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<b>Article:</b>	<b>Global Warming Potential: A Brief Guide to Understanding and Evolving</b>
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## **ABSTRACT**

### **Abstract:**

Now a days there is a serious concern about the Global Climate Change. Most of the people are still ignorant of global warming and do not consider it to be a big problem in years to come. It is a complicated issue full of worries and arguments. Constantly Fossil fuels are being used to produce electricity. Deforestation is also a reason for rise in temperatures. In this article the major causes and consequences of global warming has been reviewed and discussed to educate non-technical readers. Human activities which lead to the GW like deforestation, burning of fossil fuels etc are briefly described. Moreover, the effects of GW such as temperature increase, rising seawater level and heatwave threats, have been discussed.

**Keywords:** Global Warming, Energy, Climate Change, Gases

## **Introduction:**

Greenhouse gases (GHGs) are gases that absorb and emit energy in the form of heat, by acting as an insulation layer that warms the Earth and postpones the speed at which something departs into a vacuum. The most common gases in our world's atmosphere are carbon dioxide, methane, nitrous oxide, and water vapor. Due to the increase in concentrations of GHGs such as carbon dioxide, extra heat is trapped in the Earth's atmosphere and as a result, global temperatures rise. The capability of these gases to draw in energy (a manner otherwise known as radiative efficiency), and their lifetime in the atmosphere, are two significant behaviors in which they differ from one another (Lynch et al., 2020).

Global Warming Potential (GWP) was a technique invented by scientists in order to establish comparisons between the amount of impact each gas has on global warming. It measures how much energy 1 ton of a gas's emissions will absorb, relative to the emissions of 1 ton of CO<sub>2</sub>. The reason CO<sub>2</sub> is used as a base for all the calculations is that it is the dominant greenhouse in terms of its emissions. It also has the highest GWP potential. The greater the Global warming potential, the longer a specific number of gases warm the Earth, relative to CO<sub>2</sub>, throughout a particular period of time (Meng et al., 2018). 150 years is the average lifespan range for GWPs. Through the aid of GWPs, forecasters can compile approximations of the emission of different gases (for instance, to develop a nationwide GHG list) and politicians can evaluate the possibility to reduce emissions of particular gases and industries.

The effects of CO<sub>2</sub> emissions combined with its extremely long atmospheric residence period results in the rise of carbon dioxide in the atmosphere, leaving CO<sub>2</sub> in the earth's climate for thousands of years.

Besides different CO<sub>2</sub>, methane (CH<sub>4</sub>) also engrosses a lot of additional energy. The average ambient retention time of methane is close to ten years. Nevertheless, it has a Global Warming Potential varying from 28 to 36 due to its ability to capture significantly more energy than CO<sub>2</sub>. The Global Warming Potential also takes into account a few indirect impacts; for instance, CH<sub>4</sub> is a forerunner to ozone, another greenhouse gas (Palm et al., 2017).

High GWP gases are comprised of hydrochlorofluorocarbons (HCFCs), sulphur hexafluoride (SF<sub>6</sub>), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and chlorofluorocarbons (CFCs). For a given mass, these greenhouse gasses give a lot of additional heat than carbon dioxide (CO<sub>2</sub>). (These gases have GWPs ranging from thousands to hundreds of thousands.) N<sub>2</sub>O has a GWP 265- 298 times better than CO<sub>2</sub> and a 100-year residence duration on average. High-GWP gases are those with GWPs up to tens of thousands, such as HCFCs, CFCs, HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>). They hold a great deal more heat per unit of mass than CO<sub>2</sub> produces (Romm, 2018).

Methane has a lifespan of 12.4 years, with a Global Warming Potential of 86 during twenty years, and around 34 after hundreds of years. IPCC's fifth assessment report indicates that the GWP of methane is roughly dropping by a ratio of 2.5. F-gases, which are primarily utilized in chilling and air handling units, can also deplete the ozone layer by destroying the stratospheric layer that protects the earth from damaging ultraviolet rays. According to the

IPCC's most recent report, there are more opportunities to keep global warming below 1.5°C or even below 2°C by drastically cutting GHG emissions. The quality of air could rapidly improve in the interim (Schädler et al., 2019). The research also stated that it could take 20–80 years to stabilize the world's temperature. CFCs were widely utilized in industry, and it was later discovered that they may cause ozone in the stratosphere depletion. As a result, they were declared illegal under the Paris Agreement in 1987, and HCFCs and hydrofluorocarbons (HFCs) were suggested as a replacement in the 1980s. Subsequent research revealed that HCFCs have a strong potential to cause climate change and deplete ozone molecules. As little more than a result, the Kyoto Protocol of 1997 set a phase-out date for HCFCs of 2020-2030 and HFCs of 2025-2040.

