

# EFFECT OF GLOBAL WARMING ON AQUATIC ENVIRONMENT

## Abstract

Global warming, driven by anthropogenic activities, has become a critical environmental concern with profound implications for aquatic ecosystems. This review examines the multifaceted effects of rising temperatures and associated climate changes on aquatic environments, encompassing oceans, freshwater bodies, and estuarine ecosystems. In oceans, the thermal expansion of seawater and the accelerated melting of polar ice caps contribute to rising sea levels, posing a threat to coastal habitats and biodiversity. The alteration of oceanic currents and temperature gradients affects marine life distribution and migratory patterns, disrupting ecosystems and fisheries.

Freshwater environments face escalating challenges due to global warming. Changes in precipitation patterns lead to altered hydrological cycles, affecting river flow and water availability. Elevated temperatures impact aquatic biodiversity, with implications for fish migration, breeding, and survival. Additionally, the increased frequency of extreme weather events exacerbates the risk of floods and droughts, further stressing freshwater ecosystems. Estuarine ecosystems, acting as transition zones between freshwater and marine environments, experience unique challenges. Rising sea levels and changing salinity gradients impact estuarine habitats, affecting the abundance and distribution of estuarine-dependent species. The increased frequency of extreme weather events amplifies the risks of storm surges, causing physical damage to estuarine ecosystems and exacerbating water quality issues. Furthermore, the review explores the interplay of global warming with other stressors such as ocean acidification,

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pollution, and habitat destruction, creating complex and synergistic effects on aquatic ecosystems. The overarching consequences include biodiversity loss, altered ecosystem services, and compromised resilience in the face of environmental stressors.

**Keywords:** Global Warming, Environmental Stressors, Aquatic Ecosystems, Green House Gases, Terrestrial Habitat.

## I. INTRODUCTION

Climate change refers to the change of climate or weather patterns and the variation of time increase or decrease in seasons all over the world. Changes in climate lead to sea level rise that causes melting of ice of the glaciers or warming of the oceans and seas leading to evaporation. Climate change possess a significant danger to life, on Earth by causing disasters like drought, flood, hurricanes, etc. Climate changes enlarge dessert area and heat waves and forest fires have become more prominent or frequent nowadays. Rise in temperature causes loss of ocean ice, melting of glaciers, intense storms, droughts, etc. Climatic fluctuations cause harm to all the living organisms of the ecosystem whether terrestrial or aquatic. In case the warming is controlled, still some aspects will last-long and their affects will remain such as sea level rise, ocean heating and acidification of ocean. Change in the climate has caused a great threat to people lives with increase in flooding, food and scarcity, more diseases, more importantly economic loss. In the 21<sup>st</sup> century, climate change considered as a threat to global health as said by WHO (World Health Organization). Global warming means long term heating or warming of earth's overall temperature, a major issue of climate change. It is generally caused due to release of greenhouse gases such as carbon dioxide, chlorofluorocarbons and other pollutants. Limits of global warming not controlled by humans than environment will be at a great risk. Smaller and developing countries are the ones that are more vulnerable to climate change and have less adapting tendency. The average increase observed in the temperature of earth is 1.6°F or (0.9°C) even the sensitive region of the poles.

## II. HISTORY

Scientists since 1820s discussed climate change as heating of earth surface by sun light and observed that heat radiated from surface and trapped by the atmosphere before escaping into the space was called as greenhouse effect. In mid 18<sup>th</sup> century, many scientists did various experiments, which showed that warming effect varies for air with water vapor or moist air as compared for dry air and thus the effect is greater with CO<sub>2</sub>. John Tyndall in 1859 showed that dry air has nitrogen and oxygen about 99% that radiate heat. Gases like CO<sub>2</sub> and methane radiate heat that is absorbed and radiate back the heat it to the atmosphere. Tyndall said that change in the concentration of these gases might cause climate change in the past, as well as in ice ages. In 1896, another scientist named Svante Arrhenius attempted many experiments to prove that industrial revolution will increase CO<sub>2</sub> production in order to raise the temperature of Earth's i.e. 5-6°C. A Swedish scientist who first claimed the combustion of fossil fuels in 1896 will enhance the speed of global warming, where he also showed the relationship between the two main components i.e. environment, or the atmosphere carbon dioxide and the temperature. He also suggested that if amount of carbon dioxide in atmosphere doubles than the temperature increase will be by 5°C. Another scientist named Thomas Chamberlin researched that increase in human activities would add up atmospheric CO<sub>2</sub> and warm the earth. Both scientists worked together for the conclusion but later this research was no useful and later also forgotten for a long time and it was thought that it was insignificant to say that human activities influence rather that natural energy changes in solar energy and ocean circulation. Work on spectroscopy of infrared radiation proved that increase in amount of atmospheric carbon dioxide results in more absorption of infrared radiation. Disputes about the oceans absorbing most of the carbon dioxide is still a myth until some evidences found about life span of CO<sub>2</sub> in atmosphere it said to be 10 years.

