party.¹⁰³ Especially in the United States, there is a large political divide between those who believe in climate change and those who do not.¹⁰⁴ This gap is growing smaller, but Democrats are more likely to believe in climate change. The gap is even larger when looking at age groups. Nearly half of Americans aged 18–29 think that fossil fuels should be phased out completely compared to only 20% of Americans over the age of 65.¹⁰⁵ Belief in climate change is important because it leads to greater support for policies that would address the contributing factors and begin to solve the problem.¹⁰⁶ According to a study done by the Yale Program on Climate Change Communication, between 64–77% of Democrats felt that climate change is one of several important issues when deciding how to vote, while only between 11–24% of Republicans felt the same way.¹⁰⁷ This division makes it difficult to reach a

consensus and thus makes it difficult to pass environmental legislation, which prolongs the climate crisis. As will be discussed later in more detail, climate change is a super wicked problem, meaning that it gets worse as time goes on. Thus any delay in policy change will lead to more catastrophic consequences.¹⁰⁸

Political Division of Beliefs in Climate Change



Psychological Distance

The problem of climate change is unique because of a concept known as psychological distance that is especially prevalent in the United States. In the context of climate change, the concept of psychological

distance suggests that the farther removed an individual is from a climate-related event, the less motivated that individual will be to do something about climate change.¹⁰⁹ Psychological distance has four important aspects: spatial, social, temporal, and hypothetical. Spatial deals with distance, temporal distance is related to time, social distance deals with relationships (being in or out of a group), and hypothetical distance is the certainty of an event happening at some point.¹¹⁰ Regarding climate change for people in the United States, psychological distance contributes to why individuals, corporations, and governments are often reluctant to make the necessary changes to stop emitting greenhouse gases.

The first psychological type is spatial distance. Many of the most severe consequences are happening in places that are far removed from the United States. For example, melting sea ice and starving polar bears in the Arctic do not directly impact people in the US—this means people are less likely to care about such issues.¹¹¹ In the

Arctic, the ice sheet has been decreasing at 12.5% per decade, meaning that polar bears are quickly losing critical habitat for breeding and hunting.¹¹² Contrastingly, when people personally experience the consequences of climate change, they have a stronger tendency to start acting to mitigate the effects of it. For example, California was impacted by an extreme drought for many years that contributed to climate change.¹¹³ Because large populations lived through this, they implemented many policies to reduce emissions and conserve water.¹¹⁴

The second type is temporal distance. Many of the most disastrous consequences of climate change are still projections.^{115,116,117} Because many negative consequences are not currently being experienced, it is easier for people to procrastinate taking action until the negative consequences actually impact them.¹¹⁸



In the United States, most policymakers are wealthy and live in affluent areas that are resilient to the impacts of climate change.¹¹⁹ This is what we call social distance. They are outside of the groups most affected by the climate crisis and thereby do not feel as much pressure to change policy in favor of restoring the climate.¹²⁰ Even though there may be a perception of resilience against climate change in affluent areas, it is critical to remember that all people on the planet will be negatively impacted and that all people must come together to solve this issue. Fortunately, some policymakers have chosen to act positively to address the climate crisis in the United States. One example is Representative John Curtis from Utah who created the Conservative Climate Caucus. This

caucus was developed to advance climate policies while staying true to conservative values.¹²¹

Finally, the last type of psychological distance is hypotheticality. Climate change is one of the core “Planetary Boundaries” at the heart of all other environmental factors.¹²² The planetary boundaries are part of a framework that defines a safe space for human existence. Professor Will Steffen and his associates defined nine environmental boundaries that humans should stay within to preserve the ideal conditions for life. Climate change, specifically relating to global temperature and greenhouse gases, is one of these boundaries. It is connected to each of the other eight boundaries; if the climate changes, so will ocean acidification, freshwater use, and so on.¹²³ With climate change especially, it is impossible to determine the “point of no return” for atmospheric greenhouse gas levels and global temperature increases.¹²⁴ However, in 2015, the authors of the Planetary Boundaries paper, Steffen et al., proposed that the zone of

uncertainty lies between 350 and 450 parts per million (ppm) of carbon dioxide in the atmosphere.¹²⁵ For perspective, current atmospheric CO₂ levels are around 417 ppm globally increasing at around 2–3 ppm per year.¹²⁶ At this rate, the carbon dioxide in the atmosphere will reach its upper limit of 450 ppm within 11–16.5 years if greenhouse emissions are not drastically reduced.

