Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol 2, No.4, 2012

Climate Change: Cause & Effect

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Abstract
There has been a significant climatic change that has taken place throughout the years on Earth. Periods warmer than today as well as much colder, during glacial episodes, have alternated. Man has affected the environment throughout his stay on earth; the impact has been most intense in the relatively short era. In our time, rapid population growth with increased demand for natural resources and energy, has made society increasingly vulnerable to environmental changes, both natural and those caused by man; human activity is clearly affecting the radiation balance of the Earth. These changes have affected society in more than one way. However, there is nothing society can do about the long term influences of climatic changes. Society has tended to address the short term effects of climatic changes that influence the global temperatures within the life span of present generations. We need not only understand the mechanisms for climate change and climate variability, we also need to identify means to remedy the anthropogenic influence on Earth's climate. Variability is often expressed statistically, in terms of averages over a season or number of years, of temperature or rainfall and sometimes in terms of other variables such as wind, humidity, and so on. Variability is an important factor.
Keywords: Climate Change, Greenhouse Gases, Greenhouse Effects, Sustainable Development, Radiometer, Sunspot & Environment.

1. Introduction

In broad terms, 'climate' is the typical range of weather, including its variability, experienced at a particular place. Changes in the behavior of the weather over a longer time scale, such as one century to another, are usually referred to as 'climate change'. The climate where you live is called regional climate. It is the average weather in a place over more than 30 years. However, we can also think about the climate of an entire planet. Global climate is a description of the climate of a planet as a whole, with all the regional differences averaged. While the weather can change in just a few hours, climate changes over longer timeframe.

Climate is critical to the world as we know it. The landscape, and the plants and animals in it, are all determined to a large extent by climate acting over long intervals of time. Over geological time, climate has helped to shape mountains, build up the soils, determine the nature of the rivers, and build flood plains and deltas. At least until the advent of irrigation and industrialization, climate determined food supplies and where human beings could live.

Climate change is a worldwide problem and therefore requires a response from the entire international community. Climate change is perhaps the most pressing and urgent environmental issue on the world`s agenda. The earth`s system of air, water and land have always been dynamic. Studies of ancient climates show that there have been alternating periods of global warmth and global chill at various times. Sometimes the transitions from one state to another have been abrupt, at other time the rate of change has been slow, but in all cases change has been driven by natural processes.

One reason that climate change has become so popular and, at times, controversial topic is that many people believe it is mostly the result of human activity. Burning fossil fuels, such as oil and coal, produces by products in the form of different gases. These by product gases together act as greenhouse effect that traps solar heat, which leads to the warming of the planet, besides that there are so many other causes of climate change that can be traced back to humans e.g. deforestation. But now evidence is gathering that human activities are changing or perhaps accelerating climate change. The earth appears to be warming with unnatural speed. Can we distinguish human effects on climate change from the background of natural change? More importantly, can we predict the rate and extent of future changes and their impacts on our life? With the help of refined computer models, we can check and do it but it needs cooperation and strong determination among developed & developing nations.

Today with the help of the modern technology, human can lives in places where it was impossible before. This is achieved by the provision of buildings and complex infrastructure tuned to existing climate, such as urban and rural water supplies, drainage, bridges, roads and other communications. These involve huge investments of time and money. Trade particularly of food and fiber for manufactured goods, has also been strongly influenced by climate. Roads, buildings and towns are designed taking local climate into consideration. Design rules, both formal

and informal, zoning and safety standards are developed to crop not just with average climate but also with climatic extremes such as floods and draughts. If the climate changes human society must adapt by changing its designs, rules and infrastructure.

2. What is Climate Change?

Throughout the history of the earth the climate has been changing. What is happening now, however, is that we are hearing more and more about “the greenhouse effect”. This greenhouse effect is a natural phenomenon, in which gases and small particles trap the sun`s heat and in that way maintain a temperature which is suitable for life. Concern now is that human activities have affected the atmosphere and are intensifying the greenhouse effect, leading to climate change more rapid than has been experienced before. The effects of greenhouse gases upon the weather are complex and vary widely, depending upon where you are in the world. There has been (would be) more extreme weather events, from heat waves to hurricanes and from droughts to floods. For example in Europe summers are hotter on average than they were. In 2003, 35000 people died in the summer heat wave which brought temperatures of over 40 degrees Celsius to some areas. In Africa droughts are becoming more common. Japan is becoming warmer and scientists are modifying the rice strains sown so that yields are not adversely affected. Hurricanes and typhoons are larger, stronger and more frequent and are now occurring in some areas where they have never been seen before. It is because of the climatic change.