Researchers conclude atmospheric carbon dioxide is not a sink in ocean after some time it will be back into the atmosphere as atmospheric CO<sub>2</sub>.

As compared to 19<sup>th</sup> century scientist found that the increase of CO<sub>2</sub> in 20<sup>th</sup> century is about 10%, which made the Earth's temperature a bit warmer than earlier findings. Findings concluded that the emission of this CO<sub>2</sub> by the environment made the greenhouse gases surplus to be absorbed by the oceans. Another scientist from mid 19<sup>th</sup> century said that the green house gases emission would affect the temperature of Earth more as compared to other emission of fuels. The researchers further conclude by doing several experiments that emission of CO<sub>2</sub> from GHGs affects more or plays an important role in increasing earth's temperature by working on icebergs, which clearly proofed the level increase of carbon dioxide. In 1980s the two terms global warming and climate change became common that the can be used sometime as interchangeably. Scientist now understand that global warming is the warming or heating of earth surface where as climate change refers to the totality increase of earth's climate system. Scientists working in NASA in climate named James Hansen used global warming term in early 90s in year 1975. Climate change was used in 2000s, which described as changes by human and natural both. Now a day both terms modified as climate crisis or climate emergency instead of climate change and for global warming it is said global heating.

### **III. TEMPERATURE RISE**

Various instruments used to observe the climate warming. In the decade 2011- 2020 climate warming lies between 0.95-1.20°C as compared to the increase in 1850-1900 decades. It has said that surface temperature is rising 1.2°C every decade. According to the findings, we can said that the colder days, night has been decreased, and the warmer days and night has increased in number after rising of the temperature. The evidences of temperature increase can be easily found out by the wide range distribution changes in the water cycles and other cycles as well along with heavy precipitations and melting of the ice and snow and increase in the humidity of atmosphere. Other evidences are the changes in the flora and fauna of the earth like coral reefs formation and the deposition of calcium in reefs or the shell formation in shellfishes and delaying of flower according to the seasons. Important indicator can be said as the warming of earth's surface by GHGs and not radiating the heat back to the space rather that keeping trapped in the surface of earth and leading to increase the temperature.

The patterns of heating differ for different regions of the world. These patterns depend on the emission of greenhouse gases all along the world. The average temperature of overall land is almost twice the temperature on the earth surface, which is due to the overheating of the oceans and leading to evaporation. The North Pole is much warmer than the South Pole. The area of the northern hemisphere is not only having more land but also mostly covered by ice or snow.

### **IV. TRENDS IN GLOBAL WARMING**

Observations conclude from various experiments that air warming increased at the rate of 0.075°C per decade (1900-2000) which is 0.75°C per century.(Mitchell and Jones 2005, Girvetz et al. 2009).

Period	Warming per decade °C
1940-2000	0.12
1950-2000	0.17
1960-2000	0.23
1970-2000	0.32

The above findings clearly indicate the accelerated rate of warming in the 20<sup>th</sup> century. However, the trend of warming varies from region to regions. Some meteorological records studied by scientists Jones and Wigley indicate that the aquatic and terrestrial both region has experienced the warming and affect is since 19<sup>th</sup> century. The scientist after analysis concluded that if this is not to be controlled than global warming will be at a great risk for the upcoming future. We need to make new policies in order to reduce temperature increase, which is duly caused by the emission of the greenhouse gases and not affect the measures of agriculture and food security. Recent analysis says that across the hemisphere the seasons predicted the increase in temperature of air in 2050 as compared to other years. From the findings of the experiments locations is anticipated to be warmer are Canada increase of temperature from 3.8°C to 6.5°C; same as for china, Russia temperature predicted to be 4.8°C to 8.7°C. These warming trends of temperature increase prolonged the growing season of the crop like potato, maize, soybean, etc. which could bring enough yield from the crops and avoid drought condition with proper and sufficient water supply.

Metz et al. (2007) predicted that by the end of the 21<sup>st</sup> century the earth's surface temperature might range from 1.4 to 5.8°C. However, other predicted that if the greenhouse gases effect is not controlled and the emission of the fuels is not reduced than by 2050 the rise in the atmospheric temperature would be more than the above findings. The major gas of the greenhouse is CO<sub>2</sub> it world increase to a level of 100 million tons of carbon emitted from burning of fossil fuels. The developed countries are much equipped to fight the consequences ad compared to developing countries and are not prepared to deal with these consequences so the developing countries are more vulnerable to the consequences of the increase in atmospheric temperature.