Super Wicked Problems

Climate change is difficult to mitigate because it is very challenging to determine jurisdiction and accountability.¹²⁷ It can be hard to comprehend how burning fossil fuels in one country can impact people on the other side of the world, which leads to inaction in solving the problem.¹²⁸ Climate change is sometimes considered the largest market failure the world has ever seen.¹²⁹ This is caused, in part, by what economists call the “free-rider” problem. This is when members of a community benefit from the actions of others without taking any actions

themselves.¹³⁰ Relating to climate change, many countries act as free riders because they are reaping the benefits of burning fossil fuels without paying for the damages.¹³¹ The United States is an example of a “free-rider.” As mentioned in the context, the US has been responsible for 20% of global emissions since the start of the industrial revolution.¹³² This is almost double what China, the second largest emitter, has produced over that same timeframe, with 11% of global emissions.¹³³ The United States has a low Environmental Performance Index score, according to researchers from the Yale Center for Environmental Law and Policy, ranking 20 out of 22 wealthy democracies in the Global West.¹³⁴ This means that the US has done very little to combat environmental problems such as climate change while contributing more than any other country by a wide margin.

Because of this and other factors, climate change is considered a “super wicked problem.”¹³⁵ Many feedback loops continue to make climate change

worse. This means that the longer it takes to address climate change, the harder it will be to fix it. The consequences of climate change compound with each other and worsen the problem exponentially.¹³⁶ For example, there are currently large quantities of methane locked up in permafrost—soil that remains frozen in cold regions of the world. As the global temperature increases, this soil melts and releases all of these trapped greenhouse gases into the atmosphere, increasing the warming rate.¹³⁷

Consumerism

Production Costs

Consumerism has led to climate change because of greater energy use and waste production. Plastic production in the US contributes around 107.7 megatonnes of greenhouse gases to the atmosphere each year.¹³⁸ The United States produces around 5222 megatonnes of greenhouse gases from all sources.¹³⁹ This means that in total, plastic production accounts for around 2 percent of total emissions in the

United States. Plastic is created from oil, and the United States is a major producer and consumer of oil. People in the poorest 10% of countries consume less than one barrel of oil annually, while those living in the richest 10% often consume 60 times that amount.^{140,141} The United States falls among the richest 10% of countries worldwide, and its citizens use more oil than the global average.¹⁴² This is another example of how the United States disproportionately contributes to the climate crisis, for which more than just US citizens experience the consequences.

In addition to plastic, cement and concrete contribute to the climate crisis. This is because, during cement production, greenhouse gases such as CO₂ are emitted, which further exacerbates the climate crisis.¹⁴³ Concrete production contributes 1% of US greenhouse gas emissions.¹⁴⁴ The United States consumes 2.5 percent of the concrete produced worldwide.¹⁴⁵ According to the Portland Cement Association (PCA), approximately “30% of the cement use in the US was

for transportation infrastructure, 28% for residential buildings, 18% for nonresidential buildings, 13% for public utilities and wastewater systems, and 10% for other applications.”¹⁴⁶ The United States’ extensive use of concrete contributes to climate change. However, this is also a resource used globally, with China, India, and Vietnam using the most and the United States being the fourth largest concrete producer. China used 2.1 billion metric tons of cement, a major concrete component, while the US used 95 million metric tons.¹⁴⁷

Waste Generation

Waste comes in many forms, but food waste is one of the most problematic types contributing to climate change.¹⁴⁸ The United States emits around 113 megatonnes of greenhouse gases from food waste or about 2% of total US emissions.¹⁴⁹ This is because, in the United States, nearly one-third of all food is thrown out.¹⁵⁰ This equates to around 1 lb of food waste per day for each American.¹⁵¹ Food only accounts for 21.5% of all

municipal solid waste generated in America. The rest comprises things like paper, cardboard, glass, plastic, and yard



of all food in the United States is thrown out

trimmings.¹⁵²

In the United States, 90% of the waste is recyclable; instead, citizens send over 52% to landfills.¹⁵³ In landfills, this waste decomposes, releasing large quantities of methane, a greenhouse gas.¹⁵⁴ Landfills contribute to 15% of methane emissions in the United

