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(REVIEW ARTICLE)



Climate change, causes, economic impact and mitigation

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Abstract

The earth and its environment is currently undergoing changes, which may be natural as a result of the earth's processes or artificial, as a result of man's activities that has altered the natural earth processes. Climate change is a result of the alteration of the atmospheric balance which in-turn has diverse effects on the earth's processes and her inhabitants. The aim of this review is primarily to elaborate the climate change, the causes, economic impact and methods of mitigating climate change. The effect of climate change is massive but this article is targeted towards the economic impact of climate change and methods of eliminating this effect in this area. It is a universal challenge, it therefore requires universal attention. This article is a review work on the previous publications on climate change including journals and other articles that are closely related to this topic, it goes ahead to reveal the current situations and effect of climate change in our society today and scientifically proven means of mitigating such effects. Fossil fuels are by far the largest contributor to global climate change, accounting for over 75% of global greenhouse gas emissions and 90% of all carbon emissions. Human activities have warmed the atmosphere, ocean and land, producing widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere. The methods of mitigating climate change are primarily by reducing the use of fossil fuels in order to stop adding more CO₂, Nitrous acid and methane (which are all greenhouse gases) to the atmosphere, by using more of renewable energy such as solar energy, geothermal energy, and hydroelectricity. Practicing better farming systems to improve crop yield other than using harmful chemicals. Implementing policies against gas flaring, faulty automobiles discharging high amounts of carbon into the atmosphere, bush-burning, deforestation etc, should be practiced more.

Keywords: Climate; Climate change; Mitigation; Economic impact; Fossil fuel

1. Introduction

Global environmental problems refer to the various environmental challenges that are happening all around the world. These problems include pollution, global warming, ozone depletion, acid rain, depletion of natural resources, overpopulation, biodiversity and climate change [1, 2]. Weather is the short-term measurement of the temperature and pressure movement in an area and time. Climate is the long-term weather pattern in a region, typically averaged over 30 years [3]. Climate change refers to long-term shifts in temperatures and weather patterns. Such shifts can be natural, due to changes in the sun's activity or large volcanic eruptions but since the 1800's, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil and gas [4]. Climate change can also be referred to as the long-term change in the average weather patterns that have come to define earth's local, regional and global climates.

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Having defined climate change, it is important to look at the causes of climate change. These causes could either be natural or man-made causes of climate change. The natural causes of climate change contribute less than 30% of the current effects of climate change in the world today [5]. These natural causes include volcanic eruption, fluctuations in solar radiation, tectonic shifts and changes in our orbit. The factors may be out of human control but there are many contributors of climate change that are well within the scope and control of humans, they include: Deforestation, gas flaring, burning coal, bush-burning, chemical fertilizers, release of carbon into the atmosphere by automobiles. These human factors which are on the increase everyday contribute greatly to the adverse change in climate. These changes have in turn affected the economy of the world negatively; it has caused scarcity, brought about extinction of lots of species, caused food insecurity and sky-rocketed the cost of food and living in general [6]. There are ways of mitigating climate change especially in the areas of the human-induced factors.

This review highlights the human factors responsible for climate change, the impact on the economy and best technique of mitigating such actions, thereby reducing the effects of climate change and climate change itself. The scope majorly bothers around the economic impact of such extreme change in a world like ours and how human efforts within the terrestrial level can mitigate such effects.

2. Climate change

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. (IPCC) Svante Arrhenius, a Swedish scientist first predicted that changes in atmospheric carbon dioxide levels could substantially alter the surface temperature of the earth through the greenhouse effect in 1896. These gases carbon dioxide (CO₂), methane (CH₄), Nitrous oxide (NO) and water vapor are the greenhouse gases [7], they are responsible for the trapping of infra-red radiation and emission of the same radiation at a later time. CO₂ is released through natural processes such as volcanic eruptions, plant respiration and animals and humans breathing. CO₂ is also released through the combustion of fossil fuel like coal. The atmospheric concentration has increased by 50 % since the industrial revolution began in the 1800's as a result of human activities like the burning of fossil fuels and large scale deforestation. Due to its abundance, CO₂ is regarded as the main contributor to climate change.

