



## Review Article

# Causes and Consequences of Greenhouse Effect & Its Catastrophic Problems for Earth

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**Abstract:** The greenhouse effect refers to the trapping of heat by certain gases in the atmosphere. Although these gases occur in only trace amounts, they block significant amounts of heat from escaping out into space, thus keeping the Earth warm enough for us to survive. Without greenhouse gases, the average surface temperature of the earth would be about -18 degrees Centigrade. However humen have been adding greenhouse gases in excessive amounts to the atmosphere ever since the Industrial Revolution, which is enhancing the greenhouse effect. This increase in greenhouse gases has the potential to cause catastrophic problems for Earth and its inhabitants. The greenhouse effect causes trouble by raising the temperature of the planet. The actual rise is not very much, but the Earth's ecosystem is very fragile and small, changes can have large effects. Almost 100% of the observed temperature increase over the last 50 years has been due to the increase of greenhouse gas concentrations like water vapour, carbon dioxide (CO<sub>2</sub>), methane and ozone. Carbon dioxide is the biggest reason for the greenhouses effect that leads to global warming.

**Keywords:** Greenhouse Effects, Greenhouse Gases, Climate Change, UV-B Radiation, Airborne Fraction & Environment

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## 1. Introduction

The greenhouse effect often gets a bad rap because of its association with global warming, but the truth is we couldn't live without it. The greenhouse effect was discovered by French mathematician Joseph Fourier in 1824 and reliably experimented on by Irish physicist John Tyndall in 1858 and reported by Swedish scientist Svante Arrhenius 1896 quantitatively.

Life on earth depends on energy from the sun. About 30 per cent of the sunlight that beams toward Earth is deflected by the outer atmosphere and scattered back into space. The rest 70 per cent reaches the earth's surface and is reflected back again as a type of slow-moving energy called infrared radiation. Most of that heat caused by infrared radiation is absorbed by greenhouse gases. They can capture outgoing infrared energy from the earth because these gases having the molecules with three or more atoms. When that energy/heat in the atmosphere warms up the surroundings, it is known as the Greenhouse Effect. Thus the greenhouse effect is a naturally occurring

process by which thermal radiation from a planetary earth's surface is absorbed by atmospheric greenhouse gases, and is re-radiated in all directions.

Infact greenhouse gases make up only about 1 per cent of the Earth's atmosphere, which regulate our climate by trapping heat and holding it in a kind of warm-air blanket that surrounds the planet. This phenomenon is actually the greenhouse effect. It is estimated that the average temperature on earth without it would be colder by approximately -30 degrees celsius rather than the present 15° Celsius [1].

The concentrations of greenhouse gases are varied in atmosphere and determined by the balance between sources (emissions of the gas from human activities and natural systems) and sinks (the removal of the gas from the atmosphere by conversion to a different chemical compound). The proportion of an emission remaining in the atmosphere after a specified time (normally a year) is the airborne fraction (AF). More precisely that is the ratio of the atmospheric increase in a given year to that year's total emissions. For example airborne fraction of CO<sub>2</sub> emissions in the past 50 years (1959–2008) that remains in the atmosphere each year

has increased at  $0.25 \pm 0.21\%$ /year, from about 40% to 45%. As per carbon cycle models it is concluded that this trend was caused by a decrease in the uptake of CO<sub>2</sub> by the carbon sinks in response to climate change and variability. Changes in the CO<sub>2</sub> sinks are highly uncertain, but they could have a significant influence on future atmospheric CO<sub>2</sub> levels. It is therefore crucial to reduce the uncertainties.

The fact is that the greenhouse gases having three atoms, such as water vapor, ozone (O<sub>3</sub>), carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (NO), and also trace quantities of chlorofluorocarbons (CFC's) can have a disproportionately large effect on the average temperature of the earth. Anyhow earth's natural greenhouse effect makes life as we know it possible. However, human activities, primarily the burning of fossil fuels and deforestations, have greatly intensified the natural greenhouse effect, causing global warming.