States.¹⁵⁵ The United States is the third-biggest emitter of methane in the world.¹⁵⁶ Because methane is up to 28 times more potent for warming than carbon dioxide, landfills significantly contribute to climate change.¹⁵⁷

Consequences

Terrestrial Consequences

Desertification

Terrestrial consequences such as deforestation, food insecurity, and fires result from climate change in America because of increased heat and shifts in precipitation patterns. Climate change affects life both on land and in the water. On land, one of the primary changes is desertification.¹⁵⁸

Desertification comes both from direct human interference and anthropogenic climate change.¹⁵⁹

Earlier, this brief discussed desertification and deforestation as a contributor to climate change. Here, desertification will be explained as a consequence of climate change.

Desertification is manifested as land and vegetation degradation relating to

dryer conditions because of shifts in precipitation patterns from climate change.¹⁶⁰ Around the world, over one-third of the land has been impacted by desertification, including much of the agricultural land in the United States.¹⁶¹ In the United States, most of this desertification happens in the West and is related to decreased precipitation.¹⁶² Nearly 40% of the US is arid or semi-arid (meaning it is highly susceptible to desertification).¹⁶³ Desertification drastically impacts Americans because it limits the land that can be effectively farmed and generates dust pollution.¹⁶⁴

Food Insecurity

Climate change in the United States also harms food security. Because the climate is warming, the growing season is longer; this can limit the types of plants that can be grown and promote the growth of invasive species and weeds.¹⁶⁵ Even though an extended growing season could theoretically increase crop yield, it is expected that the actual productive

growth period will be shortened because it is paired with a shift in precipitation patterns.¹⁶⁶ In addition, increased levels of carbon in the atmosphere are limiting the nutritional value of crops grown, further contributing to food insecurity. Globally, it is estimated that protein and mineral concentrations will decrease between 5–15% while B vitamins will decrease by up to 30%.¹⁶⁷ Crop yields globally for wheat and maize have already decreased by 4–6% and will continue to decrease as extreme heat and less water cause plants to experience increased stress.¹⁶⁸ Technology may be able to help offset this loss, but it is expected that crop yields will continue to decline in the coming decades.^{169,170,171}

In addition to decreased nutritional value and more invasive species, changes in temperature and water will impact pollinators such as bees and butterflies. Because the growing season is starting earlier, researchers predict that a timing mismatch could

occur, meaning that pollinators would not pollinate at the correct time, significantly impacting seasonal crop growth and pollinator survival.¹⁷²

Fires

In the western United States, climate change has doubled the number of large fires over the past 30 years.¹⁷³ It is estimated that the area burned each year has increased eightfold since 1985.¹⁷⁴ Fires are increasing in frequency and magnitude for a few primary reasons. First, there is less water later in the year. By 2050, there is expected to be a 25% decrease in precipitation in the western United States, especially snowfall.¹⁷⁵ In many parts of the western United States, there is less rain, meaning that forests and grasslands are drier and more prone to fires.¹⁷⁶ Even though the western US is experiencing more intense drought, it is important to note that throughout most of the rest of the United States, there is an average increase in precipitation so only certain regions are impacted by wildfires.¹⁷⁷





It is estimated that the area burned each year has increased eightfold since 1985

In addition to less rain in the west, the snow is melting earlier, causing foliage to grow more quickly at the beginning of the year. It is also expected throughout the western United States that snowpack will decline by around 25% by 2050.¹⁷⁸ The problem with this is that by the end of the summer, more

tall, dry plant material is vulnerable to wildfires.¹⁷⁹

Insects are also contributing to fires. Climate change is causing temperatures in the mountains to increase, resulting in the flight season of insects increasing. One such beetle, the mountain pine beetle in the Colorado Front Range, has increased flight season by over double its historic reported season.¹⁸⁰ The beetles will infect the trees, which will eventually die. It is estimated that insect outbreaks affect over 45 times the area forest fires impact yearly.¹⁸¹ These dead trees provide fuel for summer forest fires. Because of beetles, there will be approximately an 8% decrease in net carbon uptake by forests in the United States by 2030.¹⁸²

