



*The Climate Periscope*  
*Save the climate, save the world*

## Causes of Climate Change



**SCIENTIFIC** records covering millions of years show that climate has varied greatly through the Earth's history. It has, for example, gone through ten major ice age cycles over approximately the past million years. Changes in climate can occur through both natural and human-induced causes.

The Earth's climate can be affected by natural factors that are external to the Earth's climate system such as volcanic activities, solar output as well as the earth's orbit around the sun. These factors have relatively short term and minimal effects on the climate compared to human activities that emit large amounts of greenhouse gases into the atmosphere and cause global warming and the depletion of the ozone layer or human activities that reduce the amount of carbon that is absorbed from the atmosphere. Such human activities such as the burning of fossil fuel, gas flaring, urbanisation, agriculture, deforestation, among others have been proven to be the main causes of recent climate change while the natural factors cause only minimal or short term

variation in the Earth's climate. These natural and human causes of climate change will now be examined in greater detail below to determine to what extent they contribute to the unprecedented level of climate change in the world today.

### **Natural Causes of Climate Change**

Changes in the Earth's climate during the years preceding the onset of the industrial revolution may be traced to natural causes, which include:

- **Solar Output**

The amount of energy radiated from the Sun to the Earth either increases or decreases depending on the intensity of the Sun. This invariably causes the Earth's temperature to increase or reduce depending on the strength of the Sun at any particular time. Numerical climate models predict that if there is a change in solar output by only 1%, the Earth's average temperature will change by 0.5 to 1.0 degree Celsius. However, it has been observed that solar output has not changed enough recently to explain the spike in the average temperature of the Earth in recent years. Measurements have actually shown that there has been a decrease in the intensity of the Sun in the last few decades that we have experienced astronomical global warming. Thus a change in solar output cannot be the reason for the increased warming of the Earth in recent years.

- **Orbital Shifts**

As the Earth orbits around the sun, slight variations occur in its orbit. The Earth's orbit changes in a very gradual manner from being elliptical to being almost circular and then back to elliptical in a period of about 100,000 years. As these variations occur the distance between the Sun and the Earth either increases or decreases. This affects how much of the Sun's energy reaches the Earth and in turn also affects the Earth's long term climate. The closer the Sun is to the Earth the greater the amount of radiation that it sends down to the Earth. These variations are however considered too long term to account for the recent increased warming of the Earth. It has also been observed that variations in the Sun's radiation are small relative to surface forcing associated with greenhouse gases. That, in addition to the changes in ocean, ice, and surface temperatures, the pattern of warming as a function of latitude and elevation in the atmosphere allows for fingerprinting human-caused effects.

- **Volcanic Activities**

When volcanoes erupt, they emit a mixture of aerosol particles and carbon dioxide into the air. Aerosol particles when released in large quantities in the atmosphere can have cooling effects on the Earth because they reduce the amount of the Sun's energy that reaches the Earth by reflecting sunlight away from the Earth. Carbon dioxide on the other hand causes warming by adding to the greenhouse effect. These are however very rare occurrences and the amount of carbon dioxide released into the air during a volcanic activity is actually minimal while the aerosol particles actually serve to cool the earth rather than warm it. Thus volcanic activities cannot be held culpable for the unprecedented climate change that is being experienced in the world today. This invariably means that the obvious source of the massive climate change in the world today is human causes.

### **Human Causes of Climate Change**

Over the past 250 years humans have been artificially raising the concentration of greenhouse gases in the atmosphere at an ever-increasing rate to the extent that it has upset the energy balance.

Human activities are said to be responsible for over 8 billion tons of carbon dioxide released into the atmosphere per year. Some of these gases are absorbed by forests or the ocean, and the rest accumulate in the atmosphere. Humans also release millions of pounds of methane into the atmosphere by allowing waste to decompose in landfills and by breeding large herds of methane-belching cattle. Nitrogen-based fertilizers and other soil management practices also lead to the release of nitrous oxide, another very potent greenhouse gas, into the atmosphere. Once these greenhouse gases get into the atmosphere, they stay there for decades or longer. It has been reported that since the industrial revolution began in about 1750, carbon dioxide levels have increased by about 50% and methane levels have increased by over 160% in the atmosphere. Paleoclimate readings taken from ice cores and fossil records show that these gases, two of the most abundant greenhouse gases, are at their highest levels in at least the past 650,000 years. The atmosphere today contains more greenhouse gas molecules, so more of the infrared energy emitted by the surface ends up being absorbed by the atmosphere. Since some of the extra energy from a warmer atmosphere radiates back down to the surface, the Earth's surface temperature rises. This invariably results in the deleterious effects of global warming that are being experienced today.

Some of the human activities that cause the emission of greenhouse gases into the atmosphere will now be examined in detail below.

