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Review

# Climate Change: Causes, Impacts, and Strategies for a Sustainable Future

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**Abstract:** The important topic of climate change is discussed in this article, with a focus on the historical background and present effects. It draws attention to the differences between climate change and global warming and attributes the faster pace of climate change to human activity, specifically the release of greenhouse gases into the atmosphere. Agricultural practices, deforestation, and the combustion of fossil fuels are examined in conjunction with natural contributors like volcanic emissions. There is discussion of the far-reaching effects of climate change, such as increased temperatures, rising sea levels, harsh weather, and effects on water supplies. The article emphasizes how crucial it is to mitigate and adapt to the effects of climate change by putting in place climate-resilient infrastructure, switching to renewable energy sources, and lowering greenhouse gas emissions. While recognizing the difficulties involved, it examines several approaches, including nuclear energy, wind power, carbon capture and storage, and green building techniques. To successfully address the global challenge of climate change, the conclusion emphasizes the urgent need for joint efforts by scientists, environmentalists, communities, and governments.

**Keywords:** global warming; greenhouse gases; sea-level rise; deforestation; fossil fuels; renewable energy; climate resilience; sustainable practices

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## 1. Introduction

The most frequently used environmental word today, "Climate Change" describes the shift in today's climate that has been caused by human activity (Füssel, 2007). It is one of the most pressing ecological problems of our day (Moser & Dilling, 2004; Grover, 2011). Smith et al. (2009) found overwhelming evidence of climate change. The public, governments, and scientific communities across the world are concerned about climate change. The United States National Climate Assessment released in 2018 found that the rate of climate change on Earth is increasing at an unprecedented rate, with human activities being the primary cause (Jay et al., 2018).

Although the terms "climate change" and "global warming" are sometimes used interchangeably, they refer to two distinct phenomena (Schuldt et al., 2011). A "warming" is just one phase of the wider climate system on Earth, which inherently exhibits change. Scientists have learned that long-term shifts in Earth's climate can be caused by a wide variety of reasons, thanks to data gathered from both Earth and space (Karl et al., 1995). Solar radiation, Earth's orbit, volcanic eruptions, ocean currents, and plate tectonics are all examples of such variables.

No matter how far we get with mitigation efforts, past emissions guarantee that the planet will continue to warm, and it will likely do so by more than the 20 degrees Celsius that many consider to be the threshold for 'dangerous' interference (Parry et al., 2009). Adger and Barnett (2009) warn that a 40C increase in global warming by 2100 is becoming more plausible due to the lack of an international framework for stabilizing emissions. The Arctic ice cover is melting, with a volume loss of 3% to 4% every decade since the 1970s (Ramanathan and Feng, 2008). There is no longer any doubt that the climate system is warming, as evidenced by rising worldwide average air and ocean temperatures, widespread melting of snow and ice, and a higher global mean sea level, as stated in a study by the United Nations' Intergovernmental Panel on Climate Change (IPCC). Rising temperatures and erratic weather in the tropics and middle latitudes would displace millions, if not

billions, of people from their homes, which would have disastrous economic and social consequences (Fussel, 2009).

### *Objectives*

This article's primary aims are to examine climate change's occurrence thoroughly, offer a full explanation of its historical background, differentiate it from global warming, and highlight its anthropogenic origins, specifically the contribution of greenhouse gases. The article seeks to clarify the diverse effects of climate change on the environment and human communities, encompassing elevated temperatures, sea-level elevation, and heightened occurrence of extreme weather phenomena. Moreover, it aims to emphasize the pressing need to embrace both mitigation and adaptation methods to address climate change, including examining initiatives such as decreasing greenhouse gas emissions, shifting to renewable energy sources, and developing climate-resilient infrastructure.

## **2. History of climate change**

Humans have been discussing climate change for much longer than one may assume. According to Weart (2007), the idea of climate change has been around since antiquity, and our understanding of the phenomenon has evolved as our tools for studying it have become more sophisticated. Guy Stewart Callendar was a pioneer in the field of climate science who foresaw potential issues, and his theory that carbon dioxide acts as a heat-trapping agent was confirmed by computer climate models in the 1970s. It seems the climate was so precariously balanced that even a slight change may have far-reaching consequences (Weart, 2007).