Aquatic Consequences

Flooding

Aquatic consequences such as flooding, sea level rising, and tropical storms are consequences of climate change because warmer air can hold more moisture and therefore makes storms more intense.¹⁸³ Climate

change has caused an increase in flooding because of increased precipitation in parts of the United States. While there is less water in the western United States, since 1901, average precipitation across the country has increased by approximately 4%.¹⁸⁴ Partly because of this, there has been a 20% increase in extreme 100-year flooding events throughout the United States.¹⁸⁵ It is estimated that there has been and will continue to be at least a 7% increase in extreme precipitation per degree C.¹⁸⁶ Over the next 80 years, this will result in flood damages going from \$3 billion to between \$4–7 billion.¹⁸⁷ Examples of extreme flooding occurred in the summer of 2022 in 5 regions within 5 weeks of each other throughout the United States. This is a new record. One location was Dallas, Texas, which had previously experienced a drought with the rest of the state, but conducive conditions led to what scientists call a “1000-year flood event,” which means that there is normally a 0.1% chance of that sort of flood occurring in any given year.^{188,189}

The flooding resulted in the wettest day and wettest hour on record in Dallas.¹⁹⁰ Because of climate change, these previously rare flooding events are becoming more common.¹⁹¹

Sea Level Rising

Sea levels are rising faster along the coast of the contiguous United States than global sea rising rates. Over the past 100 years, the global average rise is 17 cm; in the US, sea levels have risen closer to 28 cm.¹⁹² It is estimated that by 2100, sea level rise could displace between 4.2–13.1 million people along the coasts of the continental United States.¹⁹³ National GDP loss could be between \$70–289 billion per year by the year 2100.¹⁹⁴ The combination of human migration and GDP loss in cited States creates a major social and economic problem for the future. It is estimated that by 2050, the United States coastline could experience a foot of sea level rise.¹⁹⁵ Around 39% of the US population lives in coastal counties, meaning that flooding from higher sea levels would negatively impact the lives of hundreds of thousands of people.¹⁹⁶

There are several factors that contribute to differences in sea level rise across the world. First, when the ocean heats up from climate change, it expands. The ocean varies in temperature depending on the region, therefore it expands at different rates.^{197,198} The second reason is a phenomenon called Vertical Land Motion (VLM). VLM is when the land moves up or down due to factors such as tectonics, subsidence from oil drilling or groundwater depletion, or even land rebound after glaciers have melted.^{199,200} Climate change is why the Earth is heating up, causing the glaciers to melt and oceans to warm.

A study found that around 20% of people impacted by sea-level rise in the United States are among the most socially vulnerable.²⁰¹ This is an example of distributive environmental justice which is an explanation of how inequalities in socio-economic and cultural status generally reflect the distribution of environmental risks.²⁰² In many instances, vulnerable populations are more likely to be located in areas impacted by natural disasters related to climate change. It is estimated that 99%

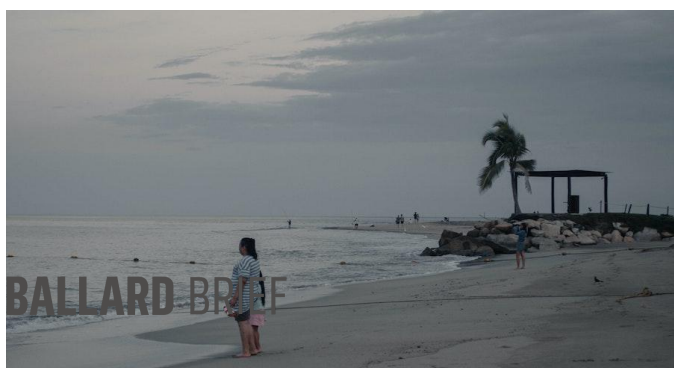
of the most socially disadvantaged people in the United States live in areas that will likely be unprotected from natural disasters related to climate change.²⁰³

