Main Physical Causes of Climate Change and Global Warming - A General Overview

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Abstract: ***The signs of global warming are becoming ever more prominent, casual observers of the media in the India. Weather changes all the time. It is highly dynamic in nature. The average pattern of weather, called climate, usually remains uniform for centuries if it is left to itself. However, the Earth is not being left alone. People are taking multi-dimensional actions that are gradually changing the morphology, physiology, and anatomy of the planet Earth and its climate in large scale. The single human activity that is most likely to have a large impact on the climate is the burning of "fossil fuels" such as coal, oil and gas. Citizens are in denial about climate change, refusing to take responsibility for controlling their emissions of carbon dioxide (CO2) and the other greenhouse gases (GHGs) that cause global warming. Although it is true that the federal government remains stalemated on how to deal with climate change, the notion that no climate action is taking place in this country is erroneous. The most intriguing story is what has been happening in state legislatures, at city council meetings, and in corporate boardrooms, as well as on college campuses, in community groups, and in a range of other local settings. Across the nation, numerous climate action programs are moving aggressively to reduce emissions of GHGs. It is rare that a week goes by without the announcement of a new initiative among recent clippings.***

Keywords: ***Weather, climate, multi-dimensional, fossil fuels, greenhouse gases***

1. Introduction

The single human activity that is most likely to have a large impact on the climate is the burning of "fossil fuels" such as coal, oil and gas. These fuels contain carbon. Burning them liberates carbon dioxide gas in the atmosphere. Since the early 1800s, when people began burning large amounts of coal and oil, the amount of carbon dioxide in the earth's atmosphere has increased by nearly 30%, and average global temperature appears to have risen between 1° and 2°F. This increment of temperature [10] is keenly related to the basic property of the gas. Carbon dioxide gas traps solar heat in the atmosphere, partly in the same way as glass traps solar heat in a sunroom or a greenhouse. For this reason, carbon dioxide is sometimes called a "greenhouse gas." As more carbon dioxide is added to the atmosphere, solar heat faces more trouble in getting out. The result is that, if everything else remains unchanged, the average temperature of the atmosphere would increase. As people burn more fossil fuels for energy they add more carbon dioxide to the atmosphere. This creates a blanket of carbon dioxide over the Earth's surface, which allows the short waves of the sun to penetrate the Earth's atmosphere, but prevents the long wave radiations (emitted from the Earth's surface) to get out. If this activity continues for a long period of time, the average temperature of the atmosphere will almost certainly rise. This is commonly referred to as global warming. Global warming is thus the increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation. The term "global warming" is a sub-set of the universal set climate change [1], which also encompasses another sub-set namely "global cooling." The United Nations Framework Convention on Climate Change (UNFCCC) uses the term "climate change" for human-induced changes and "climate variability" [2] for other changes. Climate change is therefore any long-term significant change in the "average weather" that a given region experiences and involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years. The roots of these changes can be related to several dynamic processes on Earth, external forces including variations in sunlight intensity, and more recently by human activities.

2. Objectives

Review literature on environmental behavior focusing on the current understanding of powerlessness, the commons dilemma and related perceptions regarding environmental problems, in particular climate change.

Collect qualitative and quantitative data on perceptions of powerlessness and the commons dilemma in relation to climate change.

To find out of the main causes of climate change

Discuss findings about the importance and causes of powerlessness and the common dilemma in relation to climate change.

3. Methodology

The intuitive approach to costing adaptation involves comparing a future [5] world without climate change with a future world with climate change. The difference between these two worlds entails a series of actions to adapt to the new world conditions. And the costs of these additional actions are the costs of adapting to climate change. With that in mind, the study took the following four steps:

Picking a baseline: For the timeframe, the world in 2050 was chosen, not beyond forecasting climate change and its economic impacts become even more uncertain beyond this period. Development [6] baselines were crafted for each sector, essentially establishing a growth path in the absence of climate change that determines sector-level performance indicators (such as stock of infrastructure assets, level of nutrition, and water supply availability). The baselines used a consistent set of GDP and population forecasts for 2010–50.

Choosing climate projections: Two climate scenarios were chosen to capture as large as possible a range of model predictions. Although model predictions do not diverge much in projected temperatures increases by 2050, precipitation changes vary substantially across models. For this reason, model extremes were captured by using the two model scenarios that yielded extremes of dry and wet climate projections. Catastrophic events were not captured, however.

Predicting impacts: An analysis was done to predict what the world would look like under the new climate conditions. This meant translating the impacts of changes in climate on the various economic activities (agriculture, fisheries), on people's behavior (consumption, health), on environmental conditions (water availability, oceans, forests), and on physical capital (infrastructure).

