Journal of Geoscience and Environment Protection, 2025, 13(9), 158-191
https://www.scirp.org/journal/gep
ISSN Online: 2327-4344
ISSN Print: 2327-4336

Global Warming, a More Catastrophic Climate Change Reality of the 21st Century Than Ever Before: Underlying Factors, Impact and Youth Led Mitigation

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How to cite this paper: Tumwebaze, M., William, M., Harold, M., & Ronica, K. B. (2025). Global Warming, a More Catastrophic Climate Change Reality of the 21st Century Than Ever Before: Underlying Factors, Impact and Youth Led Mitigation. *Journal of Geoscience and Environment Protection, 13,* 158-191.
https://doi.org/10.4236/gep.2025.139008

Received: May 30, 2025
Accepted: September 23, 2025
Published: September 26, 2025

Abstract

Global Warming is the recent and ongoing increase in global average surface temperature. We are currently experiencing serious changes in earth usual temperature, a notable climate change in totality referred to as global warming. Climate change is the long-term shift in weather patterns and average temperatures. Ordinary weather shifts can be in a particular place or the entire earth in totality as it is for the current earth warming. Whereas natural changes in sun's activity, large volcanic actions and earth orbital movements accounted for such climate changes in the past, since 1800 Human activities like burning of fossil fuels; coal, oil, deforestation and industrialization accounted for the unprecedented Greenhouse gases (GHGs) emissions in the 21st century, leading to exceedingly greater global average surface temperatures. The current extreme warming is a global climate change in totality. This paper aimed at exploring global warming and its implication as climate change reality of the 21st century, suggesting cost-effective youth inclusive mitigation strategies. **Results:** Published literature reveal two underlying causes of climate change as, Natural processes and Human activities. The two, are major sources of Green House-gas emissions that directly bring about global warming-climate change effect. GHGs, form a stratospheric layer that prevent excess heat escape, thereby excessively warming the earth-atmosphere surface. Greenhouse gases, Carbon dioxide (CO_2), Water vapour (H_2O), Methane (CH_4), Nitrous oxide (N_2O), Ozone (O_3) are natural GHGs, but also man-made (synthetic GHGs) like Fluorinated Gases (F-Gases); Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCS), Sulphur Hexafluoride ($SF_{6)}$ with more Global warming potential than natural

GHGs, together cause extreme warming of earth. GHGs form a blanket wrapped around the Earth, trapping the sun's heat and cause global warming. Consequences include raising sea levels with flooding of coastal towns, longer and more damaging wild fires, shrinking of ice sheets and snow cover, thawing permafrost, Ocean acidification, famine/hunger, Eco-Anxiety, Drought effects on flora and Fauna and extinction of species. Urgent Youth inclusive mitigation actions include, moving away from use of fossil fuels to renewable energy use like solar power, wind energy and geothermal, ensure energy efficiency and adopt sustainable means of transport like buses, youth inclusive awareness campaigns, afforestation and reforestation, reduced waste production, restoration and conservation of ecosystems wetlands, emission reduction policy implementation of 2015 Paris Agreement on climate change, as well as use of Carbon Capture technologies. **Conclusion:** Global warming is real. The effects are catastrophic than ever before in the 21st century due to accumulation of GHGs in atmosphere from Human activities. Urgent mitigation needed today is everyone's role including youth. Together, we can save our planet by making it green again.

Keywords

Global Warming, Climate Change, Youth Inclusive Climate Mitigation, Greenhouse Gases

1. Introduction

Climate change, is a long-term change in the average weather patterns that have come to define Earth's local and global climates (NASA Science (gov), 2024a). The terms "global warming" and "climate change" are sometimes used interchangeably, but "global warming" is only one aspect of climate change (NASA, 2024). Global warming is the long-term heating of the Earth surface observed since the pre-industrial period (between 1850-1900) due to human activities, primarily fossil fuel burning, which increase trapping greenhouse gas levels in Earth's atmosphere. Global warming therefore is not interchangeable with the term "climate change" (USGS, 2022). Climate change includes both warming and side effects of warming, such as melting glaciers and more frequent droughts (Climate.gov, 2015). Scientists have tried to divide the causes of climate change and global warming into two broad categories, natural factors and human related (anthropogenic) causes (US EPA, 2025b). The natural causes are many including earth's orbital changes, solar variations, volcanic eruptions and ocean currents. Human causes include burning of fossil fuels coal, oil gas and deforestation.

2. Background

Before industrial revolution, natural sources such as volcanic eruptions, forest fires, and seismic activities were the known distinct sources of greenhouse gases such as carbon dioxide (CO_2), CH_4, N_2O, and water vapor (H_2O) into the atmos-

phere (Yue & Gao, 2018). As from the industrial Revolution era, human activities have released large amounts of carbon dioxide and other greenhouse gases into the atmosphere (Fahey et al., 2017; Friedlingstein et al., 2022). This has changed the earth climate. Although natural processes like sun's energy and volcanic eruptions also affect the earth's climate, they do not explain the warming that has been experienced over the last century (Lan, Tans, & Thoning, 2024). Global warming an aspect of climate change, is already considered as the greatest challenge of the 21st century overtaking other previous human threats like HIV/AIDS (Bowen, Romani, & Stern, 2010). Excessive warming of the globe in the 21st century is the earth climate change in totality. Studies on climate have demonstrated that, Climate change involves heightened temperatures across numerous worlds (Schuurmans, 2021). In the current times, Climate change and global warming have threatened people with increased flooding, extreme heat, increased food and water scarcity, more diseases and economic loss. Recent studies (IOM, 2008), have demonstrated that human migration and conflict are also consequences of climate change on record with climate-related events like droughts, floods, and rising sea levels forcing people to move and potentially leading to resource scarcity and conflict. On the other hand, World health organization Report at 75 years (WHO, 2025a) has also ranked climate change as the biggest threat to global health in the 21st century impacting environmental determinants of health and posing significant risks through extreme weather, infectious diseases, and food insecurity. Furthermore, WHO proclaims that, Climate crisis is health crisis and that, the European region is in the hot seat (WHO, 2025c).

Having recognized climate change in general and global warming in particular as global emergency that goes beyond national borders, combating climate change therefore requires international cooperation and coordinated solutions. This prompted world leaders on 12 December 2015 to enact the historic Paris Agreement that, aimed at tackling climate change and its negative impacts. The UN Climate Change (2015) conference (COP21) in Paris France, a legally binding agreement was signed by 195 parties (194 states plus European Union. Fundamentally, they all agreed to substantially reduce global greenhouse gas emissions to hold global temperature increase to well below 2˚C above pre-industrial levels and pursue efforts to limit it to 1.5˚C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change. In 2023, world's efforts under the Paris Agreement were reviewed during COP28 with a decision to accelerate action across all areas, mitigation, adaptation, and finance, by 2030, including a call on governments to speed up the transition away from fossil fuels to renewable energy such as wind and solar power in their next round of climate commitments. Despite the mentioned global efforts and in contrast, Global temperature trends analysis **Figure 1** below showed mean temperature in 2023 estimated to have been 1.54˚C ± 0.06˚C (2.77˚F ± 0.11˚F) above the average temperature from 1850-1900, a period used as a pre-industrial baseline for global temperature targets.

From Figure 1 below, the global annual average for 2023 at 1.54˚C ± 0.06˚C (2.77 ± 0.11˚F) above the average during the period 1850 to 1900, is noted as the first time any year has exceeded the key.

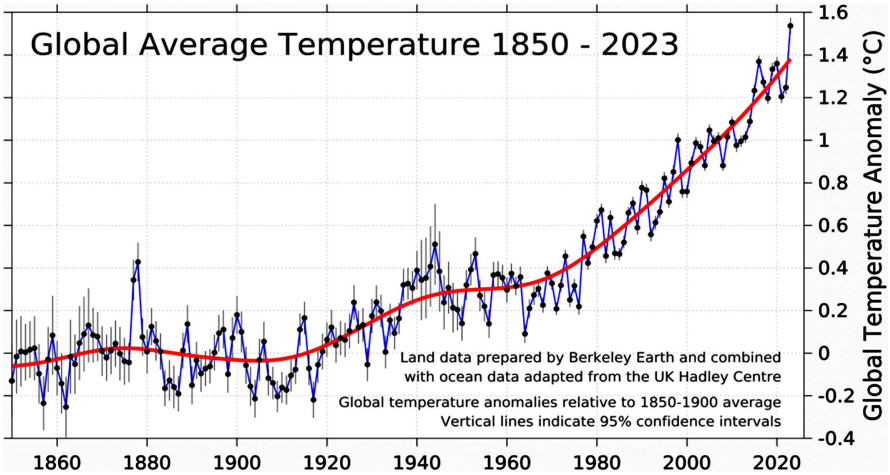


Figure 1. Global temperature trend 1850-2023 (Source: Berkerly global temperature data analysis).