Nitrous oxide (NO) is produced through the large scale use of commercial and inorganic fertilizers, fossil-fuel combustion, nitric-acid production and biomass burning.

Methane (CH₄) is produced naturally through decomposition. Human activity has displaced the natural balance as large amounts of methane are released by cattle farming, landfill waste dumps, rice farming and the traditional production of oil and gas. Water vapor is the most abundant greenhouse gas. It increases as the earth's atmosphere warms but unlike CO₂, which can remain in the atmosphere for centuries, water vapor stays in the atmosphere for a few days. The gases mentioned above are naturally produced but their increasing atmospheric concentration is man-made.

Hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulphur hexafluoride (SF₆) are solely man-made, they are present in the atmosphere in very small concentrations and they trap heat effectively [8, 9]. SF₆ which is used in high-voltage electricity equipment has a global warming potential 23,000 times greater than CO₂.

Climate scientists have shown that humans are responsible for virtually all global heating over the last 200 years. (United Nations Climate Action) The period between (2011-2020) was the warmest on record, and each of the last four decades has been warmer than any previous decade since 1850. The year 2023 was the warmest year since global records began in 1850 at 1.18°C (2.12°F) above the 20th century average of 13.9°C (57.0°F) [10].

The year was marked by near-record warm temperatures across much of the world, including record-high annual temperatures in parts of Canada, the southern United States, Central America, South America, Africa, Europe, Asia, and a large portion of the central and north-eastern Atlantic, as well as portions of the South Atlantic, Indian, and South Pacific oceans. Meanwhile, cooler-than-average temperatures were confined to parts of Antarctica and the Southern Ocean (See Figures 1 and 2)..