The Doha Amendment was established in December 2012 in Qatar following the conclusion of the first Kyoto Protocol committed. In this case, nitrogen trifluoride has been added to the Kyoto Protocol's list of emissions gases with additional commitments for the years 2013 to 2020. The Paris Climate Agreement was adopted in 2015, ending the brief existence of the Doha Amendment. The Paris Agreement's main objectives were to limit global warming to 2°C this century, improve our capacity for coping with its effects, and address issues related to greenhouse emissions reduction, adaptability, and financing. By highlighting the main causes and consequences of Global Warming Potential, this development of interpersonal offers a quick comprehension of it. Furthermore, to clarify these widely misinterpreted facts, the question of whether or not the Sun is to blame for the GWP has been raised and explored towards the conclusion of this work. The reader is directed to search out the appropriate measures and answers to reduce the GWP by a hidden important question in this essay (Thompson, 2017).

### **CAUSES:**

The main contributors to GWP are actions taken by people. According to the IPCC, over the past 50 years, approximately 95 percent of respondents of human activities have contributed to global warming. These actions are mostly connected to the use of fossil fuels, tree-clearing or deforestation, as well as agricultural and farming techniques.

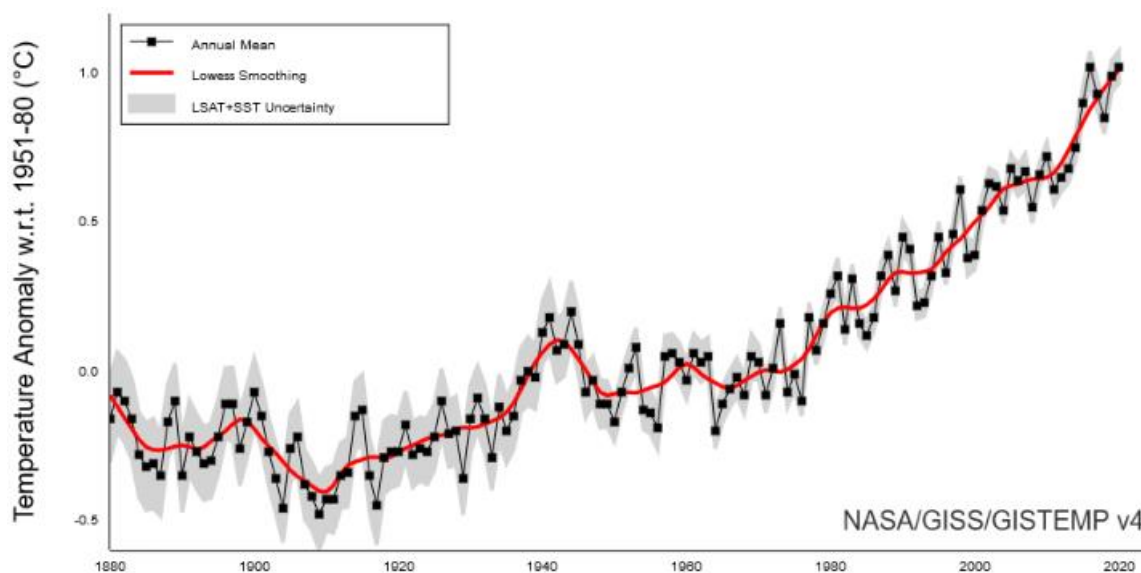
Other justifications show that human actions are not only to blame. The debate on whether or not carbon dioxide comes from biological compounds (such as volcanoes and animal exhalations) and natural phenomena in vast amounts has still not reached a conclusion. If it does, then they would again be another huge source of CO<sub>2</sub> production.

The primary factor contributing to global warming is greenhouse gas. Three principal gases, namely oxygen (20.95 percent), nitrogen (78.09 percent), and argon, make up the majority of the atmosphere on Earth (0.93 percent). These gases absorb energy quickly, and as a result, they permit the planet to receive and release limited quantities of energy. The rare gases that have the biggest impact on our climate are chlorofluorocarbons, methane, nitrogen oxides, carbon monoxide, and ozone (Hegerl et al., 2019).