For most of its history, beginning in the early nineteenth century and continuing until the late twentieth century, this subject was only broached in the scientific community (Vlassopoulos, 2012). It first became a topic of public discussion in the 1980s (Seacrest et al., 2000). Since then, on the one hand, believers have made it clear that they fear for the physical and economic stability of society because of the impact human activities are having on the global climate. On the other side, the skeptics have provided enough data to rule out the possibility that Climate Change is caused by humans. Again, those who are concerned about climate change have argued about how to handle the problem best. As a result, this subject has been argued and problematized from a variety of perspectives due to the growing public engagement in the Climate Change discourse and the resulting awareness of the potential hazards and uncertainties associated with the issue (Granderson, 2014).

The climate of Earth has been analyzed by the Intergovernmental Panel on Climate Change; an organization comprised of many climate scientists (Stocker, 2014). Over the past few years, the IPCC has released four reports investigating the links between human activities and climate change. The report titled "Climate Change 2007" stated that nearly all participants agreed that rising temperatures throughout the world are caused by human activity. For their work in bringing this issue to the forefront internationally, the IPCC was recognized with the Nobel Peace Prize

## **3. Causes of Climate Change**

It is generally accepted that greenhouse gases are one of the primary causes of global warming (Lashof and Ahuja, 1990). Because of how well they retain heat, they cause a phenomenon known as the greenhouse effect. Carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and fluorinated gases are the most important GHGs.

The sun's rays hit Earth's surface, where some of them are absorbed, while the rest are reflected up into the atmosphere as heat. Greenhouse gases then soak up some of the heat before they escape into space. Then, they either return the heat to the ground, transfer it to another greenhouse gas molecule, or release it into space. Since CO<sub>2</sub> accounts for over 75% of the total global output of greenhouse gases (Burghila et al., 2015), it is the primary source of concern among scientists.

Annual increases in methane and carbon dioxide concentrations in the atmosphere are blamed for today's warming trend (Berbisi et al., 2014). In addition to studying the development of petroleum systems in two distinct geological contexts, Berbisi et al. investigated the possibility of methane release into the atmosphere.

#### *Human Contributions*

Human activities such as burning fossil fuels, clearing forests, and farming have all contributed to a rise in greenhouse gas emissions (Xi-Liu and Qing-Xian, 2018). Burning fossil fuels raise greenhouse gases like carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and a few other gases in the atmosphere, leading to widespread climate change (Wuebbles & Jain, 2001). Eighty percent of the energy used yearly comes from fossil fuels like oil, coal, and natural gas (Arutyunov and Lisichkin, 2017). Since we rely so heavily on fossil fuels, it is challenging to transition to alternative energy sources.

Since the beginning of the industrial revolution, there has been a tremendous increase in the release of greenhouse gases (Yoro and Daramola, 2020). The main source of carbon dioxide emissions comes from the transportation industry. Another major contributor to carbon dioxide emissions is the energy industry, which includes the generation of electricity (Yoro and Daramola, 2020).

Deforestation, or the destruction of trees and forest cover, is another major contributor to global warming (Aba et al., 2017). Trees play an important role in climate regulation because they remove CO<sub>2</sub> from the air and replace it with oxygen. Reduced tree cover means less carbon sequestration and more greenhouse gas emissions because of deforestation.

Agriculture, which includes the raising of livestock and the alteration of land use, is also a major contributor to greenhouse gas emissions. When animals digest their food, they release methane, a powerful greenhouse gas. Changes in land use, such as clearing forests to make way for farms, also increase GHG emissions (Verge et al., 2007).