The research work prepared in three stages which are as follows –

4. Pre-field work

This stage includes - i) collection of districts map ii) collection of secondary information from district handbook, census report, others books and journals etc. iii) preparation of questionnaire statistical schedule for collection of primary data which are closely related with the research work.

5. Field work

By questionnaire schedule primary data will be collected from the study area. Observation schedule also help to collect the information.

6. Post field work

Collected data will be classified in a master table and various cartographic and statistical techniques will be made in support of the theoretical discussion.

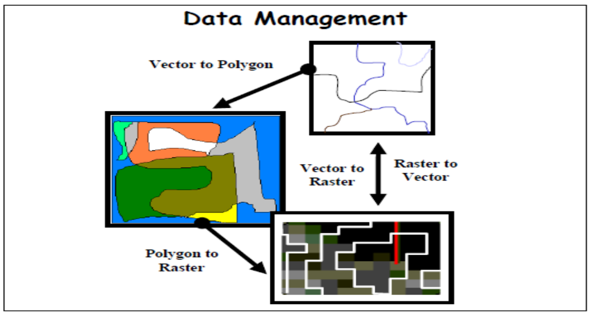

Figure 1: A Process of Data Management

7. Results

Causes of Climate Change: The general state of the Earth's climate is a function of the amount of energy stored by the climate system. More specifically it can be stated that the Earth's climate is regulated by the balance between the amount of energy the Earth receives from the Sun, in the form of light and ultraviolet radiation, and the amount of energy the Earth releases back to space, in the form of infrared heat energy. Causes of climate change involve any process that can alter this global energy balance. Scientists call this "climate forcing." Climate forcing "forces" or induces the climate to change, although the acceleration of the process is highly variable.

There are many climate forcing processes, but broadly speaking, they can be classified into internal and external types (Fig-1). External processes operate outside the planet Earth, and include changes in the global energy balance due to extraterrestrial factors like variations in the Earth's orbit around the Sun, and changes in the amount of energy received from the Sun. Internal processes operate from within the Earth's climate system, and include changes in the global energy balance due to changes in ocean circulation or changes in the composition of the atmosphere. Other climate forcing processes include the impacts of large volcanic eruptions, collisions with comets or meteorites etc. Luckily, the Earth is not hit by large comets or meteorites very often, perhaps every 20 to 30 million years or so, and therefore their associated climate changes occur rarely throughout Earth History. However, other causes of climate change influence the Earth on much shorter time scales, with changes sometimes occurring within a single generation. Indeed, our present oscillation of the composition of atmosphere due to emission of greenhouse gases [7] may be causing the global climate to change with an increased trend of atmospheric temperature. This man-made climate change associated with increasing trend of atmospheric temperature is popularly known as global warming. For convenience of the readers, we prefer to divide the causes of climate change into two broad domains: natural and manmade.

Natural factors: The work of climatologists have found evidences to suggest that only a limited number of factors are primarily responsible for most of the past episodes of climate change on the Earth. These factors include

1. **Variations in the Earth's orbital characteristics**
2. **Atmospheric carbon dioxide variations**
3. **Volcanic eruptions**

4. **Variations in solar output**
5. **Plate tectonics**

Variations in the Earth's orbital characteristics: The Milankovitch theory suggests that normal cyclical variations in three of the Earth's orbital characteristics are probably responsible for some past climatic change. The basic idea behind this theory assumes that over time these three cyclic events vary the amount of solar radiation that is received on the surface of the planet Earth. The first cyclical variation, known as eccentricity, controls the shape of the Earth's orbit around the Sun. The orbit gradually changes from being elliptical to being nearly circular and then back to elliptical in a period of about 100,000 years. The greater the eccentricity of the orbit (i.e., the more elliptical it is), the greater the variation in solar energy received at the top of the atmosphere between the Earth's closest (perihelion) and farthest (aphelion) approach to the Sun. Currently, the Earth is experiencing a period of low eccentricity. The difference in the Earth's distance from the Sun between perihelion and aphelion (which is only about 3%) is responsible for approximately a 7% variation in the amount of solar energy received at the top of the atmosphere. When the difference in this distance is at its maximum (9%), the difference in solar energy received is about 20%.

The second cyclical variation results from the fact that, as the Earth rotates on its polar axis, it wobbles like a spinning top changing the orbital timing of the equinoxes and solstices (Fig. 1.2). This effect is known as the precession of the equinox.