Climate change occurs when the Earth’s average temperature changes dramatically over time. As little as one or two degrees can be considered dramatic change because the Earth’s ecosystem depends on a very delicate balance, and even small shifts can have a far-reaching impact. A drop in average temperature can also be considered climate change, but in modern times people using the term are usually talking about global warming. The average temperature of the earth's surface has risen over the last century by 1 degree Celsius and further rises are ongoing. Some experts predict that we may be causing damage which will lead to temperature rises of 6 degrees worldwide before the end of this century. If that were allowed to happen it would be catastrophic. The effects of climate change can already be seen, in the melting of permafrost near the North Pole and the rise of sea levels. Rising ocean levels ultimately cause concern about shrinking coastlines and island land masses.

3. Causes of Climate Change

The earth's climate is dynamic and always changing through a natural cycle. What the world is more worried about is that the changes that are occurring today have been speeded up because of man's activities. These changes are being studied by scientists all over the world who are finding evidence from tree rings, pollen samples, ice cores, and sea sediments. There is a broad consensus amongst scientists that greenhouse gases released through human activity are the main factor causing climate change. The causes of climate change can be divided broadly into two categories - those that are due to natural causes and those that are created by man.

3.1 Natural Causes

There are a number of natural factors responsible for climate change. Some of the more prominent ones are continental drift, variation in the earth orbit, changes in solar output, volcanic emissions, cosmic collisions, ocean currents, the earth's tilt, and comets and meteorites. Let's look at them in a little detail.

3.1.1 Continental Drift

The discovery of fossils of tropical plants (in the form of coal deposits) in Antarctica has led to the conclusion that this frozen land at some time in the past, must have been situated closer to the equator, where the climate was tropical, with swamps and plenty of lush vegetation. The continents that we are familiar with today were formed when the landmass began gradually drifting apart, millions of years back. This drift also had an impact on the climate because it changed the physical features of the landmass, their position and the position of water bodies. The separation of the landmasses changed the flow of ocean currents and winds, which affected the climate. This drift of the continents continues even today; the Himalayan range is rising by about 1 mm (millimeter) every year because the Indian land mass is moving towards the Asian land mass, slowly but steadily.

3.1.2 Variation in Solar Out Put

Many scientist thought that the sun`s output radiation only varied by a fraction of percent over many years. However, measurements made by satellites equipped with radiometers in 1980s and 1990s suggested that the sun`s energy output may be more variable than was once thought and showed a decrease of 0.1 percent in the total amount of solar energy reaching the earth over just in 18 month time period. If this trend were to extend over several decades it could influence global climate. Numerical climate models predict that a change I solar output of only 1 percent per century would alter the earth`s average temperature by between 0.5° to 1°C.The variation in

sunspots (22 years cycle) also effect on the variability of energy of the sun rays.

3.1.3 Volcanoes

When a volcano erupts it throws out large volumes of Sulphur Dioxide (SO2), water vapor, dust, and ash into the atmosphere that can influence climatic patterns for years. There are many different types of volcanic eruptions and associated activities. Volcanoes affect people in a variety of ways, and at a variety of scales. Much more localized problems are sometimes posed by the release of toxic gases in volcanic eruptions. Fine ash from the 1883 explosion of Krakatoa, for example, was carried by the up rush of gas and vapors to a height of 27 km. It was blown around the world and caused exotic sunsets and other climatic effects. Generally millions of tons of Sulphur Dioxide gas can reach the upper levels of the atmosphere from a major eruption. The gases and dust particles partially block the incoming rays of the sun which ultimately effect on heat budget. Sulphur Dioxide combines with water to form tiny droplets of Sulphuric acid which take the form of acid rain that is very harmful to ecosystem. These droplets are so small that many of them can stay aloft for several years. They are efficient reflectors of sunlight, and screen the ground from some of the energy that it would ordinarily receive from the sun.