Furthermore, Copernicus Global Climate Highlights report (2024), reveals that, global temperatures in 2024, reached extraordinary levels, marking it the warmest year on record with temperatures over and above 1.5˚C exceeding pre-industrial levels, a crucial threshold set during Paris Agreement. Year 2024, exact average temperature was 15.1˚C, surpassing the 2023 record by 0.12˚C. This reflected an increase of 0.72˚C, over the 1991-2020 average translating to 1.6˚C rise above pre-industrial designated temperature in respect to 1.5˚C (2.7˚F) threshold (National Centre for Earth Observation, 2024). The unprecedented temperatures resulted in several consequences that included extreme heat waves, wild fires notably in Calfonia and floods in some parts of the world. The Copernicus Climate Change Service (C3S) report, "Global Climate change highlights 2024" states that, by 10th July 2024, around 44% of the globe was affected by 'strong 'to 'extreme heat stresses. This was a consequence of increased atmospheric concentrations of carbon dioxide and methane that reached record annual levels in 2024, at 422 parts per million (ppm) and 1897 parts per billion (ppb) respectively. Carbon dioxide concentrations in 2024 were 2.9 ppm higher than in 2023, and methane concentrations were 3 ppb higher. This derails and reverses global efforts to Paris agreement. Exceeding the 1.5˚C global warming threshold, as per the Paris Agreement, signifies a potential shift towards a period of multiple Tipping points (McKay et al., 2022). Tipping points are thresholds' if crossed, trigger large-scale and potentially irreversible changes in a particular part of the Earth system. Increased climate change impacts, require more stringent and rapid emissions reductions to stay within Paris agreements' goals. It is now imperative that, the world should urgently undertake significant mitigation action on rapid reduction of greenhouse gas emissions by 45 percent before 2030 and achieve net-zero emissions by mid-

century (UNDP, 2024) this is only possible with global transitioning to renewable energy and enhanced carbon sink. A multifaceted strategy involving the youth at all levels is needed. While the youth are part of the human problem factor to the environment as key contributors to burning fossil fuels for energy and transportation that releases significant amounts of carbon dioxide (CO_2). Additionally, the youth are at the fore front of deforestation problem for economic gains in charcoal production. Deforestation reduces the number of trees that can absorb CO_2 (Nature and Culture International, 2014). During photosynthesis, trees absorb carbon dioxide from the atmosphere there by acting as carbon sinks. Deforestation affects sequestration process by reducing the number of trees available to sequester carbon, subsequently resulting in atmospheric CO_2 accumulation. Furthermore, the Youth being energetic constitute a high proportion of human resource in industrial processes that produce synthetic greenhouse gases, but on the other hand, their energy and involvement could also be harnessed for positive change in reducing these emissions.

In developing countries like Uganda, youth are also engaged in agricultural practices, livestock farming and fertilizer use that are linked to global warming chain via emission of potent greenhouse gases like methane (CH_4) and nitrous oxide (N_2O). Youth often represent a significant portion of the population in urbanized settings, this concentration of young people in cities is driven by factors like rural-to-urban migration and natural population growth (Cecilia, Gordon, & David, 2015). In such urban setups, there are quite a number of processes that, disrupt natural carbon and energy balances further exacerbating warming. Important to note also is that, it is much easier to access the youth in huge numbers like in institutions of learning, this creates opportune moments for engagement in climate mitigation actions. Empowering the youth to participate in climate change or youth engagement in climate action as agents of positive change would result in long-term behavioral changes, builds a sense of responsibility, and fosters a commitment to reducing short-lived climate pollutant emissions across a large population structure (Fiona, 2023).

Despite all the aforementioned youth opportunities, previous climate mitigation efforts have not targeted the youth, yet the youth hold more future hours on the earth planet than anyone else and therefore, should be part of the global climate solution. The old American Indian proverb reminds us "Treat the earth well: it was not given to you by your parents; it was loaned to you by your children. We do not inherit the Earth from our Ancestors; we borrow it from our children". We must therefore use it reservedly, or else we won't have anything to give back.

This paper aimed at, exploring the global warming climate realities of the 21st century, implications and youth inclusive mitigation measures from a Public and socio-scientific point of view. It is based on analysis of the existing literature on numerous global pieces of evidence that influence environment. Greenhouse effect is explained in detail at three levels, and various catastrophic consequences already existing and those expected are presented in details with a major focus on Public Health catastrophes. Several sustainable mitigation measures, adaptation practices

and techniques at national and global level are also discussed in this review.

3. Methods and Materials

Systematic Review

The study aimed at exploring climate change, global warming realities of the 21st century, consequences and sustainable youth inclusive mitigation measure through literature search. We adopted literature search approach and systematically reviewed past published work on the study subject guided by the key words. Systematic literature review techniques have proved literature review as a rigorous research framework (Benita, 2021; Shaun, 2023). We analyzed the content of published scientific studies on climate change and global warming from 2000 to 2025. This enabled us to follow up the trends in global climate change with subsequent warming of the planet year by year based on the 1850-1900 pre-industrial baseline temperature status, and the 2015 Paris agreement targets as threshold temperature. This guided and limited the discussion to remain in the context of the study aim.

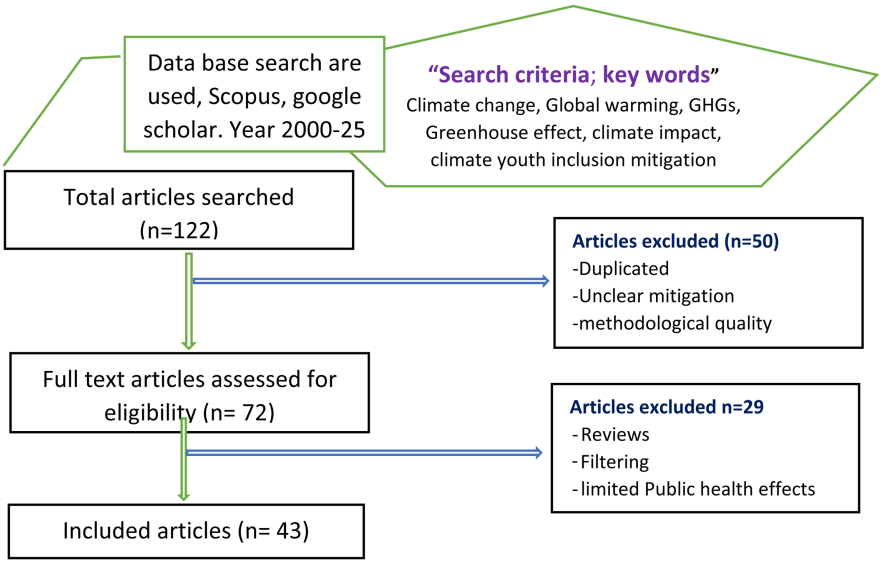


Figure 2. Reviewed paper framework analysis (Source: Constructed by the authors).

This study searched 122 articles, on different data base mentioned guided by the key words. It excluded 50 articles after reading and ascertaining duplication, unclear climate global warming mitigation measure missing responsible implementers and those with no detailed public health effects. At this level, 72 articles were eligible for final analysis. The inclusion criteria for final articles considered a clear mention of the underlying global warming factors with demonstrations, a mention of public health consequences and youth inclusive mitigation. Finally, the procedure yielded 43 articles (Figure 2 above).

4. Results and Discussion

Due to the diversity of this study findings on global warming and climate change

in respect to the study Aim, Authors adopted a concurrent study findings presentation and discussion of the study implications in context of existing research under a subheading Results and Discussion.

4.1. Studies Screened and Synthesized

A total data base generated 122, finally 43 articles met the inclusion criteria and were synthesized (referring to **Figure 2**).