The precession of the equinox has a cycle of approximately 26,000 years. According to illustration (A), the Earth is closer to the Sun in January (perihelion) and farther away in July (aphelion) at the present time. Because of precession, the reverse will be true in 13,000 years and the Earth will then be closer to the Sun in July (illustration B).

This means, of course, that if everything else remains constant, 13,000 years from now seasonal variations in the Northern Hemisphere should be greater than at present (colder winters and warmer summers) because of the closer proximity of the Earth to the Sun.

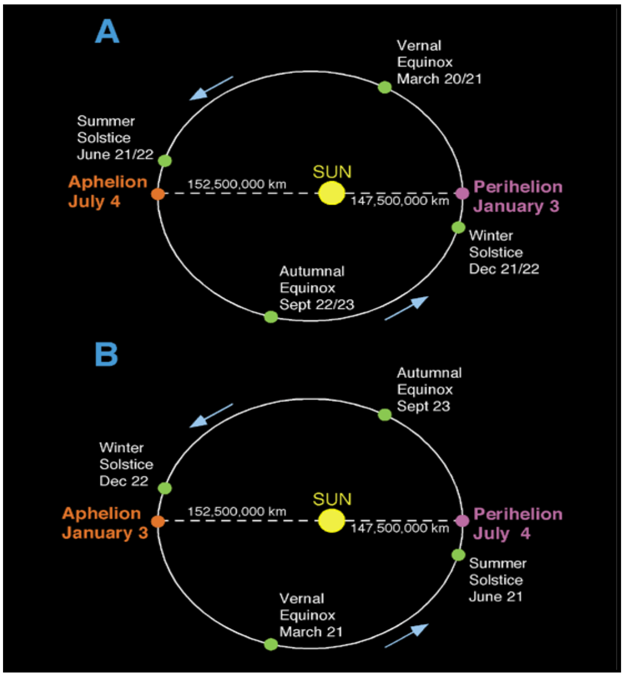

Figure 2: Modification of the timing of aphelion and perihelion over time (A=today; B=13,000 years into the future)

The third cyclical variation is related to the changes in the tilt (obliquity) of the Earth's axis of rotation over a 41,000 years period.

During the 41,000 year cycle, the tilt can deviate from approximately 22.5 to 24.5°. At the present time, the tilt of the Earth's axis is 23.5°. When the tilt is small there is less climatic variation between the summer and winter seasons in the middle and high latitudes. Winters tend to be milder and summers cooler. Warmer winters allow for more snow to fall in the high latitude regions. When the atmosphere is warmer it has a greater ability to hold water vapor and therefore more snow is produced at areas of frontal or orographic uplift. Cooler summers cause snow and ice to accumulate on the Earth's surface because less of this frozen water is melted. Thus, the net effect of a smaller tilt would be more extensive formation of glaciers in the polar latitudes.

Periods of a larger tilt result in greater seasonal climatic variation in the middle and high latitudes. At these times, winters tend to be colder and summers warmer. Colder winters produce less snow because of lower atmospheric temperatures. As a result, less snow and ice accumulates on the ground surface. Moreover, the warmer summers produced by the larger tilt provide additional energy to melt and evaporate the snow that fell and accumulated during the winter months. In conclusion, glaciers in the Polar Regions should be generally receding, with other contributing factors constant, during this part of the obliquity cycle.
Computer models and historical evidence suggest that the Milankovitch cycles exert their greatest cooling and warming influence when the troughs and peaks of all three cycles coincide with each other.

Atmospheric carbon dioxide variations: Studies on long term climate change have discovered a connection between the concentrations of carbon dioxide in the atmosphere and mean global temperature. Carbon dioxide is one of the most important gases responsible for the greenhouse effect. Certain atmospheric gases, like carbon dioxide, water vapor and methane, are able to alter the energy balance of the Earth by being able to absorb long wave radiation emitted from the Earth's surface. The net result of this process and the re-emission of long wave back to the Earth's surface increase the quantity of heat energy in the Earth's climate system. Without the greenhouse effect, the average global temperature of the Earth would be around -18° Celsius rather than the present 15° Celsius.

Researchers of the 1970s CLIMAP project documented strong evidence in deep-ocean sediments of variations in the Earth's global temperature during the past several hundred thousand years of the Earth's history. Other subsequent studies have confirmed these findings and have discovered that these temperature variations were closely correlated to the concentration of carbon dioxide in the atmosphere and variations in solar radiation received by the planet as controlled by the Milankovitch cycles. Measurements indicated that atmospheric carbon dioxide levels were about 30% lower during colder glacial periods. It was also theorized that the oceans were a major store of carbon dioxide and that they controlled the movement of this gas to and from the atmosphere. The amount of carbon dioxide that can be held in oceans is a function of temperature. Carbon dioxide is released from the oceans when global temperatures become warmer and diffuses into the ocean when temperatures are cooler. Initial alterations in global temperature were triggered by changes in received solar radiation by the Earth through the Milankovitch cycles. The increase in carbon dioxide then amplified the global warming by enhancing the greenhouse effect.