## V. TRENDS IN CHANGING OF CARBON DIOXIDE

Over past many years, there is a drastic change in the atmospheric carbon dioxide, which lie between 170µmol CO<sub>2</sub> /mol to 270 µmol CO<sub>2</sub> /mol. From industrial revolution, it steadily increased to about 399.5 µmol CO<sub>2</sub> /mol. The mean temperature increase is by 0.78°C. If the increase in global temperature is about 1.8 to 5.1C than the atmospheric CO<sub>2</sub> would reach to 700 µmol(CO<sub>2</sub>)/mol or even more than that. Current estimate says that every tear about 10 to 12 billion ton of carbon is being released into the atmosphere. These top ten countries collectively contribute about 50% of emission of carbon in context to world total emission of carbon. USA alone stands within the highest of over 20 times higher than the global average emission of carbon dioxide. About 60-70% of total emission of carbon comes from the fossil that gets burns, such as coal, oil, petroleum and natural gases like LPG. Deforestation or the burning of forest without man made activities contributes to 15-20%. Remaining contribution is from livestock rearing, overgrazing of the fields, carbon present or emitted from soil, irrigation or use of fertilizers in fields, erosion of corals and the coastal areas, degradation of wetlands, eutrophication, etc. Other reasons can be the frosting of ice or

the avalanches, frozen of the organic matter and the dead and decay matter that release the greenhouse gas and increase the atmospheric carbon.

Country name	Carbon emission (billion ton)
China	8.241
U.S.A	5.491
India	2.070
Russia	1.678
Japan	1.138
Germany	0.764
Iran	0.576
South Korea	0.568
Canada	0.520
Saudi Arabia	0.450

In 2010 top ten carbon emitting countries are as follows with the range of carbon emission billion tons.

## VI. THE GREEN HOUSE GASES

In the above topics discussed, studied about temperature increase and carbon emission due to the green house gases further continue about the green house gases and how they increase the temperature and emission of gases.

The amount of energy radiated to the earth's surface from sun is very high which is about 342 watts per square but only 22% is reflected back directly into the space by microscopic particles, molecules, particles such as aerosols, clouds, etc. rest is reflected back to earth's surface. To maintain a balance earth should eventually radiate this energy back into the space. The present life forms depend on the natural greenhouse effect for their existence. Atmosphere consists of dry air through which infra red rays can easily pass and reach earth surface without any hindrance. When atmospheric gases like water vapors, nitrous oxide, methane, carbon dioxide, and ozone absorb bulk of infrared rays. These gases collectively considered as greenhouse gases. The greenhouse gases than emits the absorbed radiation of infrared rays in all direction. These greenhouse gases together forms a blanket like layer over earth's surface and makes the partially warmer than the normal heating of earth's surface. The incoming and radiation of the infrared rays exceeds the limit that the greenhouse gases absorption also increase, which changes the balance of the radiation of the infrared rays due to changes in coming intensity of solar radiation and outgoing of infrared radiation causes forcing of radiative. Due to the imbalance, reduction in cooling of earth's surface causes increase in greenhouse gases effect. Increase in warming depends on the increase size of the greenhouse gases concentration and the radiative properties of greenhouse gases.

- 1. Difference in the Natural and Human altered Greenhouse Gas Effect:** Therefore, the green house gases are nothing but the mixture of gases that trapped on the surface of the earth and cannot go back from where they came with the source of light. This light is the radiation of heat that received by earth from sun and trapped in the earth's surface, which absorbed by plants, and other surfaces incise the glass wall of green house. The light that passes through the glass wall of the green house is the ultra violet rays. A human activity

emits many green house gases the first and foremost gas is carbon dioxide. Emission of carbon dioxide is by burning of fossil fuels as discussed earlier but major emission is by burning of oil and coal, deforestation i.e. cutting down of forest causes increase in atmospheric carbon, many factories emitting gases in to the environment increase the level of carbon dioxide in the atmosphere. These factories include cement factories, where calcium carbonate is heated generating lime and carbon dioxide. The sugar and paper mill industry that emits poisons gas into the atmosphere. The second important greenhouse poison gas is methane also known as natural gas. This gas as named natural is produced by various agricultural activities such as cow dung, manure, livestock excreta ,etc. this gas can also be produced by the human waste and the vegetable waste and plant waste that produce nitrous oxide and its interaction with the atmosphere. Other gases of green house such as chlorofluorocarbons that is the result of gases released from refrigerators, big frozen industries and the processing industries. Moreover, these cause havoc and play a negative role in increasing the global warming. That led to the increase in rise of global temperature.