## 2. Causes of Greenhouse Effect

The greenhouse effect is caused by the gases in the atmosphere which have the ability to absorb the sun's energy that is radiated back into space from earth. There are natural as well as human-made causes of the greenhouse effect. The natural causes of the Greenhouse effect are the emissions of gases like nitrous oxide, carbon dioxide, methane, ozone and water vapor. The natural greenhouse effect is actually beneficial to the Earth [4].

Actually the greenhouse effect is an essential environmental prerequisite for life on Earth. The problems begin when human activities accelerate the natural process by creating more greenhouse gases well beyond their natural levels, and have added more new greenhouse gases, such as CFCs, halons in the atmosphere than are necessary to warm the planet to an ideal temperature. This in turn is throwing the natural climatic systems off balance. Human activity is not only producing more CO<sub>2</sub> and other greenhouse gases but also severely damaging the ability of the earth to absorb carbon, via its carbon sinks through damaging and misusing the forests and oceanic plankton. Ocean individually has the capacity to absorb around 50 per cent of CO<sub>2</sub> [2].

The destruction of the ozone layer by human-made chemicals, such as CFCs, halons are allowing increased levels of harmful UV-B radiation to reach the surface of the earth. Increased levels of UV-B radiation could reduce the density of plankton in the oceans. Since plankton are the primary carbon sink of the planet, reduction in their density could result in less CO<sub>2</sub> being absorbed from the atmosphere and ultimately percentage of CO<sub>2</sub> increases in the atmosphere [3]. Some of the major human-made causes of these emissions are:

*Deforestation:* One of the major man-made causes of the Greenhouse effect is deforestation. With the increase in population, more and more forests are being cut to provide accommodation and other amenities to people. As per the report of World Resources Institute the loss of forests contribute between 12 percent and 17 percent of annual global greenhouse emission. Deforestation increases the amount of carbon-dioxide in the atmosphere in one way or other for

example due to the disappearance of trees the process of photosynthesis has been decreasing day by day (in which trees use carbon dioxide and give off oxygen in its place), which affect the optimal balance of gases in the atmosphere. As more forests are logged for timber or cut down to make way for farming, however, there are fewer trees to perform this critical function photosynthesis in which trees use carbon dioxide and give off oxygen in its place & ultimately increase carbon dioxide. The levels of deforestation have increased by about nine percent in recent times. According to FRA in 1990 forests made up 31.6 percent of the world's land areas; this has changed to 30.6 percent in 2015. Africa and South America had the highest net annual loss of forests in 2010-2015, with 2.8 and 2 million hectares respectively [5]. As per the United Nation Framework Convention on Climate Change (UNFCCC) agriculture is the most important cause of deforestation. Out of the total only seven countries named Brazil, Canada, USA, Indonesia, China, Russia & Congo amount to around 60 per cent of the total deforestation in the world. It reveals that the planet has already lost 80 per cent of its forest cover. According to the United Nations Food and Agriculture Organization (FAO), an estimated 18 million acres (7.3 million hectares) of forest are lost each year. In the last two decades, Afghanistan has lost over 70 per cent of its forests throughout the country. The major culprits of this are the industrialized countries because they consume 12 times more wood and its products per person than the non-industrialized countries for example United States has less than 5 per cent of the world's population but consumes more than 30 per cent of the world's paper [11].

The burning of wood as fuel on mass level is also the major causes of deforestation as well as releasing of more carbon dioxide into the atmosphere. Massive worldwide forest destruction results in much fewer trees to soak up CO<sub>2</sub> and add little amount of O<sub>2</sub> to the atmosphere through the process of photosynthesis and also releases the stored CO<sub>2</sub> from the trees into the atmosphere after burning, that is the extra addition of CO<sub>2</sub> in the atmosphere.