Over the past three centuries, the concentration of carbon dioxide has been increasing in the Earth's atmosphere because of human influences (Fig. 1.3). Human activities like the burning of fossil fuels, conversion of natural prairie to farmland [9], intense industrialization, urbanization and deforestation have caused the release of carbon dioxide into the atmosphere. From the early 1700s, carbon dioxide has increased from 280 parts per million to 380 parts per million in 2005. Many scientists believe that higher concentrations of carbon dioxide in the atmosphere will accelerate the greenhouse effect making the planet warmer. Scientists also believe that the present era is already experiencing global warming due to an enhancement of the greenhouse effect. Most computer climate models suggest that the globe will warm up by 1.5 - 4.5° Celsius if carbon dioxide reaches the predicted level of 600 parts per million by the year 2050.

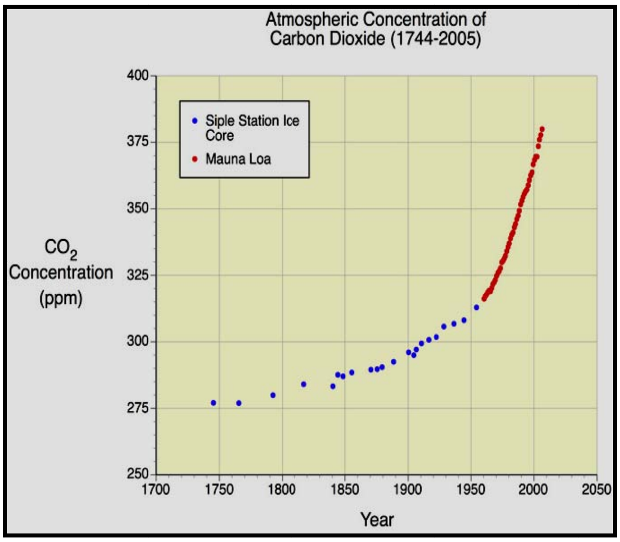

Figure 3: The following graph illustrates the rise in atmospheric carbon dioxide from 1744 to 2005. Note that the increase in carbon dioxide's concentration in the atmosphere has been exponential during the period examined. An extrapolation into the immediate future would suggest continued increase

Volcanic eruptions: For many years, climatologists have noticed a connection between large explosive volcanic eruptions and short term climatic change (Fig. 4). For example, one of the coldest years in the last two centuries occurred the year following the Tambora volcanic eruption in 1815. A number of regions across the planet Earth witnessed this lowering of atmospheric temperature. Several other major volcanic events also show a pattern of cooler global temperatures lasting 1 to 3 years after their eruption.

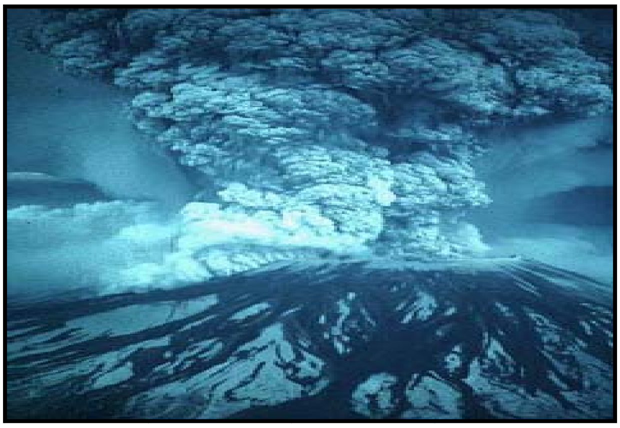

Figure 4: Explosive volcanic eruptions have been shown to have a short-term cooling effect on the atmosphere if they eject large quantities of sulphur dioxide into the stratosphere. The present figure shows the eruption of Mount St. Helens on May 18, 1980 which had a local effect on climate because of ash reducing the reception of solar radiation on the Earth's surface. Mount St. Helens had very minimal global effect on the climate because the eruption occurred at an oblique angle putting little sulphur dioxide into the stratosphere. (Source: U.S. Geological Survey; photograph by Austin Post).