4.2. Review of the Climate Change and Global Warming Concepts

4.2.1. What is Climate Change and What Is Global Warming

Climate change refers to long-term shifts in weather patterns and average temperatures (Wikipedia, 2025a; University of BATH, 2025). Changes in ordinary weather could be in a particular place over a period of time or the earth in totality: the usual expected weather patterns include moderate Rainfall during the rainy season but instead heavy rainfall or rainstorm (torrential rains or Elnino with serious floods appears, other examples include expected moderate dry season, but instead a prolonged dry spell or drought appears unexpectedly. Furthermore, normal moderate earth atmosphere temperatures are expected but instead high heat waves intensity is experienced while other climate change aspects include strong winds as Hurricanes. To date Climate change encompasses both the ongoing increase in global average temperature, known as global warming, and the broader, long-term shifts in Earth's climate patterns (University of BATH, 2025).

4.2.2. Causes of Climate Change and Global Warming

The shifts in temperatures and weather patterns may be natural, such as through variations in solar cycle (University of BATH, 2025), but since the 1800s, human activities primarily due to burning of fossil fuels like coal, oil and gas (Forster 2024; Lynas et al., 2021) are responsible for global warming. Fossil fuels—coal, oil and gas, are by far the largest contributor to global climate change, accounting for over 75 per cent of global greenhouse gas emissions and nearly 90 per cent of all carbon dioxide emissions. Other human activities include deforestation that reduces the number of trees which absorb carbon dioxide. Additionally, industrial processes and agricultural practices such as livestock farming and fertilizer use, emit potent greenhouse gases like methane (CH4) and nitrous oxide (N_2O). Greenhouse gases are chemical compounds found in earth-atmosphere surfaces that trap heat (National Grid, 2023).

4.2.3. What Are the Main Greenhouse Gases?

The main greenhouse gases include: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxides (N_2O), Fluorinated gases-Hydrofluorocarbons (HFC), Perfluorocarbons (C_2F_6, CF_4), Sulphur hexafluoride (SF_6) Water Vapor (H_2O), Ozone (O_3) Chlorofluorocarbon (CFC), Hydro chlorofluorocarbon (HCFC), Carbon tetrachloride (CCl_4) Nitrogen trifluoride (NF_3) (BYJUS, List Of Greenhouse Gases). **Figure 3** below displays different Greenhouse gases (water vapor, Nitrous oxide, Methane, carbon dioxide, ozone and Perfluorocarbon with their chemical presentation.

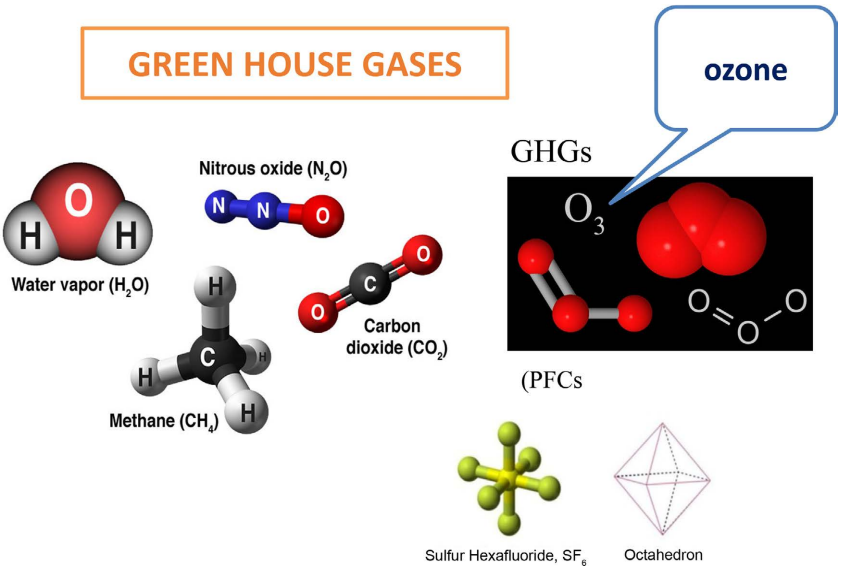


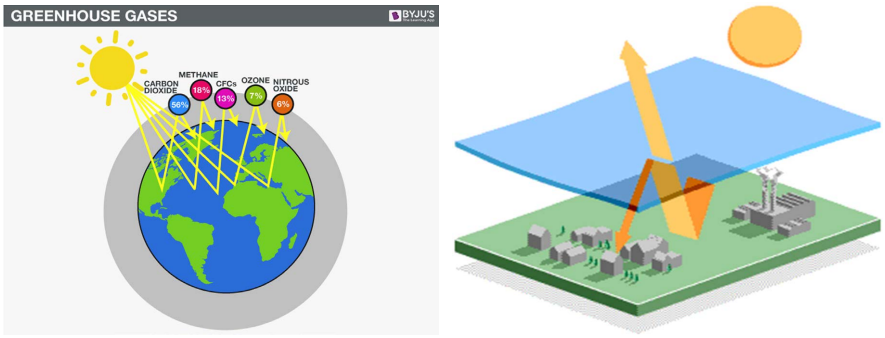
Figure 3. Chemical presentation of Main greenhouse gases (Source: Greenhouse gas molecules. Credit: NASA).

The most abundant GHG is CO_2 (National Grid, 2023). This is released through natural processes like volcanic eruptions, plant respiration, animals and humans' breathing. Methane is produced naturally through decomposition from landfills and burning of fossil fuels, the source of nitrous N_2O include fuel combustion, agricultural fertilizers, chemical, waste water treatment and biomass burning, important to note is that, whereas most of the mentioned GHGs are natural gases, the rest such as Hydrofluorochrorides (HFCs), Perfluorochrorides (PFCs), Sulphur-Hexafluoride (SF_6), Nitrogen Trifluoride (NF_3) are synthetic gases, manmade gases and do not exist naturally, they are industrial gases mainly used in refrigeration, air conditioners and aerosols, (Xtonnes, 2023). They however have a very high global warming potential compared to other gases like CO_2, CH4 and N_2O (EPA, 2025). Sulphur Hexafluoride (SF_6), which is used in high-voltage electricity equipment, has a "Global Warming Potential" (GWP) of 23,500 times greater than CO_2. Greenhouse gases control the climate through a greenhouse effect.

4.2.4. Greenhouse Effect Explained

Greenhouse effect is a natural process brought about by the Greenhouse gases like Carbon dioxide, water vapor, methane and others shown in **Figure 4(a)** below, as they trap and absorb outgoing infrared radiation (heat), that would otherwise escape into space (Richard, 2015). thereby causing natural warming of earth planet and making it habitable (NARDC, 2025). From the illustration **Figure 4(a)** and **Figure 4(b)**, the Greenhouse gases act as a thermal blanket for the Earth, absorbing heat and warming the surface to a life-supporting average of 59 degrees Fahrenheit (15 degrees Celsius). This process allows the excess heat (thick arrow shooting up in **Figure 4(b)**) to escape into atmosphere. At this level an equilibrium is established and the earth planet is at peace with nature. This is what is referred to as natural Greenhouse effect. The process was identified by scientists in the 1800s

(NARDC, 2025). NASA has observed increased GHGs emissions from human activities across the globe in the recent times (NASA Science, 2024). Too much of these greenhouse gases cause Earth's atmosphere to trap more and more heat. Consequently, disturbing the delicate balance of this complex Greenhouse system leading to Enhanced Greenhouse effect hence global warming. Figure 5 below illustrates Natural and Human enhanced greenhouse effect (Global warming).



(a) GHGs (b) Greenhouse effect

Figure 4. The GHGs, and the Green House Gases effect/action (Source: BYJU's).