*Burning of Fossil Fuels:* We all know that burning of fossil fuels, like coal, petroleum, oil and gas results in release of pollutants into the atmosphere spatially CO<sub>2</sub>. Fossil fuels such as oil, coal and natural gas are high in carbon and, when burned, produce major amounts of carbon dioxide CO<sub>2</sub>. A single gallon of gasoline, when burned, puts 19 pounds of carbon dioxide into the atmosphere [8]. These materials are used increasingly and rampantly spatially in industries. With the time, the consumption of fossil fuels is it for industrial purposes or consumers purposes would be further increased and ultimately increases the pollution levels in the world. Using fossil fuels to generate energy also releases pollutants into the atmosphere, such as sulphur dioxide (SO<sub>2</sub>).

*Industries:* Most of the industries/factories produce many gases some of that last for a longer time in the atmosphere. These gases are not naturally available in the atmosphere, such as aerosol cans, some foaming agents used in the packaging industry, fire extinguisher chemicals and cleaners used in the electronic industries that are the extra burden to

the atmosphere, which have added ultimately to the greenhouse effect. Even the cement manufacturing industries are supposed to be the major culprits of altering the composition by adding more pollutant. Most man-made machines such as the automobile contribute more to the greenhouse effect, whether they run on petrol or diesel, release harmful gases into the atmosphere and damage the composition. These gases, in turn, create the greenhouse effect in the atmosphere.

*Electrical Appliances:* Electrical appliances are amongst the major contributors to the greenhouse effect, such as refrigerators, air conditioners. Even the humble refrigerator in the house emits gases known as Chlorofluorocarbons (CFCs), which is long lived and more effective contributor to the Greenhouse effect because it break the ozone and considered as ozone depleter.

*Population Growth:* The high rate of population growth has been indirectly responsible and one of major causes of the Greenhouse effect. With the increase in population, the needs and wants of the people increases, therefore, this increases the manufacturing as well as the industrial processes along with deforestation for housing as well as agricultural/grazing purposes. This results in the increase of the release of greenhouse gases which catalyze the greenhouse effect. The increase of some farming practices and land-use changes, which is also one of the major source of greenhouse gases particularly methane (CH<sub>4</sub>) and nitrous oxide. The ultimate consequence is greenhouse effect.

### 3. Consequences/Impacts of Greenhouse Effect

The main effect of increases in atmospheric greenhouse gas concentrations is global warming. This warming is altering the earth's climate system, including its land, atmosphere, oceans, and ice, in far-reaching ways. Global warming is harming the environment in several ways including; increase of average temperature/desertification, rise in Sea level, rainfall variability and deviation in seasonal characters. Greenhouse effect has many negative effects on human being as well environment in general and ecosystem in particular. A great change in atmospheric composition has been observed because of the unwanted pollution created by human to full fill their desire which affect the greenhouse a lot. It is estimated that it will further aggravate the severity of the changes in coming 10 to 20 years if the rate of pollution is the same. On the basis of the additional pollution added human beings, it is expected that the amount of carbon dioxide (CO<sub>2</sub>) will be around 450 ppm (0.04%) by 2040; presently it is on the level of around 400 ppm. that is also much more than the pre industrial stage about 313 ppm in 1960. The harmful effects of presence of greenhouse gasses beyond the natural composition in atmosphere are ozone depletion, sea level rise and adverse effects on the biodiversity, global warming and ultimately climate change. One way or another these adverse impacts are all directly or indirectly related to the increasing

amount of greenhouse gases in the atmosphere [4].

*Increase of Average Temperature:* The term global warming refers to the increase in average temperature of the atmosphere. So the average temperature of the atmosphere may differ from a place at a particular duration and time. The increased temperature causes faster evaporation on land. Many dry areas, including the western part of American, Southern Africa, India and Australia are experiencing more severe droughts. The amount of land on the Earth suffering from drought conditions has doubled since 1970. This has occurred even as total global rainfall has increased by an estimated 10 per cent.