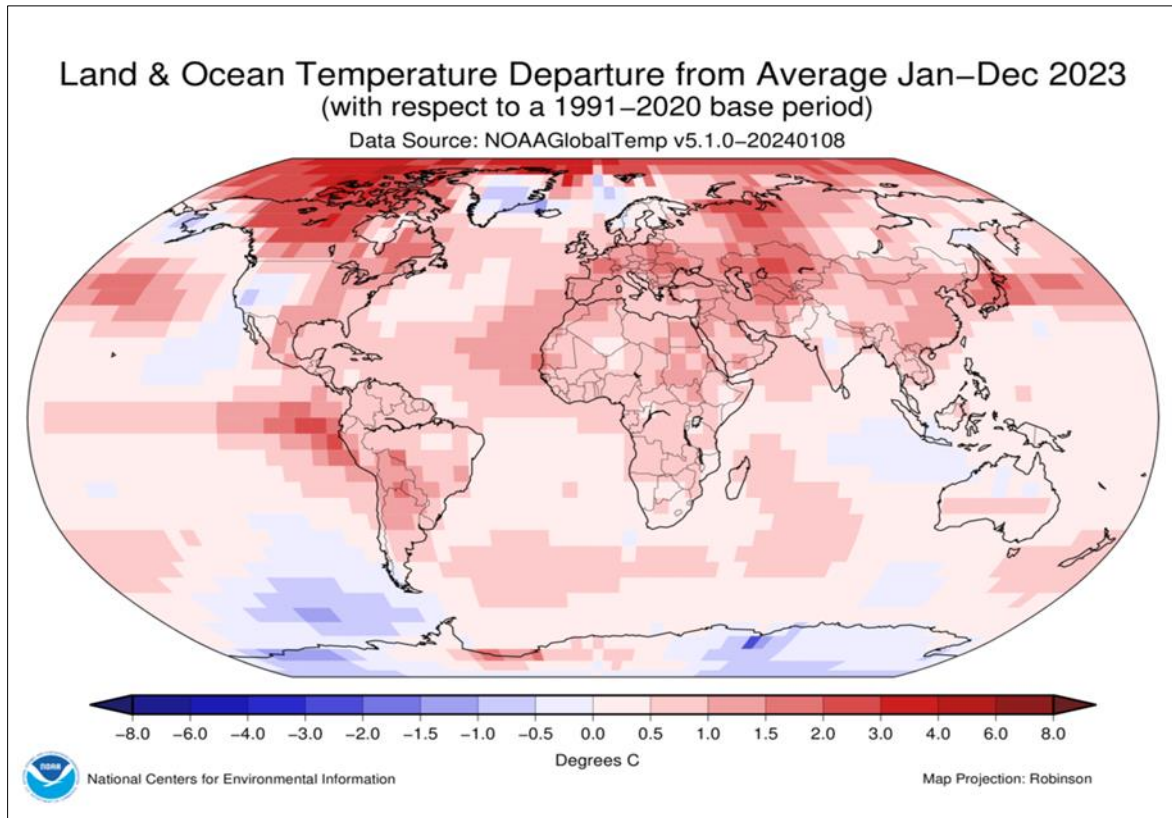


Figure 1 January-December 2023 Blended Land and Sea Surface Temperature Anomalies in degrees Celsius