**2. Effects of Global Warming:** Global warming causes many negative effects to the environments, which are as follows:

The water vapors that is produced due to lot of evaporation falls back on earth as high rainfall or even cloud burst that cause's flood condition in various region of the world. In opposite to it dry condition due to evaporation process from both sea and land causing drought conditions where both precipitation and evaporation takes place together. These two conditions cause havoc for human population because of crop failure, which leads to scarcity of food or starvation in the areas where the temperature is at extremes.

Melting of glaciers due to extreme temperature again causes drought and flood conditions. In some regions where glaciers are melting at a high rate leading to flood conditions. More than 16% of the population lives in the region, this will be affected by the melting of ice and snow. The heat waves caused by warm climate makes deluge and also sometimes leads to thunderstorms, hailstorms cloudburst, avalanches, torrents, hurricanes, etc.

Rise in sea level again counts as the most dangerous effect of global warming. Melting of icebergs, glaciers and snow make ocean and sea level rise causing flood and threat to aquatic flora fauna.

This severe change of climate is been experienced more frequent day today life. As a result, we experience more threats to our life leads to flood, forest fire, animal entering human societies, thunderstorms and most newly the earthquakes that are more frequent in 2020.

We all together should take a stand, fight as one against these consequences of global warming, and join hands with each other to decrease the effect of global warming by improving our habits and save our ecosystem.

**3. Effect of Global Warming to Terrestrial Habitat:** As word says terrestrial, the animals or the plants in fact human being that lives on land rather than in water or air. Therefore,

global warming has a affect in animals also. As the migration of some animals or the hibernation and aestivation process are disturbed by change in temperature and climate.

Increase in temperature makes them move to the cooler places like to the mountains, the alpins. The migration of the animals can be a sign of warming of earth. They are considered as a witness for a slight increase or change occurring in the environment. Many researchers and scientists said that the global warming is not only destroying the habitat of different species but also making them extinct from our ecosystem. In different parts of the world, many animals like those that Orangutan from Asia the only ape of Asia is becoming extinct, the elephants of Africa their life space is being shrinking due to which they are moving to nearby places of human homes.

- 4. Effect on Human Beings:** Human beings can severely be affected and cause many health problems. Excess of heat cause high blood pressure and heart disease leading lots of stress. Loss of crop leads to starvation and loss of lives of farmers as their only means of income is the farming and the crop production. Out breaks of drought and flood can cause many disease and entry of various viruses to our environment that harms humans and cause many infections. Rise in sea temperature cause warmer oceans causing water borne harmful disease that can risk life of humans such as cholera, and infection to the sea creature acts as poison for human. Increase in temperature cause dehydration, which can cause stone formation in kidney of humans. In 19<sup>th</sup> century, it was noticed that kidney stone was more in people as 1 person in 10 people. This trend seems to increase as the temperature becomes warmer. Another major diseases recorded was valley fever the infection which was caused by the fungi which was outbreak in many countries California, new Texas and recently in Washington and the major cause of this disease outbreak was the warming of temperature and drought condition causing dry storms or dust storms. Viruses can be easily spread with the help of wind and spores that carry virus particles. Mosquito borne disease like malaria, dengue outbreak every year in summer season. The climate change led the long lasting summer prolonged to an interval of time so there was a great increase of cases of dengue and malaria fever every year. In summer at Nile a tick borne disease came into existence which was a dangerous disease transmitted by the biting of the tick. All in over the climate change and global warming can cause a great threat to life of living beings and a great loss to their habitat.
- 5. Effect of Global Warming in Aquatic Life:** As discussed above about the rise of the sea level. As the sea level rise will be half a meter by 21<sup>st</sup> century due to melting of ice, icebergs and glaciers. The aquatic species as if fishes will be threatened by this rise of sea level and may be some species may become endangered or even extinct by the end of this century. The species that migrates to the colder region will be more affect due to this abrupt change. The migratory fishes like mullets, eels, salmons and other aquatics animals like turtle, the coral reefs, and aquatic birds that migrate from one place to another like flamingo, pelicans, etc and the crustaceans. The major threat is the loss of spawning habitat and the breeding and hatching grounds of the aquatic organisms.