There is the prediction of a rise in average temperature that is about 1.5°C to 4.5°C due to much more addition of CO<sub>2</sub> concentration as compared to pre-industrial period. The current change in temperature is about 0.88°C for a period from 1950 - 1989, while in the same period particularly India had recorded the change in the tune of 1.02°C. It is because of the industrial development and intensive agricultural activities for the sustenance of higher density of population. This increase in temperature is not spacio-temporal but it covers the whole northern hemisphere for the whole period as well. As per the model it is estimated that warming is more in higher latitude as compared to lower latitude and will be more distinct during winter than in summer. The radical change has been taken place since 1980. The average temperature along with the level of CO<sub>2</sub> has been increasing simultaneously since then. The cause of this increase belongs to different sectors such as industrialization, maximum use of non-renewable energy, agriculture practices (land use pattern) etc. which bring several changes in hydrological cycles, sea level rise and many other modifications. As temperatures rise, more water evaporates from the oceans, there would be increase in storm activities. This includes more powerful hurricanes, pacific typhoons, and an increased frequency of severe localized storms and tornadoes, which result in flooding and property damage that is now more frequent in America and eastern coastal region of Asia.

*Increase in Sea Level:* The general and ultimate perception is that due to increase in temperature and excess of heat, melting of snow and ice takes place which ultimately increase the level of seas and oceans. There are different thoughts regarding the sea level rise. The first supposed to be the main reason is extra water generated due to melting of ice from polar ice sheet as well as from mountain glaciers. The polar ice sheet which was extending to 12 million square kilometers now decreasing on fast rate as well as many mountainous glaciers has been vanished or decreasing day by day.

The second reason is the thermal expansion of sea water that is proposed by a group of scientist headed by Dr. Duncan Wingham. It is supposed to be a weak reason because at the increase of about 1°C mean rise in atmospheric temperature this much thermal is not possible. This is likely to be possible at the increase of 7° - 8°C.

It is observed that the level of sea has increased by 18 cm in the last 100 years, as per Inter governmental panel in climate change (IPCC) that the level of sea would rise up to 90 cm in next 100 years (by 2100) if the rate of heating

would be the same. The testimony of the affect is seen from the 1999 large scale flooding in California as well as in Indian western coastal region in last 10 years where the most of the coastal settlement had been already shifted. If the increase is to the tune of 90 cm, the world is going to face a catastrophe. It has a major effect on the harbors and in fishery industry as the first casualties. People have had to relocate to higher ground particularly on low-lying islands in the South Pacific, Indian Ocean and off the coast of India & Bangladesh. In Bangladesh alone, there are 15 million people living within 1 meter of sea level and another 8 million in a similar circumstance in India.

Inhabited land could be inundated if sea levels continue to rise. Much of the world's best farmland is low-lying which ultimate affect on the sustainability. Even a very modest rise in sea levels would have an enormous impact on millions of people around the world. Instead of properly managing the cause of sea level rise, attempt has been taken to manage the coastal region by constructing walls across the coast but it is not much more beneficial.

*Change in the Rainfall Patterns:* The differential heating of layer in the atmosphere is the main cause of pressure difference, which govern the rainfall system and its quantity. The air moves from high pressure to low pressure region, when it crosses the water body it become the source of rain and vice versa. The increase of average temperature substantially affect pressure region and so the wind direction and ultimately affect the rainfall pattern. Temperature anomalies over the last 100 years indicate the said pattern that some region received substantially more rainfall and some regions less rainfall and in many other places the rainfall pattern is not following any constant relationship with other climatic parameters. A critical study of positive and negative anomalies indicate only two heavy & one poor monsoon out of 10 positive anomalies and two heavy & three poor monsoon in 10 negative anomalies in northern hemisphere. The difference in mean rainfall for ten highest positive and negative anomalies is 7 cm.

It is observed that rainfall pattern has substantially changed. The regions of heavy rainfall are much more affected. Some regions receive less rain and some receive more. In some parts, the frequency of precipitation has increased by 20 per cent which brought a great change in hydrological cycle of the region. The regions which receive low rainfall are gradually moving towards the track of aridity, the best example is central & western India. It directly affect on ground water, which has been depleting day by day. Besides this the shortage of water has been observed throughout the globe due to uncertain untimely precipitation.