3.1.4 Variation in the Earth Orbit & Axis

The Earth's orbit is somewhat elliptical, which means that the distance between the earth and the sun varies over the course of a year (perihelion, 147.1 million km & aphelion152.1 million km), which ultimately affect upon distribution of solar energy. This causes the solar radiation reaching the earth to vary by about 3.5% above or below the average ‘solar constant’. The proximity to the equator also affects the climate of a place, because equatorial regions receive maximum incoming solar radiation (energy) throughout the year. As one moves pole ward the solar energy decreases.

We usually think of the earth's axis as being fixed. Actually it is not quite constant: the axis does move, at the rate of a little more than a half-degree each century. This gradual change in the direction of the earth's axis, called precession is responsible for changes in the climate. The tilt of the earth’s axis from the normal to ecliptic itself varies, undergoing a slow oscillation, with a period of about 40,000 years, between 24°36′ and 21°59′. At present the angle is 23°27′ and decreasing. Changes in the tilt of the earth can affect the severity of the seasons - more tilt means warmer summers and colder winters; less tilt means cooler summers and milder winters.

3.1.5 Distance from the Oceans, Ocean Currents & El Nino

The oceans are a major component of the climate system. They cover about 71% of the Earth and absorb about twice as much of the sun's radiation as the atmosphere or the land surface. The oceans affect the climate of a place. Coastal areas are cooler and wetter than inland areas. Clouds form when warm air from inland areas meets cool air from the ocean. These clouds work as barrier for heat and ultimately effect on climate. The center of continents is subject to a large range of temperatures. In the summer, temperatures can be very hot and dry as moisture from the sea evaporates before it reaches the center of the continent.

Certain parts of the world are influenced by ocean currents more than others. Ocean currents can increase or reduce temperatures. For example Gulf Stream is a warm ocean current, which keeps the west coast of Europe free from ice in the winter and, in the summer warmer than other place of similar latitude. Much of the heat that escapes from the oceans is in the form of water vapor, the most abundant greenhouse gas on Earth. Yet, water vapor also contributes to the formation of clouds, which shade the surface and have a net cooling effect.

The El Niño event in the Pacific Ocean can affect climatic conditions all over the world. El Nino, which affects wind and rainfall patterns, has been blamed for droughts and floods in countries around the Pacific Rim. El Nino refers to the irregular warming of surface water in the Pacific. The warmer water pumps energy and moisture into the atmosphere, altering global wind and rainfall patterns.

3.2 Human Influence

The factors above affect the climate naturally. However, we cannot forget the influence of humans on our climate. We have been affecting the climate since we appeared on this earth millions of years ago. In those times, the effect on the climate was small because of the very low density of population. As the population increases, more and more land that was covered with vegetation has been cleared to make way for houses as well as for other uses which badly affect the composition of atmosphere spatially carbon dioxide and oxygen. Natural resources are being used extensively for construction, industries, transport, and consumption. Consumerism has increased by leaps and bounds due to increase in population to an incredible extent, creating mountains of waste that ultimately affect the environment.

The Industrial Revolution, starting at the end of the 19th century, has had a huge effect on climate. The invention of the motor engine and the increased burning of Fossil fuels such as oil, coal and natural gas supply most of the

energy needed to run vehicles generate electricity for industries, households, etc. The energy sector is responsible for about 3/4 of the carbon dioxide emissions, 1/5 of the methane emissions and a large quantity of nitrous oxide. It also produces nitrogen oxides (NO2) and carbon monoxide (CO) which is not greenhouse gases but do have an influence on the chemical cycles in the atmosphere that produce or destroy greenhouse gases.

4. Source and Sinks of Greenhouse Gases

The heat-retaining greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and tropospheric ozone (O3). They have maintained a delicate balance of incoming solar radiation and outgoing heat radiation for millions of years. Over the last two centuries, however, human activity has altered this balance by dramatically adding to the amounts of these gases, and by introducing new artificially created "super absorbent" greenhouse gases such as chlorofluorocarbons (CFCs) and halons. If the current trends in the atmospheric of these gases continue, the total concentration of greenhouse gases by the mid 21 century could be double what it was before the industrial revolution. Computer models set up to calculate the possible changes indicate that such a doubling could result in temperatures changing at a rate beyond anything which the earth`s ecosystem has experienced for many millennia.

Since the Industrial Revolution the atmospheric concentrations of several greenhouse gases have been increasing, primarily due to human activities. These greenhouse gases have long atmospheric lifetimes, ranging from decades to centuries. Thus emissions caused by current human activities have implications far into the future.