#### *Nature Contributions*

Volcanic emissions of carbon dioxide (CO<sub>2</sub>) also contribute to climate change (Riebeek, 2010). Historically, volcanoes have been a source of CO<sub>2</sub> emissions for millions of years (Shine et al., 1990). However, when compared to human-caused CO<sub>2</sub> emissions, the amount these sources provide is negligible, and they cannot account for the century-long rise in atmospheric CO<sub>2</sub> levels (Shine et al., 1990). NASA estimates that annual volcanic CO<sub>2</sub> emissions total between 130 and 230 million metric tons. However, humans release more than 100 times as much CO<sub>2</sub> into the atmosphere annually from burning fossil fuels, or around 26 billion tons (Riebeek, 2010).

### **4. Impacts of Climate Change**

There are several ways in which climate change harms the natural world and human communities. Rising temperatures, harsh weather, rising sea levels, impacts on water supplies, etc., are the most noticeable effects.

#### *Rising Temperatures*

As greenhouse gas emissions rise, so does the amount of heat trap in Earth's atmosphere, according to NASA. Scientists estimate a 1°C increase in global temperatures since the industrial revolution, with further increases of up to 4°C possible by the century's conclusion.

#### *Sea-Level Rise*

The melting of ice sheets has been linked to global warming as well (Riebeek, 2010). Rising sea levels caused by melting ice threaten the existence of several islands (Riebeek, 2010). NASA estimates that up to 10% of the global population resides in regions that are around 30 feet above sea level. In addition, over 125 billion tons of ice are melting annually from Greenland and West Antarctic ice sheets (Riebeek, 2010). In this century, sea levels could increase as much as six feet, according to some

estimates (Wuebbles & Jain, 2001). Coastal and low-lying areas are in danger as rising sea levels bring about flooding, erosion, and saltwater intrusion.

#### *Extreme Weather Events*

Hurricanes, droughts, and wildfires are becoming more often and destructive because of climate change. Damage to property, casualties, and displaced populations all add up to huge monetary and human costs from these disasters.

For example, since 2002, the frequency with which extreme weather events occur in Romania has increased. The 2007 drought was the worst in the country's recorded history (Burghila et al., 2015). Warmer temperatures, which are primarily the result of the emission of greenhouse gases, have also contributed to the increased severity of hurricanes. When the air is warmer, there is more potential energy to be used. Most of a hurricane's initial power comes from the ocean, and with the oceans getting warmer due to the greenhouse effect, storms are more powerful than they otherwise would be. This results in stronger hurricanes. With colder water, storms would have less energy to do damage (Wuebbles & Jain, 2001). More water vapor may be held in the sky at higher temperatures, leading to heavier downpours (Riebeek, 2010).

#### *Impact on Water Supply system*

Water availability, water quality, and the treatment of drinking water are all negatively impacted by climate change (Mo et al., 2016). It needs to be determined how climate change may affect human access to potable water due to specific locales, local water supplies, and water technology. Both the greatest and lowest emission levels projected by the Intergovernmental Panel on Climate Change (IPCC) (Mo et al., 2016) pose a small risk of reducing energy and chemical consumption in the future.

### **5. Mitigating and Adapting to Climate Change**

A mix of mitigation and adaptation strategies is needed to combat climate change. Reducing greenhouse gas emissions is the goal of mitigation efforts, while reducing the negative effects of climate change on people and the environment is the goal of adaptation efforts.

Improvements in energy efficiency, increased use of renewable energy sources, and promotion of sustainable land use practices are all examples of efforts that can be taken to mitigate the effects of climate change (Owusu and Asumadu-Sarkodie, 2016). Policies and regulations can be implemented by both governments and corporations to encourage GHG reduction.

Climate-resilient infrastructure, such as sea walls and flood barriers, and land-use planning strategies to mitigate flood and erosion risks are examples of adaptation measures (Vallejo, 2017). Governments and communities can also prepare for emergency situations by creating emergency response plans to use in the case of severe weather.

There have been numerous international talks and arguments about how to counteract climate change. There are several variables, however, that affect the solutions' economic viability and ongoing maintenance costs. Wind power, nuclear power, carbon capture, storage, and utilization of green buildings are among those deemed effective in slowing the rate of climate change.