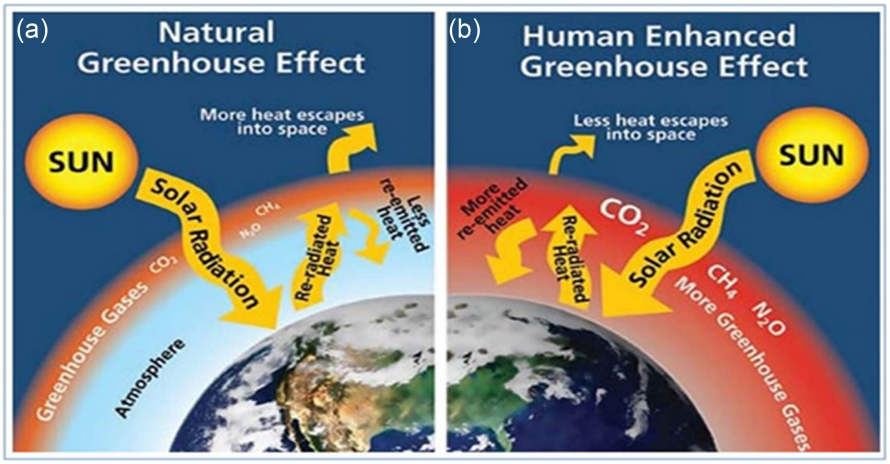


Figure 5. (a) Natural Greenhouse effect (Normal); (b) Human enhanced Greenhouse effect (Global warming) (Source: Published by Wiley and the institution of engineering and Technology; Online ISSN: 1750-0443).

4.2.5. Human Enhanced Greenhouse Effect Explained

The recent and ongoing increase in global surface temperature i.e. global warming is an aspect of climate change caused by concentration of Greenhouse Gases in the atmosphere. Studies have shown that, for over the last 150 years, human activities are responsible for almost all the increase in greenhouse gases in the atmosphere (NASA Science, 2024). Too much of these greenhouse gases cause Earth's atmosphere to trap more and more heat. Consequently, disturbing the delicate balance of this complex Greenhouse system leading to global warming. For over the last 150 years, human activities are responsible for almost all the increase in greenhouse gases in the atmosphere (US EPA, 2025a). In 2015 under the Paris

Agreement, countries agreed to significantly reduce global greenhouse gas emissions to enable the long-term global average surface temperature increase to be kept well below 2˚C above pre-industrial levels and pursue efforts to limit it to 1.5˚C (UN Climate Change, 2015). To every one's surprise however, 2024, global temperatures surpassed the 1.5˚C threshold above pre-industrial levels, marking the first calendar year to do so, raising concerns about the Paris Agreement's long-term temperature goals. This demonstrated laxity in global climate change action, business taken as usual, destroying nature through human activities. But nature is not a passive observer as it can fight back catastrophically. Sooner or later, humanity is taking nature to the 3rd aspect of the Greenhouse effect which is the Runaway Greenhouse effect as illustrated in **Figure 6** below.

Figure 6. Runaway Greenhouse effect (Source: https://stock.adobe.com/search?k=global+warming+earth).

4.2.6. Run away Greenhouse Effect Explained

A runaway greenhouse effect is a catastrophic scenario where a planet's surface temperature rises uncontrollably due to a positive feedback loop, trapping more and more heat, ultimately leading to a Venus-like hellscape (Wikipedia, 2025d). This occurs when GHGs accumulate in the atmosphere through positive feedback cycle to such an extent that, they substantially block radiated heat from escaping into space leading to increased temperature on the planet. This prevents the earth planet from cooling and from having water on its surface. A runaway version of the greenhouse effect if defined by a limit on planets outgoing long wave radiation which is reached due to higher surface temperatures evaporating water into the atmosphere (Kaltenegger, 2015). **Figure 6** above portrays the catastrophic consequence of global warming effect if we continue business as usual. By 2030, the Runway effect will be more evident with drying of water bodies and increasing desertification of the planned from high temperature. **Figure 6** last 2 images, depict the earth planet on fire, it means that, temperatures on the planet will have risen to a level of water boiling point making water in lakes, rivers and oceans to vaporize into the atmosphere, causing further heat trapping. These are glaring realities of the cur-

rent and future catastrophes of climate change if we don't take urgent action to reverse the trend. From National Archives (gov) (2025), the former US President Barak Obama, white house speech once said "we are the first generation to feel the effects of climate change and we are the last generation who can do something about it".

4.3. Practical Reflection on Underlying and Direct Human Causes of Climate Change and Global Warming

4.3.1. Population Explosion

The current global population at 8.2 billion people, remains the single most underlying driver to human effects on climate change. With a single country like India with 1.46 billion people, China 1.41 billion, USA 347 million, Indonesia 285 million people, Pakistan 285 million, Nigeria in the 6th global ranking position with 237 million and Uganda in 31st position global ranking with 51 million people. The unmatched population pressure on earth planet is exceedingly population overshoot. The resultant impact includes environmental degradation, Pollution, more toxic wastes damage to biosphere and people, Displacement of plants & animals species. Burning of gas, coal and oil increasing concentration of CO_2 in the atmosphere, altering the global climate with numerous public health effects. Population explosion in the developing countries drives, Rapid urbanization as people migrate from rural setting to urban centers seeking opportunities. In developing countries, a country like Uganda where the author comes from, recent reports (UN HABITAT Uganda, 2023) urbanization rate is 25% - 26% of the total population. Urbanization leads to infrastructure development-effect on ecosystems, this is due to increased energy consumption, more so in electricity generation, transportation and industry, which in turn aggravates greenhouse gas emissions intensifying climate change. (Semieniuk et al., 2021).

Unprecedented population growth exacerbates climate change by increasing resource consumption, greenhouse gas emissions, and environmental degradation, potentially leading to more frequent and severe extreme weather events.

4.3.2. Burning of Fossil Fuels

Burning fossil fuels is a direct, human climate change factor that releases a massive amount of carbon dioxide (CO_2) annually (Climate.gov., 2025). In 2024, global CO_2 emissions, including those from fossil fuels and land-use changes reached a high record of 37.4 billion tones and was projected to reach highest record of 41.6 billion tons by end of the year up from 40.6 billion tons in 2023 (ESSD Copernicus, 2025). about 45% of this is from coal, 35% from oil and about 20% from gas. Fossil fuels—coal, oil and gas, are by far the largest contributor to global climate change, accounting for over 75 per cent of global greenhouse gas emissions and nearly 90 per cent of all carbon dioxide emissions. Burning of fossil fuels as a human activity leading to climate change, is through a number of activities include, electricity generation by burning coal, extraction of coal, oil and natural gases, vehicles on the road and jet fuels/air craft fossil fuel burning. See **Figure 7** below depicting the current picture of greenhouse gases emission on most busy road in the developed

and developing countries.

Figure 7. Cars emit clouds of exhaust fumes during a traffic jam (Source: Shutter stock).

4.3.3. Deforestation

Cutting down of trees, clearing and burning trees for charcoal is another Human activity that leads to accumulation of carbon dioxide in the atmosphere (EOS Data Analytics, 2023; Climate Council, 2024). Primarily deforestation is a carbon source, as it releases stored carbon into the atmosphere, but also removing trees from the environment leads to accumulation CO_2 in the atmosphere that would otherwise be removed during photosynthesis at the same time release oxygen. This process counterbalances the carbon dioxide from the industrial activities and fossil fuel burning to nature's desired levels. Deforestation therefore, is the human worst regrettable triad tragedy of the 21st century because, it is a direct carbon source release, destroys carbon sink (absorption) and affects oxygen formation subsequently ozone formation. According to the World Resource Institutes' Global Forest Watch (GFW), which monitors and analyses deforestation, the Amazon basins tropical rainforests, spanning across nine South American countries, store an estimated 150 - 200 billion tons of carbon in its biomass and soils playing a significant role in regulating global climate. Despite the aforementioned critical role, the amazon rainforest faces intensified threats from deforestation by illegal loggers, potentially leading to a shift from absorbing to emitting carbon dioxide. Furthermore, it's on record that the Amazon forest fires produce three fold amount of carbon dioxide than the forest can absorb thus, creating a negative loop. The research published in the journal nature revealed that, fires produced about 1.5bn tones of CO_2 a year with forest growth removing 0.5 bn tons. The 1bn tons of carbon dioxide left in the atmosphere is equivalent to the annual emissions released in Japan, the world's fifth-biggest polluter.

Trees draw in CO_2 through photosynthesis, storing carbon in their trunks, branches, leaves and roots. When plants die or shade leaves much of the carbon gets deposited into the soil. Over time, this cyclic absorption keeps atmospheric CO_2 in check. In the recent study reports Lukas Fischer (2025), asks whether the Amazon will remain a carbon sink or carbon source. This year 2025, Brazil will host the COP30 climate conference in the heart of the Amazon rainforest, putting the spotlight on one of the worlds' most important tropical environments, a bio-

diversity hotspot and globally important carbon sink (GLF Forest, 2025).