4.1 Carbon Dioxide (CO_2)

Carbon dioxide is undoubtedly, the most important greenhouse gas in the atmosphere. CO2 is emitted to the atmosphere by three main sources, energy production, industrial activities and land use changes, but energy production contributes over 70% of the total. Changes in land use pattern, deforestation, land clearing, agriculture, and other activities have all led to a rise in the emission of carbon dioxide.

The atmospheric concentration of CO2 was 353 parts per million (ppm) in 1990. This is more than 25% higher than the value in 18th century of about 280ppm. It is far higher than at any time in past 160,000 years as revealed by cores taken from Antarctic ice. The present increase is about 1.8ppm per year due to emissions from human activities. These emissions are estimated to be about 21±2 billion tons per year of CO2 due to fossil fuel burning, and 2-9 billion tones per year due to deforestation. The time taken for atmospheric CO2 to adjust to changes in sources or sinks is 50-200 years, because o the slow exchange of carbon between the surface waters and deeper layers of the oceans. Thus CO2 emitted into the atmosphere today will influence the atmospheric concentration of CO2 for centuries to come. Therefore limiting CO2 emissions in the energy sector will have the greatest impact on total global greenhouse gas emissions.

4.2 Methane (MH_4)

Methane is another important greenhouse gas in the atmosphere. About ¼ of all methane emissions are said to come from domesticated animals such as dairy cows, goats, pigs, buffaloes, camels, horses, and sheep. These animals produce methane during the cud-chewing process. Methane is also released from rice or paddy fields that are flooded during the sowing and maturing periods. When soil is covered with water it becomes anaerobic or lacking in oxygen. Under such conditions, methane-producing bacteria and other organisms decompose organic matter in the soil to form methane. Methane is also emitted during the process of oil drilling, coal mining and also from leaking gas pipelines (due to accidents and poor maintenance of sites).

The current methane concentration of 1.73ppm is more than double the preindustrial value of about 0.8ppm. Human activities have increased the input to the atmosphere. The removal of methane is possible only by reaction with hydroxyl radical (OH). However, with the increasing methane output and a possible decline of available hydroxyl radicals due to buildup of other pollutants.

4.3 Chlorofluorocarbons (CFCs)

The family o human made CFCs gases and closely related chemicals, such as carbon tetrachloride (CCL4) and methyl chloroform or 1,1,1-trichloroethane (CH3CCL3), have come into attention in the last few years because of their effects on stratospheric ozone. The greenhouse effect of CFCs is significant globally, even though they exist in very much lower concentrations. Future emission will be much lower than today`s because of the international agreement set out in the Montreal Protocol to protect the ozone layer. Hence the greenhouse effects of these compounds will gradually lessen during the next century.

4.4 Nitrous Oxide (N_2O)

Here are major uncertainties about the source of the present increase in nitrous oxide, but human activities are

implicated. There is a significant annual source from combustion and biomass burning. Agricultural practices may stimulate emissions of nitrous oxide from soils. A large amount of nitrous oxide emission has been attributed to fertilizer application. This in turn depends on the type of fertilizer that is used, how and when it is used and the methods of tilling that are followed. Contributions are also made by leguminous plants, such as beans and pulses that add nitrogen to the soil. The current atmospheric concentration of nitrous oxide, at 310 parts per billion (ppb) is now about 8% greater than in the pre-industrial era.

5. How we all Contribute Every Day

All of us in our daily lives contribute our bit to this change in the climate. Give these points a good, serious thought:

- Electricity is the main source of power in urban areas. All our gadgets run on electricity generated mainly from thermal power plants. These thermal power plants are run on fossil fuels (mostly coal) and are responsible for the emission of huge amounts of greenhouse gases and other pollutants.
- Cars, buses, and trucks are the principal ways by which goods and people are transported in most of our cities. These are run mainly on petrol or diesel, both fossil fuels.
- We generate large quantities of waste in the form of plastics that remain in the environment for many years and cause damage.
- We use a huge quantity of paper in our work at schools and in offices. Have we ever thought about the number of trees that we use in a day?
- Timber is used in large quantities for construction of houses, which means that large areas of forest have to be cut down.
- A growing population has meant more and more mouths to feed. Because the land area available for agriculture is limited (and in fact, is actually shrinking as a result of ecological degradation!), high-yielding varieties of crop are being grown to increase the agricultural output from a given area of land. However, such high-yielding varieties of crops require large quantities of fertilizers; and more fertilizer means more emissions of nitrous oxide, both from the field into which it is put and the fertilizer industry that makes it. Pollution also results from the run-off of fertilizer into water bodies.