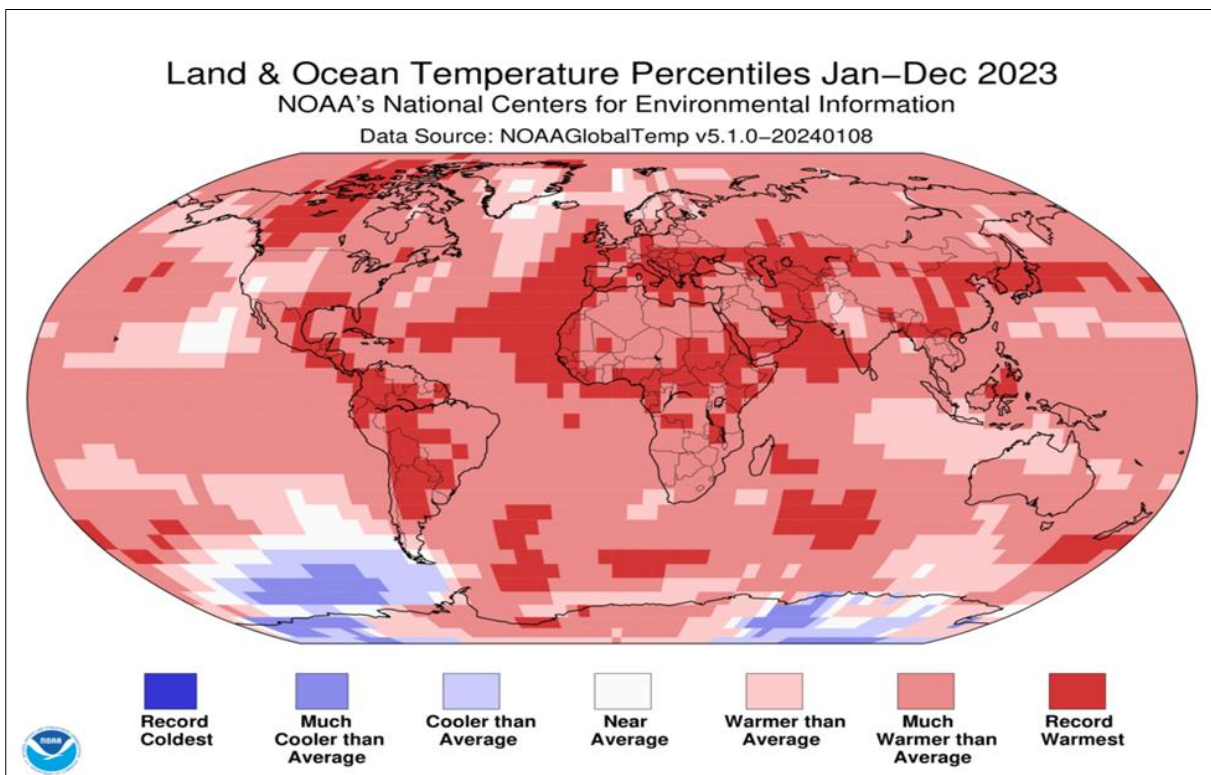


Figure 2 January-December 2023 Blended Land and Sea Surface Temperature Percentiles

A lot of persons think climate change is all about the increase in temperature, as true as it sounds, it is just the beginning and a part of the whole story, because the earth is a system and a change in one part of that system would affect other parts of the system. Such effects would include; intense droughts, failing biodiversity, rising sea levels, displacement of settlements, flooding, severe fires, poor food production and scarcity, melting polar ice, crumbling of world economy and high mortality rate resulting from health challenges.

Climate change seems like a minor threat but it really isn't minor. Global temperature is projected to warm by about 1.5°C by 2050 and 2-4°C by 2100 according to Wisconsin Department of Natural Resources, 2020. This means that the coldest year moving forward will be warmer than the warmest year that we experienced in the 20th century.

3. Causes of climate change

Greenhouse gases at a balanced ratio in the atmosphere are not considered dangerous, it only becomes a problem when there is more than the required amount of greenhouse gases in the atmosphere, which is currently the situation of the earth. Nature knows exactly how to replenish its resources when there is depletion and bring about a balance in due time but human activities have continually distorted the balance, never allowing the earth to attain a new balance. The decision and activities of man that disrupts the atmospheric balance by the addition of greenhouse gases into the atmosphere are the causes of climate change, not forgetting the natural processes as well. Such activities include:

3.1 Global carbon cycle

Emissions of several important greenhouse gases that result from human activity have increased substantially since large-scale industrialization began in the mid-1800s. Most of these human-caused (anthropogenic) greenhouse gas emissions were CO₂ from burning fossil fuels [11].

Concentrations of CO₂ in the atmosphere are naturally regulated by many processes that are part of the global carbon cycle. The flux, or movement, of carbon between the atmosphere and the earth's land and oceans is dominated by natural processes like plant photosynthesis. Although these natural processes can absorb some of the anthropogenic CO₂ emissions produced each year (measured in carbon equivalent terms), starting in about 1950, emissions began exceeding the capacity of these processes to absorb carbon (Figure 3).