The term 'greenhouse gases' (otherwise known as 'radiately trace element species') is frequently used to describe these trace gases (RITS). The typical gas levels in the atmosphere

are changed by these gases. RITS traps emitted heat while also allowing solar heat to reach the earth. Most of the light reaches the earth's surface due to the decrease in the rate of heat-absorbing and radiation caused by the increase in greenhouse gas concentrations.

The cause of the green gas (or greenhouse) effect is entirely linked to human activity. One of the greenhouse gases that warms the atmosphere is carbon dioxide. According to research, the quantity of carbon dioxide gas has increased since before pre-industrial times. Estimates for the increase ranged from 280 to 380 parts per million (ppm)



**Figure 1:** Global mean estimation based on land and ocean data

**Source** (Environmental and Energy Study Institute (EESI), 2021).

### Usage of fossil fuels:

The burn of fossil fuels (such as coal, oil, gas, etc.) for generating electricity, powering transportation, and operating different energy sectors is the leading cause of GWP. The reason for this is as they are used, the release of GHGs, especially CO<sub>2</sub>, is very high. More effort has been made to decrease the reliance on fossil fuels and seek environmentally friendly alternatives with no GHGs emissions in the last few years.

Previously, there has been a 1C increase in the average world temperature. More sea-level rise, exacting weather, species extermination, extinction of species, food lack, failing health, and amplified poverty are all dangers related to heating exceeding 1.5°C. Rendering to the Intergovernmental Panel on Climate Change (IPCC), emissions and fuel consumption are the main factors contributing to climate change. 80 to 90 percent of the world's CO<sub>2</sub> emissions in 2018 were produced by industry and fossil fuels. As the worst fossil fuel, coal is responsible for more than 0.3C of the 1C rise in regular world temperatures. As a consequence, it is the primary cause of the upsurge in global temperatures (Van der Meulen, 2019).

On the other hand, burning oil results in significant carbon dioxide emissions; it accounts for around one-third of global carbon dioxide emissions. Additionally, there has been a lot of oil spillage in recent times that have a catastrophic effect on the environment of our seas. As opposed to coal and oil, natural gas is frequently touted as a clean source of energy. Natural gas, which contributes roughly 5% of all global carbon dioxide emissions, is already a fossil fuel.

Renewable energy foundations, such as solar, wind, biomass, etc., have been a good alternative and show outstanding performance in many energy sectors. However, nuclear power generation has also been introduced as an essential energy source to minimize GHGs. Despite the essential role of renewable technologies, they are still not fast-growing and cannot overcome worldwide economic expansion and population growth. According to the IEA, today's world still heavily uses fossil fuels, and it will remain that way for a long time. Moreover, the IEA stated that renewables would provide 50% of energy demand by 2040, led by solar energy technologies.

**Deforestation:**

The burning of fossil fuels has commanded an upsurge in atmospheric carbon dioxide levels that are higher than what can be absorbed by current carbon sequestration-like forests. This increase has been exacerbated by the destruction of carbon sinks owing to rainforests and other activities. As more carbon dioxide accumulates in the troposphere, heat is trapped inside the lower atmosphere, causing global warming. The current level of carbon dioxide is the greatest in humanity's history (Benkman, 2018).

At the very same time, when climate change intensifies, carbon reserves in forests, as well as other natural carbon drains, will become even more unstable. Due to climate change, floods, tropical storms, increased temperatures, and fire conditions are becoming more severe and frequent. As a result, forestry losses will keep rising, increasing the amount of carbon dioxide emitted into the sky. Harvesting harms the climate because when trees are cut, the carbon they are storing is emitted into the atmosphere, where it mixes with other greenhouse gases and causes global warming. Steps should be taken to stop deforestation effective immediately.

Climate experts agree that the current contribution of CO<sub>2</sub> from tropical deforestation to global warming pollution is much less than 10%. This proportion has decreased in the past few decades, in part as a result of some progress in reducing deforestation. According to most estimates, the destruction of tropical rainforests releases more CO<sub>2</sub> into the atmosphere than all the automobiles and trucks combined that are driven on the planet's highways. The World Carfree Network (WCN) estimates that automobiles and trucks contribute roughly 14% of the world's carbon dioxide emissions, whereas most analysts put the figure at 15% or more.

It is common knowledge that forest ecosystems use photosynthesis to take in CO<sub>2</sub> from the atmosphere, store carbon (C), and returned it to the atmosphere (O<sub>2</sub>), which is a key factor in maintaining a stable climate. By putting carbon as CO<sub>2</sub> back into the atmosphere, deforestation, as well as other tree-clearing operations have a significant impact on the rise in

GHGs and eventually boost Global Warming Potential. The United Nations' Food and Agriculture Organization estimates that each year, deforestation releases between 25 and 30 percent of GHGs, increasing the Global Warming Potential in turn. When trees are destroyed, a large portion of the carbon is unconfined back into the atmosphere as CO<sub>2</sub>. That is how forest degradation and deforestation affect global warming (A. Harris, 2022).