Figure 8 above shows human destruction of the two global tropical Rainforest Reserves (Amazon and Congo basin). Forest destruction is now a crisis of the earth planet responsible for the current Global Warming catastrophe.

(a) Amazon massive deforestation (b) DRC massive deforestation

Figure 8. Deforestation of the global Tropical Rainforests; Amazon and Congo Basin (Source: The largest seizure of illegal timber in Brazil's history saw police recover 226,000 cubic meters (8 million cubic feet) of wood on the border between the states of Amazonas and Pará in March 2021. Image courtesy of the Federal Police in Amazonas state).

4.3.4. Industrial Sector: Human Source of Greenhouse Gases as Direct Cause of Climate Change

Manufacturing industry produces emissions from various industrial processes that include, metal smelting and processing, iron, steel, electronics, plastics, clothes, and other goods. From these activities, Greenhouse gases such as Carbon dioxide (CO_2)) Methane CH_4) Nitrous Oxide (N_2O), Chloroflourocarbon (CFCs), Sulphur Hexafluoride (SF_6) and Carbon Tetrafluorid (CF_4) are emitted into the atmosphere (IPCC Guidelines, 2006).

Manufacturing industry produces emissions from burning Fossil fuels industrial process include but not limited to Metal smelting and processing, iron, steel, electronics, plastics, clothes, and other goods. From these activities, Greenhouse gases such as Carbon dioxide (CO_2)) MethaneCH4) Nitrous Oxide Chloroflourocarbon (CFCs), Sulphur Hexafluoride (SF_6) and Carbon Tetrafluorid (CF_4) are emitted. Figure 9 below shows industrial emissions of GHGs.

Figure 9. Industrial GHG emissions (Source: Getty images: carbon emission stock photos).

4.3.5: Agriculture Sector

This is another Human source of Greenhouse gas emissions. From Rice Paddy fields (Steinfeld et al., 2006) Animal husbandly (ruminants) and fertilizer usage. GHG s released include; -Methane, carbon dioxide and Nitrous oxide. Livestock therefore is a major source of greenhouse gas emissions, but at the same time live stock is affected by climate change.

4.3.6. Waste Management

Waste is environmentally safely managed in a landfill. Sanitary landfill lead to decomposition of organic matter anaerobically, thereby producing huge quantities of methane gas (Balasus et al., 2025), with other waste disposal producing carbon dioxide. Methane is a powerful greenhouse gas, and reducing methane emissions is a priority for mitigating near-term climate change (Shindell et al., 2024; Lee, 2022). Targeted methane reductions are crucial alongside decarbonization efforts to minimize global warming because methane, a potent greenhouse gas, contributes significantly to near-term warming, and reducing its emissions is a highly effective strategy. Global methane assessment shows that, reducing human-caused methane emissions by 45% this decade, could avoid 0.3% of global warming by 2045. This would definitely help keep the Paris agreement's goal limiting global temperatures within 1.5 degrees. In August 2024 waste mismanagement in Uganda at Kitezi landfill Kampala metropolitan, got the world by surprise when a heap of garbage killed people in their homes. Reported on VOA English news, 24 dead in Uganda land fill collapse (VOA News, 2024). This seemed like natures' revenge and warning for human actions on nature. Everyone else in the world should have learnt from Uganda-Kitezi landfill case that, nature cannot be cheated. This literally means that, man mismanaged nature with a mountainous heap of waste in Uganda, and nature non selectively revenged by crushing human beings in their homes, notwithstanding the very homes where the waste had been generated and come from.

4.3.7. Concluding on the Underlying Causes

From the above presentation, it can be summarized that, human activities are the primary drivers of global warming and climate change in general from fossil fuel burning plant and burning of gasoline for transportation. Additionally, animal and agriculture activities together with fertilizers application as well as Deforestation contribute significantly. All these release enormous Greenhouse gases which act like a natural blanket around the earth planate, trapping excessive heat re-emitting back leading to global warming.

4.4. Impact of Climate Change/Global Warming

4.4.1. Extreme Heat Waves

At the time of writing this paper April May June 2025, many parts of the globe were experiencing heat wave i.e. an extended period of abnormally warm weather. According to Copernicus climate service 2025, the global-average surface temper-

ature for April 2025 was 1.51˚C above the estimated 1850-1900 average used to define the pre-industrial level and was the 21st month in the previous 22 months for which the global-average surface air temperature was more than 1.5˚C above the pre-industrial level surpassing the 2015 Paris threshold of 1.5ºC. According to the ERA5 dataset, a reanalysis data set provided by Copernicus climate change service (C3S), global temperatures in April 2025, were 1.51˚C warmer than pre-industrial average. A 1-degree Celsius increase in global temperature impacts severely on human societies and planet due to intense heat waves (NRDC, 2022).

4.4.2. Another Glaring Consequence of Global Warming is Increased Sea Level (NASA Science (gov), 2024a)

among other devastating effects like, extreme droughts, wildfires, and tropical storms. Global sea level has risen about 8 inches (0.2 meters) since reliable record keeping began in 1880 (NASA Science (gov), 2024a). By 2100, scientist project that it will rise at least another foot 90.3 meters), but possibly as high as 6.6 feet 92 meters) in a high emissions scenario. Sea level is rising because of added water from melting ice and the expansion of sea water as it expands. Consequently, this increases the risk of flooding to low lying communities and high risk coastal properties whose development has been encouraged by todays insurance systems (Renee, 2022).

4.4.3. Longer and More Damaging Wild Fires

Extreme high global temperatures lead to drying of the earth planet. Extra drying worsens natural dry spells and droughts, thereby increasing risk of heat waves and wildfires (Sun et al., 2019). The earth warming climate impacts the natural environment by amplifying wildland fire activity and more intense forest fires (Wikipedia, 2025b). Fire is a globally significant phenomenon affecting both human and wildland ecosystems (Moritz et al., 2012). Recent studies have showed that wild fires in western United States are due to human –caused climate change, and that this continues to be the dominant contributor to the increase of wildfire risk in other parts of US (Ostoja et al., 2023) Other related studies have established, similar and several devastating consequences of climate change as forest fires, drought, and pest outbreaks, to the livelihood of forest dependent communities. Similarly recent studies have observed that, the intensity and frequency of drought (Diffenbaugh et al., 2017) a consequence of climate change is impacting severely to the wellbeing of global forests.

4.4.4. Ocean Acidification

Ocean acidification refers to a reduction in the pH of the ocean over an extended period of time, caused by uptake of carbon dioxide from atmosphere (Alaska Nature and Science, 2024). Carbon dioxide has been accumulating in the atmosphere since industrial revolution due to burning of fossil fuels i.e., car emissions and changing land use as deforestation. The ocean absorbs about 30% atmospheric CO_2 (NOAA, 2025) to form carbonic acid (H_2CO_3), a weak acid that breaks (or "dissociates") into hydrogen ions (H^+) and bicarbonate ions (HCO_3^-). and the

level of acidity increases as the atmospheric CO_2 increases, making the water more acidic and potentially destroying aquatic life as a result of decreased pH (NOAA, 2025).

4.4.5. Global Warming Impact on Ice and Permafrost

Extreme temperatures due to anthropogenic activities are shrinking the world glaciers at the sometime disrupting the delicate balance of the mountains unique ecosystems, putting endemic plants and animals at risk. From Uganda's perspective, global warming (Uchoa & BBC World Service, 2021) has rapidly led to melting of glaciers on Mount Rwenzori with majority of the ice cover, having disappeared since 1906. Similarly, global warming has caused breaking up of the permafrost (permanently frozen ground) **Figure 10** below due to the raising temperatures primarily from climate change (NASA Jet Propulsion Laboratories, 2022).

Figure 10. Permafrost coastal bluff at Alaska (Source: Thawing permafrost can result in the loss of terrain, as seen in this image where part of the coastal bluff along Drew Point, Alaska, has collapsed into the ocean. Credit: Benjamin Jones, USGS).

Thawing of permafrost gives way to trapped greenhouse gases like methane, microbes and chemicals like DDT the banned pesticide (NASA Jet Propulsion Laboratories, 2022). The trapped and released Methane gas adds to the already existing from other sources and this accelerates global warming process, in addition thawing of permafrost destabilizes infrastructure, Public Health, ecosystems and alters the land scape.