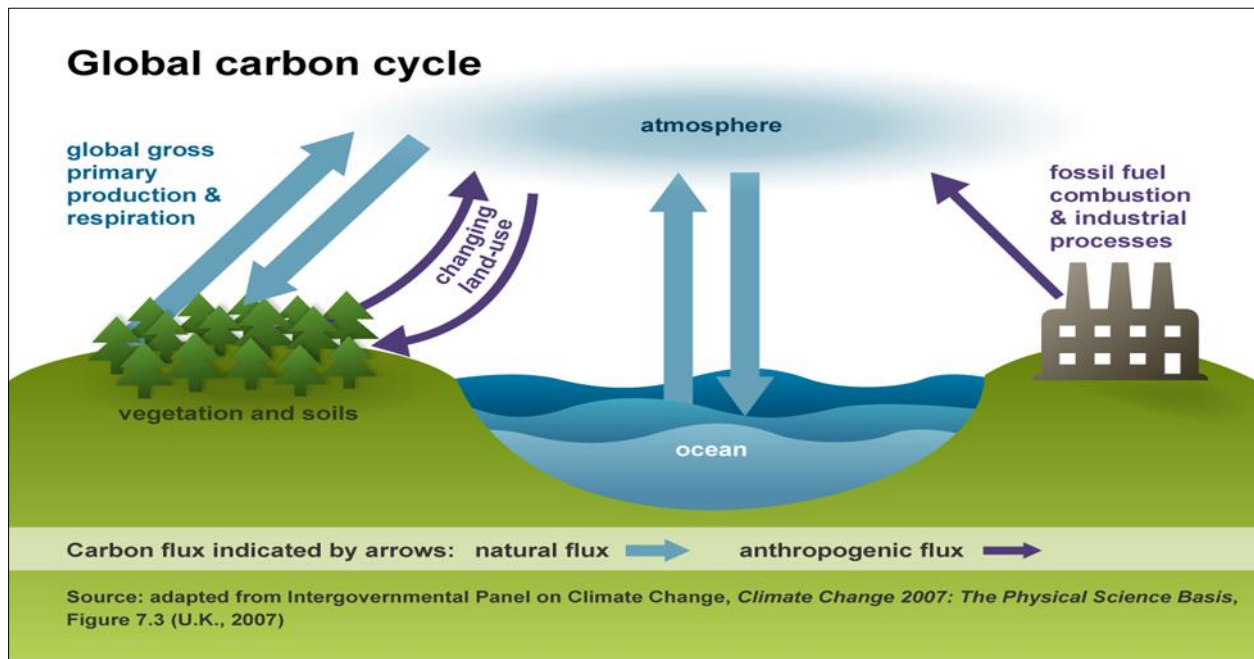


Figure 3 Global carbon cycle

3.2 Agriculture

Human efforts to produce food and rear animals for diverse reasons has become of the major contributors of climate change in recent times. Greenhouse gas emission from agriculture come from livestock such as cows, agricultural soils

and rice production. Anthropogenic climate change is caused by multiple climate pollutants, with CO₂, CH₄ and N₂O the three largest individual contributors to global warming [12]. Agriculture and food production is associated with all three of these gases, but direct agricultural emissions are unusual in being dominated by CH₄ and N₂O.

3.3 Deforestation

The cutting down of trees for various purposes by humans without plans of replacing the fallen trees is a serious challenge to sustainability and the environment. Trees in our world are a means of regulating the atmospheric balance besides being a comfortable to some species of animals. The role of trees in the absorption of CO₂ cannot be underestimated, a tree absorbs an average of 10-40 kg of CO₂ per year over a lifetime [13].

3.4 Vehicles and transportation

The bicycle is the most efficient means of transportation in terms of energy use and environmental pollution. Before the industrial age, human travels had little or no impact on the climate of the earth (See Figure 4).