Tropical Storms and Hurricanes

In addition to the sea level rising, hurricanes are a serious environmental hazard directly linked to climate change. Climate change is attributed to increasing the frequency of the most intense categories of hurricanes.²⁰⁴ In the United States, it is estimated that tropical storms will increase by 2–11% in intensity by the end of the century.²⁰⁵ It is possible that his greater intensity could result in up to a 54% increase in annual damage by the end of the century.²⁰⁶ The reason for this is three-pronged. First, warmer air can hold more moisture resulting in heavier rains as the Earth continues to warm. Second, the warmer water causes wind speeds to increase. And finally, higher sea levels and the destruction of barrier habitats result in more destructive storm surges as the water is pushed up

further on the land.²⁰⁷ Hurricanes destroy homes and infrastructure and cut off sources of food and water for the residents.²⁰⁸ In addition, hundreds of people have their lives ended early each year in the US because of hurricanes.²⁰⁹ Climate change has exacerbated previously existing hurricane damages. During the 2017 hurricane season, there were 6 major storms of category 3 or higher. This was double the average number of yearly intense storms from 1979 to 2017.²¹⁰

Distributive environmental justice is also an issue with hurricanes. For example, according to Brodie et al., in the case of Hurricane Katrina, “more than 90% [of the evacuees] were African American, and approximately 6 in 10 had household incomes below \$20,000 in 2004.”²¹¹ This is a significant issue and will continue to get worse as climate change brings about more dangerous storms.



Social Consequence

Distributive Justice

Social consequences such as distributive justice and mental health issues are a result of climate change because of historic prejudices and a lack of resources available for people impacted by climate change. No matter the consequence, the impacts of climate change have the tendency to disproportionately affect certain groups over others.²¹² Those who are already most vulnerable include the poor, elderly, young, or otherwise marginalized.²¹³ The reason for this, as has been discussed throughout this brief, these socially vulnerable people often live in areas that don't have the infrastructure to resist damage from natural disasters from climate change. Facilities that burn fossil fuels are more likely to be built in low-income African American or Latinx neighborhoods because these people often did not have a voice in the local politics to say no.^{214,215} For example, communities where the majority of residents were people of color tended

to experience 40% greater exposure to industrial cancer-causing air pollution than predominately white communities according to one study.²¹⁶ Furthermore, climate change could increase poverty levels to nearly 30% in the coming decades and facilitate a decline in estimated life spans.²¹⁷

Mental Health

There are also many mental health consequences associated with climate change as well. In the United States, nearly 60% of Americans are concerned or overwhelmed by the looming presence of climate change.²¹⁸ There is a growing sense of impending doom that is afflicting people across the country, especially among young adults. This is likely because the younger generation is the group that has been left with the responsibility of restoring the climate over the coming decades.²¹⁹ The most common outcome of this is anxiety for the future.²²⁰ A study from the American Psychological Association found that 47% of young adults experience anxiety from climate change that

impacts their daily lives.²²¹ This anxiety can either be adaptive and lead people to positive action, or it can be maladaptive and lead to feelings of helplessness and even suicide.²²²

Warmer temperatures from climate change also contribute to adverse mental impacts. Studies have shown that increased heat has a strong positive correlation with increased aggressive behavior such as crime or domestic violence.²²³ Increased heat can also lead to greater psychological stress and possibly suicidal behavior.²²⁴

Practices

Electrifying Everything

In order to restore the climate to Holocene-like conditions and address the consequences of climate change, two major things must happen. First, greenhouse gas emissions must be cut by implementing a large-scale roll-out of renewable energy and the electrification of appliances, vehicles, and buildings.²²⁵ Second, the current greenhouse gases in the atmosphere must be drawn down

and sequestered.²²⁶



Looking at sources of renewable energy, solar, and wind are the cheapest forms of energy in the United States right now.²²⁷ The price of solar has dropped 91%, and the price of wind energy has dropped 71% since 2009. Transitioning away from fossil fuels is both feasible and critical for mitigating the effects of climate change in America and the world.²²⁸ The effort to “electrify everything” will require a tripling in current electricity generation and a better-connected electrical grid system.²²⁹ This would allow Americans to access renewable energy at any time, rain or shine. Transitioning to renewable energy and decarbonizing America brings with it a plethora of benefits. Most immediately, this change will eliminate all domestic air pollution

related to climate change. This could save over 350,000 lives annually in the United States.²³⁰ In addition, this will cut down about one-fifth of all emissions output worldwide.²³¹