6. Effects of Climate Change

The effects of climate change are complex. They can be both direct and indirect. For example, more rain may lead directly to either greater or smaller crop yields, depending on factors such as the type of crop, the soil and the present climate. Indirect effects could include changes in supply and demands as a result of these larger or smaller yields, both regionally and globally, and the resulting changes in commodity prices, the profitability of farming, and the affordability of food and effects on health.

Studies of specific local impacts of climate changes have been conducted by hundreds of research groups, these groups have found that climate change would greatly affect many natural system like forest, rivers and wildlife, as well as human activities and society e.g. tens of millions of people of small islands and low laying coastal areas at severe risk of flooding from sea level rises and storm surges. The consensus on aggregate impacts is that globally the total of all the market impacts may be small positive or negative (1 or 2% of GDP) at small global warming (less than 2° or 3°C), but will become increasingly negative at greater warming. How much warming has happened? According to IPCC during the last 100 years, the world`s surface air temperature increased an average of one degree centigrade. This may not sound like very much change, but even one degree can affect the earth. There growing evidence that climate change is already having significant effect on the world`s physical, biological and human systems, and it is expected that these effects will become sever. For example, the sea level rose about 15cm during the 20th century due to melting of glacier ice and expansion of warmer sea water. It has been predicted that the sea level may rise as much as 59cm during 21 century intimidating coastal communities, wetlands and coral reefs. The summer thickness of sea ice is about half of what it was in 1950. This melting ice may lead to changes in ocean circulation and speed up warming in the Arctic. Over the past 100 years, mountain glaciers in all areas of the world have decreased in size and so has the amount of permafrost in the Arctic. Greenland's ice sheet is melting faster too. Warmer waters in the shallow oceans have contributed to the death of about a quarter of the world's coral reefs in the last few decades. Many of the coral animals died after weakened by bleaching, a process attached to warm waters. Warmer temperatures have led to more intense rainfall causing flooding in certain areas and higher rate of evaporation leading to drought in some other areas. As temperatures warm, species like coral reefs and polar animals may either move to cooler habitat or die. Seasons are changing. Heat waves have become more frequent and there is evidence that the number of hurricanes has increased in the Atlantic since 1970. Warmer temperatures affect human health as there is an increase in the growth of disease carrying organisms like mosquitoes. Sea water is becoming more acidic which again affects the coral reefs and other marine life.

7. Conclusion

The Earth's climate is characterized by change. Throughout Earth's history the climate has varied between warm and cold. During the last million years the climate cycles have varied between glacial and interglacial periods, each cycle having a length of about 100,000 years. In comparison with the lifespan of a human being, ''natural'' changes in the climate are very slow. In the history of advanced human societies, changes have been somewhat larger, to the extent that they may have had a dramatic impact on societies. Historical records show that human society has experienced, suffered, but also managed to adapt to climate change. However, with a growing world population, increasing land-use, and increasing vulnerability to changes in climate, climate change has become an issue of general concern. The issue is in short, if human activity has a negative influence on the global climate, then humans have a responsibility to mitigate the problem. The cause of today's climate change is a matter of scientific debate. Is the twentieth century warming trend due to Anthropogenic Global Warming or an effect of ''natural'' climate variability? Needless to say, modern human society has made an imprint on the whole of the Earth's environment, has influenced the global ecosystem, and is combusting fossil fuels on a massive scale. CO2 is also the gas of life without which there would be no advanced life on Earth (it is the basis for photosynthesis). The present situation is not sustainable; too much CO2 is being released and this calls for immediate action.

The threat of global climate problem is growing and due to the nature of the problem, national actions through regional and international mechanisms are required. However, these actions must be carried within a sustainable and equitable development framework. The paper discussed several options and policies but implementing them require detailed analysis to ensure that national benefits are maximized. The importance of local control and management within a politically committed environment cannot be over-emphasized in ensuring sustainable development.

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