- **Burning of Fossil Fuel**

Fossil fuel (coal, oil and gas) combustion produces carbon dioxide, the primary greenhouse gas that causes the Earth to warm. In itself carbon dioxide is not a particularly dangerous gas. But the amount that is being released into the atmosphere on a daily basis through human activities makes it the most damaging greenhouse gas. Human activities contribute greatly to global warming by adding excessive amounts of greenhouse gases to the atmosphere through driving cars as well as using electricity from coal fired power plants. Fossil fuel consumption for electricity production and heat generation is said to be responsible for about 41.7% of global greenhouse gas emissions, making the power sector the largest source of emissions. Since the beginning of the Industrial Revolution in the mid-1700s levels of carbon dioxide have been found to have risen by over 50% largely due to the burning of fossil fuels such as coal, oil and natural gas. This has been accelerated by the rapid growth of the human population and developments in technology and agriculture. The build-up of these greenhouse gases in the atmosphere alter the radiative balance of the atmosphere, the net effect of which is to warm the Earth's surface and the lower atmosphere as greenhouse gases absorb some of the earth's outgoing heat radiation and reradiate it back towards the Earth surface.

- **Agriculture**

Agriculture accounts for about 20% of total greenhouse gas emissions mainly through the release of carbon dioxide from farmland soils as a result of inappropriate farming and grazing practices such as burning of forests to make room for farmlands. Since forests act as sinks that remove carbon from the atmosphere and place it in the ground, the destruction of the forests not only releases carbon directly into the atmosphere, it also destroys carbon sinks that would have removed carbon dioxide from the atmosphere. Bush burning therefore acts as a double-edged sword in accelerating the pace of climate change.

Another aspect of agriculture that causes a significant amount of greenhouse gas emissions is livestock farming. Emissions are caused by feed production, enteric fermentation, animal waste and land use change. Cattle are responsible for a relatively large amount of greenhouse gas emissions, primarily due to methane emissions resulting from enteric fermentation. Enteric fermentation is a natural part of the digestive process in ruminant animals such as cattle, sheep, goats, and buffalo. Microbes in the digestive tract decompose and ferment food, producing methane as a by-product through the process of burping. Enteric methane emissions from ruminant animals raised for their meat and milk account for as much as 30% of global

anthropogenic methane emissions, and factors such as feed quality, animal size, and environmental temperature increase the amount of methane an animal produces if left unchecked. Thus, with the increase in the demand and consumption of livestock more methane will be released into the atmosphere, thereby increasing the rate of global warming. Though methane has a short lifespan in the atmosphere, it is particularly dangerous because methane traps 84 times more heat than carbon dioxide over the first two decades after it is released into the air. Even over a 100-year period, the comparative warming effect of enteric methane is 28 times greater than carbon dioxide.

Also, due to rapid population growth, there is increasing demand for food and higher crop yields. As a result more chemical fertilizers are used instead of the natural manure. These chemical fertilizers release nitrogen oxide into the atmosphere. Nitrogen oxide has about 300 times more heat trapping capacity per unit of volume than carbon dioxide. After carbon dioxide and methane, nitrous oxide (N<sub>2</sub>O) is the most potent greenhouse gas. It also destroys the ozone layer, which protects the planet from harmful ultraviolet rays.

- **Urbanisation and Deforestation**

As the population of cities across the world grows, cities need to expand to accommodate the increased population. This decreases the amount of vegetation available to absorb carbon dioxide from the atmosphere. Increased population also means that more greenhouse gases are produced, especially through pollution and waste output. Also, large swaths of forest areas are being cleared in order to meet man's quest for urbanisation, industrialisation as well as production of food crops.

Forests help to absorb and store carbon dioxide from the atmosphere. So as trees are being cut down the amount of carbon dioxide in the air will invariably increase. According to the Regional Centre of Expertise on Sustainable Development for Education, Nigeria loses its forests at the rate of 11.1% annually, making it the highest in the world, while in the wider world an estimated 13 billion hectares of land is deforested every year in the tropical region of the world. Most of these forests are being cleared for logging, timber sale, subsistence agriculture, charcoal and collection of wood for sale. This in addition to exacerbating the problem of climate change also leads to the loss of biodiversity, atmospheric pollution and calamities such as desertification, acid rain and flood.

- **Gas Flaring**

Another very significant contributor to greenhouse gas emissions in Nigeria is gas flaring. Gas flaring is responsible for emission of over 48 million tonnes of greenhouse gases per year in Nigeria. Although the flaring of associated gas is illegal in Nigeria, the practice still continues unabated at oil fields in the country because of lack of gas infrastructure, low domestic demand for natural gas and lack of a transparent gas market. Also, because penalties for gas flaring are low and enforcement weak, the companies responsible for ending the flaring have at present little incentive to do so. The practice still continues today despite the efforts of the government to utilize gas in Nigeria.

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