### **Agriculture and Farming:**

Twenty to thirty out of each hundred greenhouse gases that are released into the atmosphere come from the agriculture sector, which also contributes the highest N<sub>2</sub>O (FF59 percent), which can destroy the stratosphere and cause other health problems. The main cause of the 50% rise in N<sub>2</sub>O emissions between 2000 and 2050 are agricultural fertilizers. On the other hand, the cultivation of rice and animals (cows, sheep, and cattle) produces methane or CH<sub>4</sub>. Livestock plays a significant role in contributing to the Global warming potential through enteric fermentation, which accounts for 12 percent of CH<sub>4</sub> emissions. However, paddy rice fields emit a high percentage of CH<sub>4</sub> gas emissions into continuously flooded fields, which adds to the GWP. Numerous other human activities contribute to the GWP, including the methane emissions from landfills, oil, and gas, various petroleum sectors, refrigerants used in industrial operations, etc (Biswal, 2021).

### **Consequences**

GWP has become a pressing issue in modern society, and numerous problems have emerged that endanger humanity. Our climate is affected by wind patterns, temperature, air pressure, and moisture. There are several climates throughout the world, including dry, mild, tropical, and much more. The seasons there are determined by the climate. Since we are living creatures, our environment has an impact on all aspects of our existence. For us to live a regular life, we need to live one that is steady and healthy ("Awareness on global warming among school students," 2020). However, this condition is being disturbed by climate change. All of us must be aware that the earth's temperature has risen by one degree C. Even though it appears to be a modest number presently, the effects it causes are enormous.

We are only seeing hotter days because of global warming. Every year, we surpass the previous record for the hottest day, month, or year. The unsettling temperature has reached 54 degrees Celsius. This is the only reason for the regular and severe extreme weather occurrences we experience. Natural calamities like forest fires, droughts, floods, and others are occurring more frequently. Glaciers and arctic ice are also melting as a consequence of global warming alone. The only effect of all this melting ice is an increase in ocean water levels. As a result, sea levels are rising, and the smaller islands and coastal towns are seriously at risk.

In addition, the temperature and acidity of our oceans are rising. These bodies of water have become more acidic as a result of absorbing the majority of the extra heat and carbon dioxide. Coral bleaching also results from this and fuels stronger storms. Aquatic life is at serious risk due to the growing pH, which also upsets their food chain. Some of these effects include:

**Temperature Increase:**

The rise in CO<sub>2</sub> emissions in the atmosphere surrounds the earth like a blanket, preventing the heat in the atmosphere from escaping. In its latest report, IPCC noted that, "the last three decades have indeed been progressively warmer at Earth's crust than any previous decade before 1850." The recent decade was the warmest on record globally, according to scientists and the measurements made, and 2016 was hotter than 2015 by more than 1 C. The average global temperature rises together along with greenhouse gases in the atmosphere. The hottest decades on record were from 2011 to 2020. Every decade subsequent to the 1980s has been hotter than the first one.

There are additional hot days plus heat waves in nearly all land places. Warmer temperatures worsen heart-related illnesses and force additional stimulation when working outside. As soon as the weather is warmer, wildfires start and spread more rapidly. The Arctic has warmed at least twice as rapidly along with the rest of the world. Together animals on land and in the water are at risk from climate change. As the temperatures rise, these risks rise as well. The rate of extermination on the planet is 1,000 times higher now than it has ever been in humankind's past, and this is deteriorated by climate change. Within the next numerous decades, one million species face extinction. Among some of the numerous dangers associated with climate are forest fires, severe weather, and exotic pests and illnesses (Albrich et al., 2020).

**Rising sea level:**

Almost all of the heat from climate change is absorbed by the ocean. All ocean depths have experienced a significant increase in ocean warmth during the past 20 years. Warmer waters become a heater, therefore, as the sea warms, so does its capacity. Sea levels upsurge as a consequence of melting ice sheets, imperiling coastal and island people. Additionally, carbon dioxide is absorbed by the water, keeping it out of the atmosphere. Additional carbon dioxide leads to the water becoming more acidic, endangering coral reefs and aquatic life.