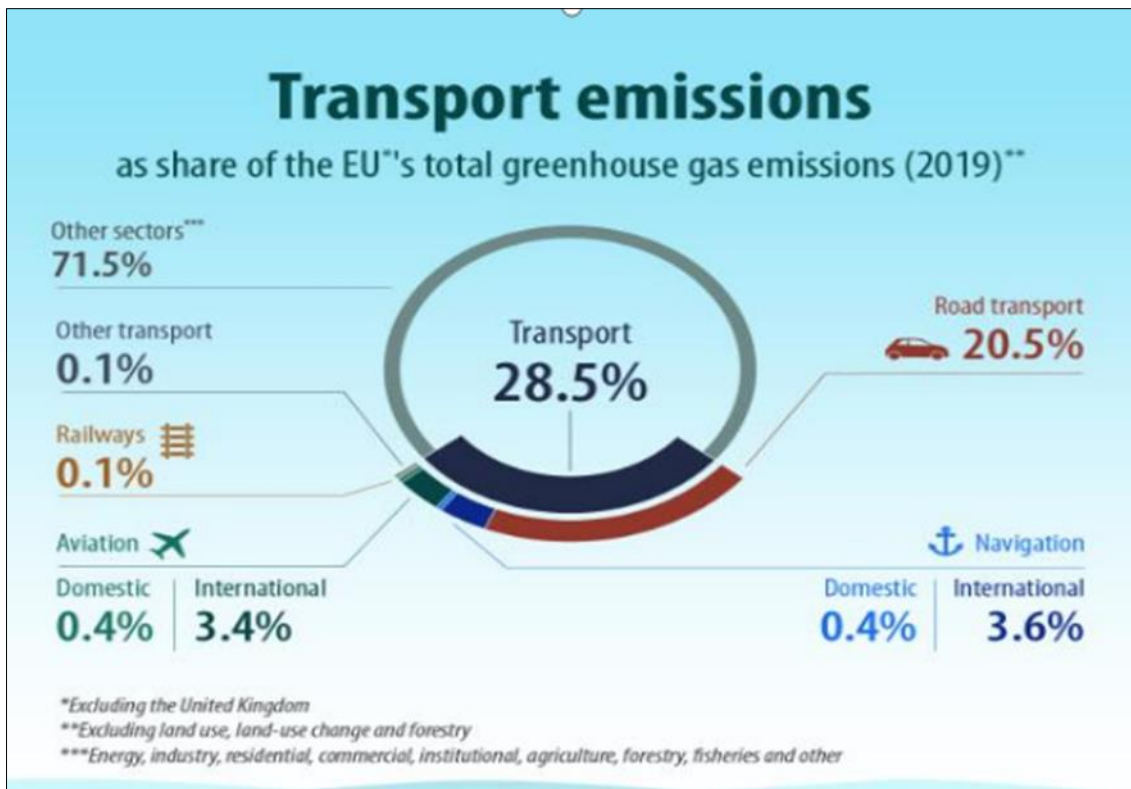


Figure 4 Share of transport emissions in the EU in 2019

Today, transportation generates about a fourth of global carbon dioxide emissions. Fossil-fueled transportation emissions also creates smog, soot and other harmful air pollution. Besides cars, airplanes, ships and trains produce a large portion of the world's greenhouse gas emissions. Ships, besides releasing almost 3 % of the world's CO₂ are a main source of nitrous oxide and black carbon (soot). With international trade expected to increase in the coming years, emissions from ships and boats may increase by as much as 250 % by 2050 according to Center for biological diversity, 2023

3.5 Landfills and dumps

A third of all food produced is lost or wasted, that's around 1.3 billion tonnes of food – costing the global economy close to \$940 billion each year [14]. The three most wasted food items on a consumer level are fruits, vegetables and breads. This enormous amount of food when trashed forms the solid waste from landfills and dumps that generate the majority of methane emissions from the sector. The organic matter decays slowly over decades, releasing what is known as landfill gas (LFG), a combination of methane, an even more potent greenhouse gas and carbon dioxide. Global food waste has a bigger greenhouse emissions footprint than the entire airline industry, global plastic production and global oil extraction. Food waste is responsible for up to 11.8% of all global greenhouse gas emissions [15].

3.6 Power plants

Operating power plants that burn coal, oil or natural gas emits air pollutants into the atmosphere. These air pollutants include, Sulphur dioxide (SO₂), Nitrogen oxide (NO), carbon monoxide (CO), Ozone(O₃), particulate matter (PM₁₀ PM₂₅), and lead(Pb). SO₂ has been a cause of acid rain precipitation, commonly known as “acid rain”, which can damage vegetation and acidify lakes. Ozone is a principal component of smog and can result in respiratory health and other environmental effects. Particulate matter (PM) includes dust and smaller particles with a maximum particle diameter of 10 Microns (PM₁₀). Small particulates have been shown to cause respiratory problems because they can penetrate deeper into the lungs than the larger particulates. All of this, is outside the noise pollution and space a sizeable power plant will generate and occupy. Power plants are the largest source of airborne emissions of mercury. Mercury is a potent neurotoxin which affects the nervous system and brain functions, particularly in infants and children and other significant health effects [16].