This transition can only be accomplished by policy changes. In 2022 the United States passed what was considered “the most significant climate legislation in US history.”²³² This act provides funding and tax credits for organizations and individuals to purchase electric appliances and vehicles and to transition to renewable energy. Policies like this are only passed after members of Congress receive pressure from their constituents. Organizations such as the Sierra Club, the Wilderness Society, and The Nature Conservancy often send petitions or letter-writing campaigns to help citizens use their voices to request change from lawmakers.^{233,234,235} At the center of all of these initiatives is communication. Change starts with people talking about issues that are important to them. Dr. Katharine Hayhoe, the chief scientist for The Nature Conservancy and one of the leading voices on climate change invites

everyone to start talking more about the effects of climate change. Most importantly, however, Dr. Hayhoe encourages that these conversations must be focused on hope for a better world.²³⁶ Fear and guilt are not effective motivators for personal action; rather, they will end up pushing people away from acting.²³⁷ By focusing on how climate change is personally meaningful in people's lives, the psychological distance that often prevents individuals from caring can be reduced.²³⁸

Insights from the South Australian Region

In the United States, there are not any current examples of complete electrification or decarbonization. However, the country of South Australia offers insight into the process and rewards of moving to green energy. In 2020, the country was generating over 60% of its energy from wind and solar sources.²³⁹ This came after being completely dependent on fossil fuels less than two decades ago. Because of this transition, energy prices have dropped to around 3.6c/kWh during the

day.²⁴⁰ This drop in prices is especially meaningful for low-income families because electricity now takes up a smaller percentage of their monthly bills.

When looking at projections for eliminating fossil fuels over the next 50 years, there are incredible savings in terms of human life and economic gain. It is estimated that limiting warming to 2°C would “prevent roughly 4.5 million premature deaths, about 1.4 million hospitalizations and emergency room visits, ~300 million lost workdays, about 1.7 million incidences of dementia, and about 440 million tons of crop losses in the United States.”²⁴¹

Gaps

Even after eliminating all greenhouse gas emissions, most of the negative effects of climate change would not immediately be resolved; it takes a very long time for these gases to be drawn back to Earth.²⁴² This is accomplished over time by supporting Earth's natural “sinks,” or places that naturally pull carbon and other gases down from the atmosphere. These

include places like forests, freshwater streams and lakes, and the ocean.²⁴³ There are also no places that have transitioned 100% to green energy sources, making it difficult to determine what the full impact of decarbonizing America would be. It is also important to note that even when emissions are reduced in the United States, the issue of climate change will still not be fixed. Every other country would need to follow suit in decarbonizing their economy. However, because the United States is one of the most prominent countries in the world, it is possible that other nations would follow its example.²⁴⁴ Unfortunately, the United States has usually not been the first to take charge of international matters regarding the environment. In 1997, the Kyoto Protocol was presented to members of the United Nations. Representatives from the United States initially signed the agreement but never ratified it and eventually withdrew their signatures.²⁴⁵ This protocol required participating countries to lower their emissions by

5% of their 1990 levels. The next international climate treaty came in 2015 with the Paris Agreement. This required participating countries to set their own goals to reduce a certain percentage of emissions and to report on progress made every five years. The goal was to prevent Earth from warming over 2°C above 1850 temperatures. President Donald Trump withdrew the United States from this agreement for a time until President Joe Biden reentered the Paris Agreement during the first few months of his presidency.²⁴⁶ There are no incentives for countries to keep their commitments which have put most countries lagging behind what they committed to do. One study suggests that even if all countries met their goals, it would only limit warming to 2.9°C which is significantly warmer than what is hoped for.²⁴⁷

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