Internationally, it became clear that GWP was to blame for the sea level increase. The extension of saltwater brought on by warming as well as the melting of glaciers and ice caps rose sea levels. Additionally, whenever ice sheets melt, the albedo (sunlight reflection) decreases, which dramatically increases global warming potential (GWP). According to the *Changes in Climatic Conditions 2017* report by the American Meteorological Society (AMS), the sea level increased by around 77 millimeters in 2017 compared to 1993.

Because of the rise in sea levels caused by glacier melting, several islands are in danger of disappearing entirely (Riebeek). Approximately 10% of the world's population, according to NASA, resides in regions that are around 30 feet above sea level (NASA). Additionally, the ice sheets in West Antarctica and Greenland are melting 125 billion tonnes of ice year (Riebeek) (Ali Mozaffari, 2022).



**Threats of heatwaves:**

Heat-related diseases and fatalities are projected to rise as heat waves become worse. Climate change is predicted to result in thousands of heat-related deaths annually in the US by the end of the 21st century. Globally, warm days are becoming hotter and much more frequent, whereas cold days are becoming less frequent. Every day historic high temperatures have occurred twice as frequently as low temperatures over the mainland United States. Over the previous ten years, it increased from a nearly 1:1 ratio in the 1950s. However, in some regions of the country, the 1930s still hold the record for most consecutive heat waves (mainly due to the Dust Bowl). Heat waves are getting more often, and violent heat waves are now more common in the West of the U.S. (Bansal et al., 2016).

Like most places, daily maximum and minimum temperatures will increase by at least 5 degrees Fahrenheit by the center of the last century, and by 10 degrees Fahrenheit by the conclusion of greenhouse gas emissions (Arto Blanco et al., 2017). Even by the middle of the century, most locations are expected to have 20 to 30 additional days that are 90 degrees Fahrenheit or above.

Heatwaves can enhance the risk of wildfires because they dry out the water and green flora, which acts as fuel for faster combustion.

**Health issues:**

Climate change is a major danger to public health. Some of the medicinal implications of climate change include increased hunger and poor nutrition in communities where children neither grow nor obtain enough food, air pollution, illness, severe weather, forced displacement, and pressure on mental health. Environment-related factors kill 13 million people annually. Severe weather raises the death toll and makes it difficult for medical services to stay pace with the increased variety of diseases brought on by shifting weather patterns. Humans experience heat stress when their bodies are unable to adequately cool down. Perspiration is normally a way for the body to calm itself, but then in conditions of high humidity, perspiration won't evaporate as rapidly, which could result in heat exhaustion (Chand, 2020).

High evening temperatures and high humidity are probably the main factors causing heat-related sickness and fatalities. Without a break from the heat at night, people may experience pain and health issues, especially those without resources available to help cool themselves, who are frequently those who are underprivileged. Older people, newborns, kids, those with ongoing medical issues, and outdoor laborers are populations who are especially susceptible to heat stress. Improvements in heat-related ailments, such as kidney failure, cardiovascular problems, and respiratory issues are also linked to hot days. High heat also has an impact on the quality of the air (Dellink et al., 2017).

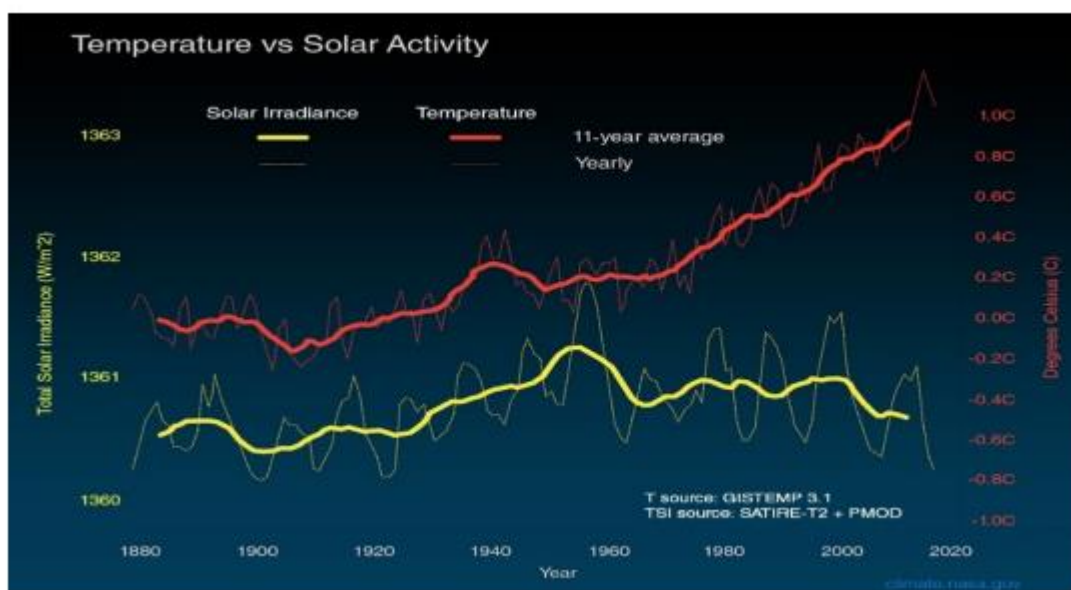
Days with high temperatures and plenty of sunshine can boost the creation of ground-level ozone, a dangerous pollutant that has been the principal ingredient in smog and that is able to impair the circulatory tract (Iler et al., 2021). Asthmatics are especially vulnerable to