4.4.6. Global Warming Consequences on Human Health

Global warming has detrimental effects on human health including heat related illnesses, spread of communicable diseases, and exacerbation of already existing cardiovascular conditions and asthma. Furthermore, extreme heat can lead to reduced air and water quality, disruptions in food security, and mental health challenges (Climate.Gov., 2020). According to the World Health organization (WHO) estimates, climate change might be responsible for 250,000 additional death per year during 2030-2050. Theses deaths are attributed to extreme weather induced mortality and morbidity and expansion of Vector borne diseases (Lemery,

Knowlton, & Sorensen, 2021).

4.4.7. Psychological Impacts of Climate Change-Global Warming

Global warming and the other broader consequence of climate change boost the extent of anxiety, distress, and other issues in public, pushing them to develop various mental-related problems (Weir, 2016; Berry et al., 2008). Besides, frequent exposure to extreme climatic catastrophes such as geological disasters also imprints post traumatic disorder, and their universal occurrence paves the way to developing chronic psychological dysfunction (Berry, 2009) Moreover, repetitive listening from media also cause anxiety. Similarly, communities living in flood-prone areas constantly live in extreme fear of drowning and die by floods. In addition to human lives, the flood-induced destruction of physical infra structure is a specific reason for putting pressure on these communities (Ogden, 2018), with subsequent health problems and hence a need for supporting psychological resilience during climate change crisis.

4.4.8. Global Warming Impact on Vector Borne Diseases

While Global rising temperature has resulted in extinction of many species, on the other hand, this warming temperature might favor the thriving of some new organisms Warm weather, induced by global warming favors growth and development of vector–agent life cycles particularly, fleas, ticks and mosquitoes that carry and transmit diseases (CDC, 2024), this subsequently increases a person's risk for vector bone infections like, Lyme disease, dengue fever, West Nile Virus disease, Plague and Tularemia. Global warming has led to a shift in geographical distribution of vector borne diseases. According to world Health organization for Animal Health (WOAH), disease such as Epizootic hemorrhagic fevers, Crimean-Congo fever, tick-borne encephalitis and Bluetongue are already spreading to Europe.

4.4.9. Biodiversity Loss

Global warming drives biodiversity loss, by exerting pressure on ecosystems with resultant shifts in habitat ranges potentially causing extinctions of those that cannot get accustomed to drastic environmental changes (WHO, 2025b). Subsequently, this affects vital ecosystem services like clean air, water, and food production for continued human existence, but also vulnerable ecosystems like coral reefs, wetlands, and forest are equally susceptible.

4.5. Worsening Inequality

4.5.1. Worsening Inequality

The climate catastrophe aggravates existing inequities, disproportionately impacting the poor and marginalized due to greater vulnerability and exposure to climate threats (NRDC, 2022) These inequalities manifest in economic, social, and health disparities, ultimately widening the gap between the wealthy and vulnerable (NRDC, 2022) Whereas more industrialized nations, have historically emitted more greenhouse gases, developing countries, due to limited resources and infrastructure, face the greatest challenges in adapting to the impacts of climate change (UNDP, 2024).

4.5.2. Impacts on Agriculture

Climate change threatens agricultural yields by inducing heat stress, altering rainfall patterns, and increasing pest and disease threats (Saleem et al., 2025). This significantly impacts agriculture by reduced crop yields, increased water scarcity, and soil degradation. But also, agricultural practices contribute to greenhouse gas emissions, further exacerbating climate change. Adapting to and mitigating climate change therefore, is crucial for ensuring food security and maintaining a sustainable agricultural.

4.6. Climate Change-Global Warming Mitigation

4.6.1. Background to Climate Change Mitigation

This study aimed at exploring the Underlying factors, impact and Mitigation measures of global warming as catastrophic climate change reality of the 21st century; Global warming mitigation refers to actions taken to reduce or prevent the release of greenhouse gases into the atmosphere, thereby slowing or reversing the warming of the planet (UNDP, 2024). The December 2015, Paris agreement on climate change was adopted by 196 UN member states, to limit global warming to well below 2 degrees Celsius, preferably 1.5 degrees Celsius compared to pre-industrial levels. Limiting global warming to the critical threshold of 1.5˚C, is imperative for the world to undertake significant mitigation action. This involves reducing sources of emissions, such as from burning fossil fuels, and enhancing carbon sinks (UNDP, 2024). Significant global effort is needed to cause substantial reduction of 45% greenhouse gas emissions by 2030 and achieving net-zero emissions by mid-century (IPCC synthetic Report, 2022). SDG 13, emphasizes climate change mitigation as a need to take urgent action to offset carbon emissions from human activities (Goal 13 Climate action). However, this cannot be achieved by a few individuals, it requires global solidarity and we must act now, together we can leaving no one behind as depicted by multiracial global hands around the globe.

Figure 11. Multiracial unity hands protecting earth planet (Source: http://www.shutterstock.com/).

Figure 11 above, shows Multiracial-multiple hands together in a powerful display of unity, gently cradling and protecting the earth globe. The sphere showcases vibrant blue oceans and green continent encircled by gentle supporting hands. This demonstrates humanity's shared responsibility for our planet, and the power of collective action in protecting our mother earth planet which is our global home. Mitigation action should be now not tomorrow, otherwise should man continue with his destructive activities, nature is already hitting back and might continue retaliating catastrophically.

The United Nations Secretary General Ban Ki-Moon (United Nations News, 2014) once said that, there is no planet B, no other planet currently found to support human life, although Astronomers have discovered more than 400 exoplanets to date, none of them serve as an alternative to earth planet. On the other hand UN Secretary General Antonio Guterres (UN.Org, 2025), during the one planet summit, remarked that, because of human activities effects on the environment, nature is striking back. The temperatures are exceedingly raising, Biodiversity collapsing, deserts spreading, fires, floods, and hurricanes are more frequent and extreme than ever before, this literally means that, when you harm nature, nature crushes you in turn. Guterres statement is not far different from one common assertion by some scholars that, a planet pushed to the edge will eventually turn on us. Addressing the consequences of global warming necessitates implementation of measures aimed at reducing greenhouse gas emissions and enhancing carbon sinks (UNDP, 2024) everyone has a role to play in climate change mitigation. In his message to Mr. Manuel Pulgar-Vidal, Minister of the Environment of Peru and President-Designate of the Conference or COP 20, now late Pope Francis, expressed his support to the UN conference 1st -12th December 2014 in Lima Peru on climate change. He had this to say "the time for seeking global solution for climate change is running out, and that we can find suitable solutions only if we act together and in agreement" (Vatican Radio, 2014-12-11 12:29:00) furthermore, Pope mentioned that, Climate Change is a serious ethical and moral responsibility. That said, together we can do the following to stop global warming.

4.6.2. United Nations Development Program

Recommends moving away from burning of fossil fuels as source of energy (UNDP Climate Promise, 2025), and emphasizes adopting renewable energy such as solar power, Wind energy, Geothermal. Bioenergy, Nuclear energy and hydropower. In recent years, global transitioning to renewable energy has become a critical strategy to address climate change challenges, enhance energy security, and foster sustainable development. Transitioning to renewable energy was proposed and developed by Mark Z Jacobson, professor at Stanford University, he also developed roadmaps to transition countries, cities, and towns to 100% clean, renewable energy for all purposes. As many countries strive to reduce dependence on fossil fuels, greenhouse gas emissions, the possibility of transitioning to 100% renewable energy has gained significant attention (Wang, Zhang, & Zhang, 2021).

Renewable sources like, solar, wind, hydro and geothermal will help to overcome the environmentally damaging fossil fuels.

4.6.3. Use of Solar Energy

Solar Power: Utilizing photovoltaic systems or solar thermal technology would save the world from the devastating effects of greenhouse gases from burning of fossil fuels. Solar power is a renewable energy source that produces electricity using sunlight, and it does not release greenhouse gases during operation (Ember, 2024).

Figure 12. Below displays solar plant installation (Source: Solar power station, Getty images).

With zero greenhouse gas emission during operation, solar energy source like that in **Figure 12** above becomes a clean and environmentally friendly alternative to traditional power generation methods like burning fossil fuels Furthermore, solar power as clean energy plays a crucial role in the decarbonization of our societies and reverse the worst impact of climate change UN report on climate action asserts that, the need to reduce carbon emissions by half by 2030 and reach net-zero by 2050 is now more urgent than ever before. Every day, the sun gives off far more energy than we need to power everything on earth (Fortum, 2025). After all, the UN Secretary General ANTONIO GUTERRES, reiterates that, "it's time to stop burning our planet, and start investing in the abundant renewable energy all around us".