Evaporation is considered as a man made destruction, which at present is causing loss about 6% to the rivers that are evaporated due to the activities of the humans. The evaporation caused increase in the salinity and decrease in the area of the lake so the aquatic species moving from open waters to the enclosed water imposing them to live in



the hazard condition of being extinct, endangered and threatened species. Floods and drought condition causes' mortality, economic loss, disease outbreak in fishes, even invasion of wild species that causes threat to local species. Influence estuarine and marine environment due to increase in temperature causing precipitation, wind and circulation in waters. Effects breeding grounds of fishes, decreased level of dissolved oxygen, storm conditions and changes in the circulation cycles. Retreat of cold-water fishes and expansion of warm water species towards poles.

Increase in nitrogen and nitrogenous compounds cause dominancy of the invasive species with respect to the native species. As an example, a small Erythreanmytilid mussel, *Brachidontespharaonis*, which was common in the Levant Sea, moved to Mediterranean Sea in high temperature waters. A significant increase in the global temperatures supported the growth and dominancy of the invasive species in the natural water bodies. Another example is the freshwater red swamp crayfish (*Procambrusclarkii*), an invasive species that was introduced in Egypt unknowingly but late the species dominated the water of the Nile River and many other connected rivers flowing in Egypt. The drastic and continuous change in temperature leads to increase in nitrogen deposition, eutrophication, increased acidification i.e. deposition of carbonate, sulphate, and nitrates, and causing hypoxia conditions.

Coral reefs one of the most important resources of income, food, habitat and much other ground of the aquatic animals. Many reefs are affected by the climate and non-climate changes. These changes affect the corals by bleaching of the reefs that destroy the beauty of the corals. Increase in the atmospheric carbon dioxide the deposition of calcium carbonate decrease, which helps in the formation of the reefs. Mangroves provide protection, feed, shelter, breeding grounds to the fishes and other aquatic organisms against natural disasters. Mangrove present in the periphery in the coastal area acts as protector of the coastline. Increase in sea level rise the exploitation and development of these mangroves has decrease their strengths and led to a drastic loss of the mangroves.

Increases in surface area and sea surface temperature adversely affect the beds of sea grass, which provide habitat to many marine fishes and in the production of plant productivity. However, due to the factors, the growth rates have decreased and reduction in light penetration due to which plants productivity decreased.

- 6. Measures to Prevent Global Warming:** The emission of gases might modified by natural energy sources like wind energy, solar energy, biomass, geothermal energy and the hydro-energy. This will clean our environment and will not any pollution to the environment and no toxic will enter the earth surface. This energy is ecofriendly, will balance ecology, and will deplete the fossil fuels. Government should start many policies and set some rues for the factories and industries so that they use less toxic elements and increase use of renewable resources instead of conventional resources. Many NGOs and other groups of people should motivate people to alter the use of renewable energy sources instead of fossil fuel burning largely. Another solution to lesser the effect of fossil fuel burning is to cut the use of vehicles. People should prefer public transport, cycles and some prefer walking which is good in every means of health. People using their own vehicles should take the responsibility in their hands for destroying the ecosystem for the nation future generation. In factories, regular monitoring of the filters and even in the cars

the pollution of cars should be checked so that emission of fuels should be less. Friends should share their ride to go around whether for work any other activity. Now a day's our efficient engineers has also made efforts by modifying vehicles' into battery cars that are used by most of the people which will automatically decrease the emission of the gases in to the environment. People should be encouraged for the use of such vehicles. Very important issue that's deforestation or cutting of forest should not be encouraged by the environment instead government should set some rules for growing trees and even policies should be made like an individual calculation of growing trees per month so that people gets encouraged to grow more and more trees in their surroundings. Builders and contractors should also back off in cutting down of trees for their own profits and make loss in our environment. Other measures can be restoration of habitats by protecting parks, road less areas. Fishing practices can be done by use of monitoring devices, maintaining genetic diversity. Use of water and conservation water should be increase. Developing hydrological energy and renewable sources to decrease emission of carbon dioxide government should take steps towards these measures.

## VII. CONCLUSION

He scientific and environment goes hand by hand as compared in the global warming consequences and also the involvement of human beings also plays an important role in it. As we know, global warming is a big hazard for our earth and we should take care of this as soon as possible for keeping the resources secure for our future generations. The problem of global warming is not only a threat to humans but also to the animal and aquatic environment and plants. Flood conditions, drought, and rise of sea level, melting of ice, agricultural land loss and destruction to fish grounds these problems should be tackled as early as possible. Some methods should be formed to tackle these problems. Many organizations should come forward with new ideas of innovation to improve this issue of global warming in earth. Developed countries should help developing countries to restore their resources.

A major reason for dealing this issue, we should know every perspective i.e. the need of the reliable resources and their source so that we can improve the global standard of living. We should develop skills for improvement and new techniques generation, new reversible experiments on earth and the economic loss and cost benefits by taking early action to reduce the emission.

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