this pollutant's effects. Additionally, increased air conditioning use uses more energy, and, dependent on the source of electricity, releases various pollutants like particles that also affect the quality of the air. The very same vulnerable groups that are already directly harmed by heat are particularly in danger from these increases in ozone and particle matter.

In locations with a typically cold environment where residents are not accustomed to the strong heat, the extreme weather events brought on by global warming potentially raise hospitalization and fatality rates. Ross examined how GWP has affected the health and found that both extremes of temperature had an elevated mortality rate. According to the study, 14800 people died as a result of the rising temperatures that hit Europe in August 2003. Furthermore, the effects of the rising temperatures and potential repercussions on those with chronic illnesses like diabetes, hypertension, and cardiovascular disease were significant (Kumar, 2018).

## Sun and GWP

Given that heat from the sun, which is the world's main energy source, adds to Global warming potential, most people believe that the earth is infested. Numerous investigations revealed the inverse correlation, demonstrating that if the GWP was caused by solar irradiance, the temperature increase should be seen in all levels of the atmosphere. By way of a result of the heat absorbed by Greenhouse gases in the air, the research showed that the upper atmospheric layers are cooler than the weaker level (Djekic et al., 2019). Additionally, solar



radiation production from the sun decreased slightly after 1978, according to the satellite instruments used to detect it. This means that the earth does not receive much energy from the sun to be heated. As a result, it can be said that the sun is to be not to be blamed for the Global warming potential.

Figure 2: Global temperature vs. sun energy on earth

Source (NASA, 2021)

**Conclusion:**

The Global average temperature homeostasis is disrupted by climate change, which has an important impact on both society and the environment. The impacts of climate change are divided into direct and indirect effects. Because of the rising atmospheric concentrations of greenhouse gases throughout the process of global heating, the energy content and resulting shift in earth's temperature have a substantial effect on both people and the environment. Many people have consistently disregarded scientific evidence of the seriousness of climate change. Research indicates that extensive involvement will successfully mitigate the effects of global warming. Environmental activists emphasize the importance of public participation in all programs to halt environmental deterioration brought on by climate change (Ebi & Hess, 2020).

This article provides non-technical readers with a basic understanding of the global warming potential (GWP) by simply examining the main causes and effects. The main contributors to GWP have been identified as human activities, including the combustion of fossil fuels, forest and deforestation, and farming and agriculture operations. The primary effects of GWP include rising temperatures, sea-level rise, and dangers of heatwaves. Furthermore, the last section addressed the frequently asked subject of whether or not the sun is to blame for global warming. This page is intended to give non-technical readers a foundational understanding of one of the most important problems in today's society.

Dreadful warnings of approaching anarchy and an unforeseeable calamity only seem to motivate attempts. Additionally, even though human activities have continued to worsen the greenhouse gasses and contribute to global warming, activities are routinely ignored. Without a question, global warming is a serious issue. Everybody has the power to solve this issue by adopting a healthy lifestyle.

These remedies range from simple household chores to intricate government programs like emissions trading, to lessen these consequences.

The universe is suffering more damage as a result of rising industrialization and technology. Water scarcity, agricultural growth, people's health, and civic unrest are a few of these repercussions (Alibašić, 2020). Due to the wide range of societal disciplines involved, dealing with the problem of global warming is exceedingly challenging. Lawmakers and economists see it as a problem or an opportunity, while ecologists see it as a danger to the environment and marine scientists as a concern about the planet's acidification. Consequently, everyone has a responsibility to adopt sustainable lives.

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