4.6.4. Wind Energy

Installing wind turbines to harness wind energy**.** Wind energy is a dynamic clean energy solution that aligns with several United Nations Sustainable Development Goals, including affordable and clean Energy (SDG7), climate action (SDG 13) and decent work and economic growth (SDG 8) (Energy Warden, 2024). Furthermore, wind energy aligns with the goals of the 2015 Paris Agreement by significantly reducing greenhouse gas emissions and promoting renewable energy sources. It's now on record that, wind technology is playing an important role in the shift towards sustainable energy, aligning with goals of 2015 Paris Agreement

(IRENA, 2019) Wind along a long with solar, is expected to be the major driver of renewable energy growth with wind becoming the second source of global renewable electricity generation by the end of the 21st century, according to the international Energy Agency (IRENA, 2019). Wind turbines generate electricity without producing harmful emissions, making them a sustainable and environmentally friendly option. **Figure 13** below demonstrates how Rwanda, a developing country has paved its way through clean energy by investing heavily in wind electricity generation.

Figure 13. Rwanda wind energy (Source: Shutter stock).

4.6.5. Use of Geothermal Renewable energy

Geothermal is one of the most reliable renewable sources of energy, because the processes of heat generation is beneath the surface of the earth and goes on continuously self-replenishing without any interruption (BKV Energy, 2024). The uninterruptedly produced heat beneath the earth surface is tapped for electricity generation and indoor heating without producing greenhouse gases that affect climate. Important to note here is that, although, Geothermal, wind and solar are all renewable energy sources only Geothermal provides consistent, baseload power, in the absence of effective wind to run the turbines and solar radiation obscured by clouds, geothermal source is unstoppable.

4.6.6. Use of Biomass energy

This is renewable organic matter from plants and animals containing stored chemical energy from the sun, generated through photosynthesis (Energy Theory, 2023). Biomass is about using inherent energy in biological materials to generate electricity and heat. Essentially biomass refers to all plants, agricultural crops, wood, yard clippings, and even animal waste that can be utilized as a source of power. Derived from organic materials, it converts biological matter into electricity, heat and biofuels. (Biomass Energy, 2024), this source has been referred to as Nature's own power plant. During photosynthesis, plants absorb carbon dioxide and sunlight to produce oxygen and organic compounds, storing energy in their structure (Biomass Energy, 2024), Amongst, the available renewable energy op-

tions, biomass derived from the sun through photosynthesis, makes it abundant, renewable, and relatively cost-effective. The international community, through the 2025 Paris Agreement on climate change and the United Nations' Sustainable Development Goals (SDGs), have increasingly recognized the significance of bioenergy in achieving sustainable development and climate mitigation targets. The Paris Agreement, goals to limit global temperature rise, highlights transitioning towards low-carbon energy sources. The European Union aims to reduce greenhouse gas emissions by 55% and to achieve 50% renewable energy consumption by 2030 (Song et al., 2025; Rusănescu et al., 2024).

4.6.7. Use of Sustainable Transportation

The transport sector ranks among highest polluters and producers of CO_2. It requires to activate the EU forces to transform transport sector from tradition (with highest negative impact on the environment) to green development (Dzwigol et al., 2023), Sustainable transportation therefore is about reducing emissions from transportation to combat global GHG emissions. Shifting towards zero emission transportation modes like electric vehicles and public transport also promotes fuel efficiency (Environment Literacy Council, 2024). The global effort to electrify transport is further supported by advancements in renewable energy, making it possible to power EVs with cleaner electricity, thereby maximizing their environmental benefit (Abdullah, 2024). On the other hand, electric vehicles are very expensive, compared to other ordinary types because of the batteries and other technology costs. To expedite global transitioning in transport, various Governments should provide incentives through reduced tax and vehicle costs to make them affordable for consumers (Abdullah, 2024).

4.6.8. Engage in Active Transport

Active mobility, i.e. promoting walking and cycling by creating safe pathways with other lowest carbon modes of transport can make communities achieve sustainable economic and social goals. According to the world resource institute, active transport helps to reduce GHGs emissions so as to achieve global targets (World Resource Institute, 2021). Furthermore, the reports mention that, Cities contribute 70% of the world's GHG emissions and 21% of these come from urban transport alone. Shifting to walking and cycling can drastically reduce emissions and is the quickest and most efficient way to decarbonize transport. After all, Hippocrates, the Ancient Greek physician also regarded as the father of modern medicine asserted that, "walking is the best human medicine". Shifting to active transport therefore, benefits nature in general, but also man as an individual.

4.6.9. Investing in Carbon Capture: A New Technology to Reduce GHG Emissions

According to Adrian Corless, chief Executive officer Carbon capture. Direct Air Capture (DAC) is a new technology for achieving a net-Zero future, as highlighted by the IPCC's 2023 assessment report (UNFCC, 2021). It is widely recognized as the benchmark for carbon removal methods.

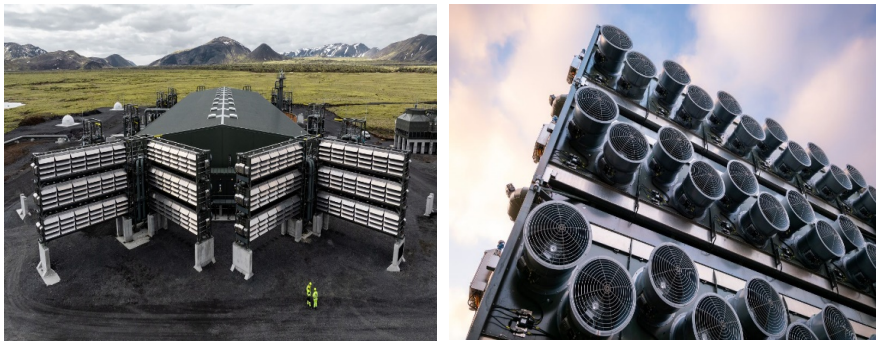


Figure 14. Clime works' Mammoth plant in Hellisheiði, Iceland. DAC plant (Source: CNN-Oli Haukur Myrdal/Climeworks, Mammoth Climeworks).

4.7. Sustainable Practices in Land-Use and Forestry

Sustainable land use is about managing land in a way that meets the current human needs without compromising the ability of future generations to meet theirs. It plays a significant climate change mitigation role by reducing GHG emissions and enhancing carbon sequestration (WOCAT, 2025). Practices like forest preservation, restoration of degraded land using sustainable agriculture techniques fulfil this goal and offer co-benefits like biodiversity conservation, and improved livelihoods.

4.7.1. Afforestation and Reforestation, Planting Trees to Absorb CO_2

Afforestation refers to the process of establishing forests in areas where there was no forest before, such as barren land or areas that have been deforested (Carbon Registry, 2025), trees are planted and allowed to grow naturally, this increases overall forest cover and is a natural climate change mitigation strategy. Reforestation is the process of restoring or replanting forests that have been destroyed or demaged through deforestation, wildfires or chacoal burning (Wikipedia, 2025c). Reforestation is by far the best natural method for mitigating changes to climate (Griscom et al., 2017; Fargione et al., 2018). The obvious potential of reforestation to sequester carbon to mitigate climate change is recognized by policymakers and scientists world over (Locatelli et al., 2015). The two initiatives, Afforestation and Reforestation therefore, are significant practical solutions for climate change-global warming mitigation and restoration of ecosystems. Global awareness scale up of afforestation-Reforestation strategy and individualizing implementation of the same as household targets before 2050 world over, would lead to sustainable humanity survival on our single mother earth planet.

4.7.2. Making Earth Green by Integrating Nature into Buildings to Stop Global Warming

Whereas afforestation and Reforestation strategy has been discussed and is a globally promoted strategy to combat climate change (Carbon Registry, 2025), nurturing nature into urban buildings by planting trees to make urban forests, establishing vertical gardens, living walls and green infrastructure (Gupta, 2025) can help to absorb carbon dioxide, lower temperatures and reduce heat islands, enhance

air quality, improve quality of life in urban setting generally becoming a powerful global warming mitigation measure. Figure 15 below demonstrates the practical reality of the desired future with nature integrated in urban buildings.