#### *Wind power*

The Environmental Protection Agency (EPA) reports that, since 1990, wind power has more than doubled worldwide. The Environmental Protection Agency (EPA) estimates that the environmental impact of electricity generated by wind turbines is negligible. Further, the Environmental Protection Agency (EPA) notes that wind turbines do not necessitate the use of water. Wind turbines reduced power sector water use by 36.5 billion gallons in 2013, according to the U.S. Department of Energy. Wind energy benefits include a reduction in carbon dioxide (CO<sub>2</sub>) emissions in 2013 of about 115 million metric tons, which is equivalent to the annual emissions of 20 million cars (Wiser et al., 2016).

Wind power, however, faces several obstacles. Birds and bats have been killed after colliding with the turbines' rotating blades, which is a major issue (Smallwood and Bell, 2020). However, avoiding constructing wind turbines in places with a large concentration of migratory birds and bats is one answer to the problem of birds and bats being killed by the spinning blades. The blades of wind turbines could also be designed to only turn above a specified wind speed.

#### *Nuclear Power*

By using nuclear power instead of burning coal or natural gas to generate electricity, Právělie and Bandoc (2018) estimate that 1.2–2.4 Gt CO<sub>2</sub> emissions can be avoided yearly. The report predicts that a total investment of almost \$ 4 trillion would be needed to increase nuclear plant capacity to around 930 GW by 2050, bringing it in line with the 2 °C objective established by the Paris accord.

Several significant drawbacks exist despite nuclear energy's reputation as a low-carbon solution for climate change mitigation. To begin, developing a nuclear power plant requires a large initial investment and ongoing expenses. As an additional concern, nuclear power poses a significant risk of radioactive pollution to the surrounding environment due to the potential for reactor accidents and the peril of nuclear waste management (Právělie and Bandoc 2018).

#### *Carbon capture, storage, and utilization*

Carbon potential decarbonization strategy with applications in the power and industrial sectors, carbon capture and storage hold much promise (Lau et al., 2021). Separating and capturing CO<sub>2</sub> gases from processes that use fossil fuels like coal, oil, or gas is the basis of this technique. After CO<sub>2</sub> has been caught, it is transferred to underground reservoirs, where it will remain for thousands of years (Lau et al., 2021). The primary goal is to reduce emissions while still making use of fossil fuels. Pre-combustion capture, post-combustion capture, and oxyfuel combustion are the three primary methods of capture. There is a unique method for removing and storing carbon dioxide in each of these technologies. However, post-combustion capture technologies have the most potential for widespread use and make the most sense for retrofit projects (Vinca et al., 2018). Safety concerns relating to leakage and the need for secure storage are two major issues with carbon capture and storage. There is yet no evidence that carbon collection, storage, and utilization can be implemented on a large scale.

#### *Green Buildings*

Present-day buildings release carbon dioxide (CO<sub>2</sub>) because they rely on fossil fuels for heating, cooling, and powering electrical systems. Buildings are responsible for 30% of the United States' total greenhouse gas emissions, so making them more eco-friendly is a priority (Skillington et al., 2022). Reduced carbon dioxide emissions can be achieved through the installation of energy-efficient lighting, heating, and cooling systems. As a result, we use less fossil fuel to generate energy, which in turn lessens our contribution to global warming gases (Energy-Efficient Buildings).

## **6. Conclusion**

Climate change is a serious worldwide problem that demands immediate attention if its damaging effects are to be lessened. Human activities like burning fossil fuels, deforestation, and agriculture release greenhouse gases into the atmosphere, which are the primary driver of climate change. Increases in average global temperatures, sea levels, and the frequency and intensity of extreme weather events are all consequences of climate change. The only way to combat climate change is through a combination of mitigation and adaptation strategies. Reducing greenhouse gas emissions and building climate-resilient infrastructure are two areas where governments, businesses, and individuals can all make significant contributions. To meet these difficulties and fight climate change, scientists, environmentalists, communities, and policymakers must work actively and together.

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