*Changes in Seasonal Characters:* Due to change in air temperature and rainfall patterns, it is observed that the seasonal characters have been substantial changing/shifting a lot throughout the globe. At many places the duration of winter has extended and at some place summer along with more severity. So uncertainty is more common which reduces the degree of dependability on weather. For example, pre-monsoon showers (summer rainfall) in India have reduced

to a large extent, while during November-December cyclonic rainfall has become a regular feature. Similarly, the length of winter with low temperature and high temperature in summer has also increased at many places and vice versa to other localities. This change is observed particularly in the last 15-20 years due to unchecked maximum use of fossil fuels, which added more & more CO<sub>2</sub> along with other greenhouse gases.

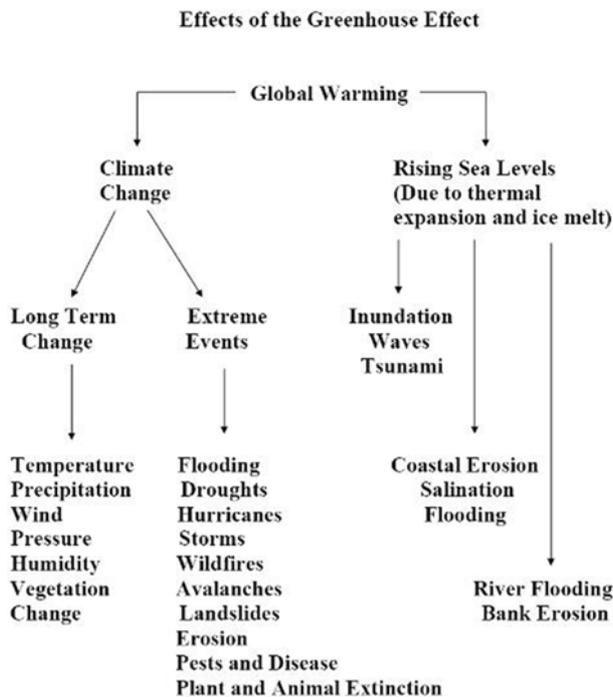
*Rapid Climate Shifts:* Scientists are convinced that past cycles of climate change on the Earth have been anything but slow and incremental, ever since the idea that the earth may warm over time as a result of human-created problems. Research indicates that the earth's climate exists in a stable state for many thousands of years. Then, pressure for change builds due to increase in carbon levels as well as changes in solar radiation. At some point, the earth reaches a tipping point where global climate systems and ocean currents are radically altered over the course of only a small time span sometime even months. Ironically, changes in the climate due to excess greenhouse gases are causing higher frequency both in drought and floods. The situation is too grim to rethink regarding the present climatic classification that is equatorial, tropical, sub-tropical, temperate and polar climates, because it is observed that the climatic character has been shifting from tropical to sub-tropical and sub-tropical to temperate and so on at many places.

*Expansion of Disease Carriers:* There would be expansion in the territory of diseases, either by moving to higher elevations in mountainous areas or by expanding their territory farther from the equator. This expansion will expose millions of humans to the often deadly infectious diseases that some animals transmit. It is clear from World Health Organization report that extreme high air temperatures contribute directly to deaths from cardiovascular and respiratory disease, particularly among elderly people. In the heat wave of summer 2003 in Europe for example, more than 70 000 excess deaths were recorded [7]. As per the record in 2005 about 150,000 annual deaths worldwide have been tied due to climate change already. Climate related deaths are expected to cause approximately 250000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress between 2030 and 2050; 38 000 due to heat exposure in elderly people, 48 000 due to diarrhea, 60 000 due to malaria, and 95 000 due to childhood under nutrition [9]. The main causes for these deaths are heat waves & droughts as well as floods and more powerful storms linked to climate change.