4. Climate change and global warming

Often times, climate change and global warming are used interchangeably, it is important that we know what the both terms refer to. While the both have to do with the increase in temperature of our system as a result of the amount of greenhouse gases in the atmosphere, there is distinct difference. Global warming is the long-term heating of the Earth's surface due to the human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. Global warming was first noted between 1850 and 1900. Climate change is the long-term variation in the average weather patterns that have come to define Earth's local, regional and global climates with a broad range of effects such as the ones discussed above. It therefore goes to say, that global warming is a smaller picture of climate change, we can also say that climate change encompasses global warming and the corresponding effects on diverse levels of the Earth [17].

5. Economic impacts of climate change

Climate change has affected the world in ways better imagined, it promises to cause more harm if humans do not start retracting from their current ways of exploiting the Earth's resources. Climate change has endangered the life of humans and animals, negatively influenced the quality and quantity of agricultural products. Climate change has caused unemployment, forcefully displaced people, increased the mortality rate of humans, it has also caused the spread of waterborne and foodborne diseases. Climate change has disrupted the balance of the earth, thereby causing financial instability in the nations of the Earth. Climate change is exacerbating both water scarcity and water related hazards (such as floods and droughts), as rising temperatures disrupt precipitation patterns and the entire water cycle. (UNICEF). Climate change affects the world's water in complex. From unpredictable rainfall patterns to shrinking ice sheets, rising sea levels, floods and droughts – most impacts of climate change come down to water. (UN Water) [18].

About two billion people worldwide don't have access to safe drinking water today according to SDG Report in 2022, and roughly half of the world's population is experiencing severe water scarcity for at least part of the year(IPCC) [19]. These numbers are expected to increase, exacerbated by climate change and population growth (WMO). Sea-level is projected to extend salinization of groundwater, decreasing freshwater availability for humans and ecosystems in coastal areas (IPCC) [20].

6. Mitigation of climate change

Climate change and the effects can be mitigated by deliberate actions to ensure that all human factors that are contributing to our current environmental challenge are checked. This action would include, better means of transportation other than fossil-fuel engine vehicles, methods of recycling waste other than dumping in the open, sustainable methods of producing better quality of food without the use of harmful pesticides and fertilizers, policies that will curtail the use of power plants where they cannot be completely eradicated in order to monitor the rate of hazardous emissions by such plants. Governments should invest in and promote solar energy and geothermal energy, to aid the cost of purchasing solar components thereby reducing the use of generators and in turn reducing the amount of gases emitted by generator uses. Afforestation should be imbibed as a national practice, to reduce the rate of desertification and also improve the air quality by means of absorption of carbon in the atmosphere by trees [21, 22].

Wetlands such as mangroves, sea grasses, marshes and swamps are highly effective carbon sinks that absorb and store CO₂, helping to reduce greenhouse gas emissions (UNEP). We need to safeguard the ocean, the ocean generates 50% of the oxygen we need, absorbs 25% of all carbon dioxide emissions and captures 90% of the excess heat generated by these emissions. It is not just ‘the lungs of the planet’ but also it's the largest ‘carbon sink’ – a vital buffer against climate

change. Ocean habitats such as sea grasses and mangroves, along with their associated food webs, can sequester carbon dioxide from the atmosphere at rates up to four times higher than terrestrial forests can. Their ability to capture and store carbon make mangrove highly valuable in the fight against climate change (United Nations). Green shipping, this means moving away from traditional fossil fuel to zero-emission energy sources, such as hydrogen, ammonia, methanol or wind. [23].

7. Conclusions

The earth is nearing a catastrophic end with the surge of heat-trapping gases consistently being released into Earth's atmosphere. Climate change is a world problem resulting from various activities of man on the surface of the Earth that is affecting the global economy and has the tendency of causing more harm if taken subtly. Conscious effort is required to mitigate the effects of climate change in our world today and more importantly, activities that cause the emission of greenhouse gases into the atmosphere should be checkmated while the activities that promote absorption of greenhouse gases should be practiced more.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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