Figure 15. Designing cites with Nature in Mind (Source: Bas Fransen, CEO EcoMacher-2024).

Recent studies (Eco Macher, 2024), have demonstrated that, during heat waves, Cities integrated with nature, experience temperature reductions of 2˚C - 8˚C compared to areas without green infrastructure. In addition, air quality in improved by vegetation filtering pollutants with the enhanced carbon sequestration contributing to climate change mitigation. Urban nature integration at the moment may sound and appear as an exclusive venture for the developed world because of affordability, compared to the less developed, but climate change mitigation is a concept that should leave no one behind, a few developing countries have taken strides to transform their cities by establishing tree canopies and urban forests a case in example is Kigali city Rwanda. Figure 16 below.

Figure 16. Kigali city urban Tree canopy (Source: Mucyo Serge/UNDP Rwanda).

Figure 16 above shows that Kigali city is already on track, integrating nature into urban development, the trees bring about the cooling effect and this offsets the expense on use of air conditioners and purify the air around thereby improv-

ing the quality of life of people. Wide scale use of solar energy system observed on rooftop, also demonstrates the country's effort transitioning to green energy use. All these are strategies not only contributing to global effort towards zero carbon emission and global warming mitigation, but such growth and developments in Kigali City, could facilitate the nation's economic transitioning to a middle status and probably high income status by 2050. In line with this therefore, the future of urban cities in the developing countries and elsewhere should embrace urban nature integration for sustainable development

4.7.3: Enforcing Climate Change Policies and Regulations and Creating a Supportive Environment for Implementation

Time for this could have been yesterday, but not later than today, for world leaders to walk the talk from the international environment conferences and summits. Way back in 1992, the United Nations Conference on Environment and Development (UNCED) otherwise known as the Earth Summit was held in Rio de Janeiro, Brazil from June 3rd to 14th. Sustainable development concept was conceived, that the current global needs by then, could be met without compromising ability of the future generations to meet their own needs. The concept was perceived as an attainable goal, for all the people of the world, regardless of being at local, national or international level. Just 5 years later, in 1997 Kyoto protocol was adopted and entered into force on 16th February 2005. This aimed at reducing GHG emissions, by committing 37 industrialized countries and the European Union to reduce their emissions by 5% below 1990 levels, over the first five year commitment period 2008-2012. As of now (2025) they are 192 parties to the protocol and the targets are not achieved. The question at hand is what went wrong? Apparently what appears to be more legally binding, widely publicized, globally trusted and positively perceived policy on climate is the UN Climate Change Conference (2015) known as PARIS AGREEMENT. Adopted by 196 parties at the UN climate change conference (COP21) in Paris France 12th December 2015 with a Global commitment to hold the increase in global average temperature to below 2˚C and limit temperature increase to 1.5˚C above pre-industrial levels. Important to note is that, realizing this target would require a reduction in greenhouse gas emissions by 45 percent before 2030 and achieving net-zero emissions by mid-century. Previously mentioned in this write up is that, surprisingly the 2024 global average temperature surpassed the 2015 Paris agreement target to equivalent of 1.60˚C (McKay et al., 2022), above an estimate of the 1850-1900 temperature pre-industrial level. The same question is asked? What went wrong? Have the leaders been walking the talk?

The recent UN climate change conference–United Arab Emirates from 30th November-12th December 2023. While reviewing progress on efforts to address climate change under the Paris Agreement, world leaders observed that, global progress was too slow across all areas of climate Action (UNFCCC, 2024) from reducing green gas emissions. The same question remains unanswered: have the leaders been walking the talk? What went wrong?

From this discussion, world leaders seem to have scored on developing feasible local, national and international policies on climate change that would save the globe from ecological collapse driven by climate crisis; however, the biggest missing link is effective enforcement of policy implementation. World leaders, sitting back and watching naïve people i.e. people with limited awareness of catastrophic consequences of human effects on environment should be a global blame on world leaders who after attending global summits and conferences go into relaxation mode. This is not a "one shoe fits all" blame, on the other hand, literature has it that, Rwanda was the first African country to implement total ban on use of polyethylene bags way back in 2008 (REMA, 2008). The policy was very clear, manufacturing, import, distribution and commercial use of plastic bags is illegal in Rwanda, punishable by jail for one year. Travelers from neighboring countries like Uganda with plastic bags, the bags are confiscated by border authorities and dropped for disposal at the border. This implies that, even the local leaders in the country together with security operatives have been empowered by the top leadership to implement, and enforce climate resilient policies. This zero-tolerance policy has made Rwanda one of the most litter-free countries in the world and the country is on track to fulfilling the global climate change policies. The leader walks the talk and this level of commitment to climate change laws enforcement is what is missing elsewhere, yet globally required to make the world a better place to live in.

4.7.4. Investing in Mental Health Support to Communities Facing Climate Change Impact

The need for mental Health support to people facing extreme weather events cannot be underscored because, direct and indirect consequences like depression, anxiety and Post-traumatic Stress disorder, have long lasting impacts on mental wellbeing of the affected individuals (Strong Minds Mental Health, 2025). Providing mental Health support therefore, helps build resilience and improves coping mechanisms, more so for vulnerable populations. More exciting roles and benefits of psychosocial support to victims of extreme climate are more evidenced in the following studies: Kitezi Land slide Kampala-Uganda waste damp killing 35 people and displacing thousands of people, Severe drought in Zambia due to lack of rain causing crop failure and during the worst cholera outbreak in Zambia following heavy rains. Strong minds were there in the 3 mentioned scenarios providing mental health support to people in the affected communities, this helped communities cope up with challenges. One survivor had this to say, "Losing everything I had was a traumatic experience, but with help of Strong Minds support group sessions, I was able to overcome depression and find ways to rebuild my life", Suzan, Mbale District Uganda Land slide survivor (Strong Minds Mental Health, 2025).

4.7.5. Investing and Supporting Youth-Led Initiatives That Allow Young People to Take Positive Climate Action

The apex of this study's goal was, to explore the underlying global warming-cli-

mate change factors, the impact and Youth led mitigation measures. The UN slogan by 193 UN members states during 2015 SDGs promulgation was, leaving no one behind in every action of the global transformation Agenda. This meant that all people, including those who are most vulnerable, should be included in the pursuit of sustainable development. It emphasizes the importance of addressing inequalities and reaching the furthest behind first. Empowering and engaging the Youth to take an active role in combating climate change fosters a culture of sustainability in communities and fulfils the principle of inclusiveness (Gupta & Vegelin, 2016) Youth led climate Action, is therefore a generational shift, not only to address climate change consequences, but also a call to a more equitable and sustained future (Funds for NGO's, 2025), where young generation are part of the solution and not part of the problem in processes that affect their lives and our mother earth planet. Besides, the Youth (15 - 24 years) constitute estimated 16% of the global population approximately 1.2 billion people in 2025 according to the United Nations International Youth day Resources (UN, Global Issues Youth, 2025). The Youth population is projected to reach 1.3 billion by 2030. This highlights the critical role and momentous action youth can contribute in climate change mitigation. Important to note also is that during the Global Goals Youth summit, the youth of today are recognized as leaders of tomorrow.

5. Conclusion

Climate change-Global warming is real. It's the recent and ongoing increase in average global surface temperature. It's due to accumulation of Greenhouse gases (GHGs) in atmosphere as result of both natural sources and human activities. In recent times, it is noted that, the extreme concentration of greenhouse gases in the atmosphere is due to human activity emissions. Consequences of global warming are the worst catastrophes of the 21st century to humanity and nature itself. Urgent climate change mitigation is needed by all, leaving no one behind, because nature is for everyone and all of us together should be up to care for nature. The most feasible and sustainable way is to make our mother earth planet green again through youth led mitigation measures.

Authors' Contribution

Research Design and implementation: MT, MW, KBR; Data collection: MT, MH; Data Analysis and interpretation: MT, MH, KBR; Manuscript writing: MT, MW, KBR; Manuscript Review for intellectual content; All authors approved the final version of the manuscript.

Compliance with Ethical Standards

This was a Systematic Review study that analyzed and synthesized findings from previously published studies. We did not engage human subjects during data collection and therefore, the study wasn't eligible for ethical approval.

Conflicts of Interest

There are no conflicts of interest among the authors to publishing this study.

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