Due to change of climate many new region become the favorable spot of many diseases and pests of plants/animals that follow a particular rhythm because of specific response of causal organism to a set of environmental conditions. Hence, it is extending beyond their previous limit and creates more problems. Technically it is called 'pre-disposing' factors. Due to environmental change, the disease/pests may occur with greater virulence or may subside. Hence, the unpredictable attack of pests and diseases in recent years has been observed on several places where it was not found earlier because of contentious increase in temperature. Many insignificant

pests/diseases are attaining major proportions because composition of microbial population is affected by shift in temperature and hydrological cycles. For example, sap sucking insects called 'aphids' are favorably multiplied in large number if day temperature is between 15 - 20°C and humidity is 60 - 80%. Many new diseases such as neck-blast in paddy, wiltin cotton, as well as new pests like Armigera in cotton, nematode attack in paddy have been reported in the region where it was not found at all. Some diseases like black arm in cotton, blight in paddy, and canker in guava have gradually reduced. In the same way the attack of some diseases in human beings is pre-disposed by many environmental factors. For example, low temperature and high humidity favor asthma, coastal climate favoring elephantiasis, heavy rainfall favoring malaria are now very common in the region where it was not before. Transmitted by *Anopheles* mosquitoes, malaria kills almost 600 000 people every year – mainly African children under 5 years old. The spread of mosquito borne diseases like malaria in USA, UK and dengue in India are the examples of tropical habitat moving northward favoring growth and development of mosquito population in unconventional areas. Changes in climate are likely to lengthen the transmission seasons of important vector-borne diseases and to alter their geographic range. For example, climate change is projected to widen significantly the area of China where the snail-borne disease schistosomiasis occurs [12].

*The Consequences/Impacts of Greenhouse Effect can be more precisely summarized as*



#### 4. Approaching a Slippery Slope

Global temperatures have risen about 0.8° Celsius already. As a result of this increase, the vast arctic tundra is melting, releasing enormous volumes of both carbon dioxide and

methane into the atmosphere along with a lot of fresh water, which ultimately effect on plankton as well as sea level. This creates the possibility of a self-reinforcing loop of climate change: as more carbon dioxide and methane are released from the arctic tundra.

According to accumulating evidence, oceans are losing its capacity to absorb as well as retain carbon due to addition of more fresh water. This is significant because the world's oceans hold 50 times more carbon than the world's forests and grasslands. The decreasing capacity of the Earth's carbon sinks through ocean to absorb carbon could further increase the climate problem.

#### 5. Conclusion

After going through the consequences/impacts of greenhouse effect, it is very clear that unwanted & extreme events are on the rise. The bottom line is that the emissions of greenhouse gases must be reduced. Spatially the industrialized countries have the major share of the responsibility for creating the problem and for finding the solutions also. They have developed their industrial base through the use of vast amounts of fossil fuels. This has resulted in high concentrations of CO<sub>2</sub> in the atmosphere. Still their per capita emissions of CO<sub>2</sub> continue to be tens of times larger than all of the developing countries.

We must develop industrial practices and means of transportation which are less dependent on fossil fuels and ultimately manage completely without them. Reducing use of fossil fuels would considerably reduce the amount of carbon dioxide produced as well as reducing the levels of the pollutants.

To achieve the optimum level one can either use less fossil fuels, eliminating CFCs altogether, and slowing down deforestation. This can be achieved best either through energy conservation, including better use of public transport or through renewable energy such as solar, wave and wind energy as well as some alternative energy sources. Stopping deforestation by using renewable forests and planting a new tree whenever one is felled, it would help to raise the carbon dioxide absorbing ability of the planet also. Instead of deforestation we have to start afforestation to soak up CO<sub>2</sub>. So we can make a difference by controlling future greenhouse gas emissions and keep the problem under wraps.

One can help and save energy in different ways individually also. There are two key areas where individuals can help and reduce the emissions of CO<sub>2</sub>. These are electricity consumption and transportation.

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