At first, scientists thought that the dust emitted into the atmosphere from large volcanic eruptions was responsible for the cooling by partially blocking the transmission of solar radiation to the Earth's surface. However, measurements indicate that most of the dust thrown in the atmosphere returned to the Earth's surface within six months. Recent stratospheric data suggests that large explosive volcanic eruptions also eject huge amounts of sulphur dioxide gas which remains in the atmosphere for as long as three years. Atmospheric chemists have determined that the ejected sulphur dioxide gas reacts with water vapour commonly found in the stratosphere to form a dense optically bright haze layer that reduces the atmospheric transmission of some of the Sun's incoming radiation.

Figure 5: Ash column generated by the eruption of Mount Pinatubo on 12th June, 1991. The strongest eruption of Mount Pinatubo occurred three days later on 15th June, 1991 (Source: US Geological Survey)

Variations in solar output: Until recently, many scientists thought that the Sun's output of radiation only varied by a fraction of a percent over many years. However, measurements made by satellites equipped with radiometers in the 1980s and 1990s suggested that the Sun's energy output may be more variable than was once thought. Measurements made during the early 1980s showed a decrease of 0.1 percent in the total amount of solar energy reaching the Earth over just an 18 month time period. If this trend were to extend over several decades, it could influence global climate. Numerical climatic models predict that a change in solar output of only 1 percent per century would alter the Earth's average temperature by between 0.5 to 1.0° Celsius.

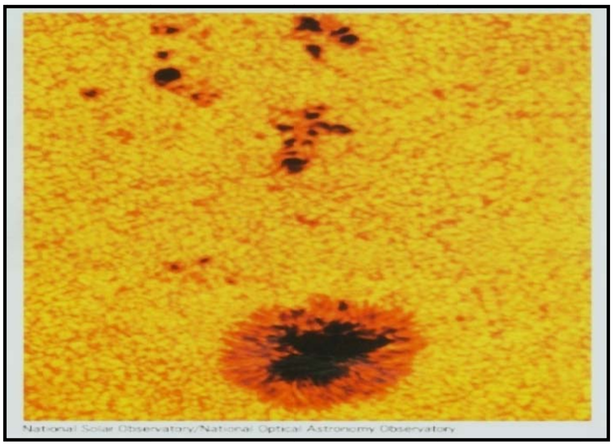

Figure 6: Sunspots on the Sun’s surface

The number and size of sunspots show cyclical patterns, reaching a maximum about every 11, 90, and 180 years. The decrease in solar energy observed in the early 1980s corresponds to a period of maximum sunspot activity based on the 11- year cycle. In addition, measurements made with a solar telescope from 1976 to 1980 showed that during this period, as the number and size of sunspots increased, the Sun's surface cooled by about 6° Celsius. Apparently, the sunspots prevented some of the Sun's energy from leaving its surface. However, these findings tend to contradict observations made on longer time scales. Observations of the Sun during the middle of the Little Ice Age (1650 to 1750) indicated that very little sunspot activity was occurring on the Sun's surface. The Little Ice Age was a time of a much cooler global climate and some scientists correlate this occurrence with a reduction in solar activity over a period of 90 or 180 years. Measurements have shown that these 90 and 180 year cycles influence the amplitude of the 11 year sunspot cycle. It is hypothesized that during times of low amplitude, like the Maunder Minimum, the Sun's output of radiation is reduced. Observations by astronomers during this period (1645 to 1715) revealed very little sunspot activity occurring on the Sun.

During periods of maximum sunspot activity, the Sun's magnetic field is strong. When sunspot activity is low, the Sun's magnetic field weakens. The magnetic field of the Sun also reverses every 22 years, during a sunspot minimum. Some scientists believe that the periodic droughts on the Great Plains of the United States are in some way correlated with this 22 year cycle.

Plate tectonics: The phenomenon of plate tectonics also plays a major role in the event of climate change. On the longest time scales, plate tectonics will reorient the position of continents, shape oceans, build and tear down mountains and generally serve to provide the matrix upon which climate exists. More recently, plate motions have been implicated in the intensification of the present ice age when, approximately 3 million years ago, the North and South American plate’s collided to form the Isthmus of Panama and shut off direct mixing between the Atlantic and Pacific Oceans. The movement of the plate and subsequent subduction also regulate the condition of the climate. Slow subduction is associated with narrow mid-oceanic ridge and low volcanic activity. Under this condition, there is maximum exposure of marine limestone to weathering, which draws more carbon dioxide from the atmosphere to participate in the reactions resulting in the cooling effect. The opposite phenomenon of warming is linked to faster subduction process.

8. Conclusion

These natural calamities are direct threats to the security of the poor people, which not only result in the displacement of people from their root, but also pose adverse impact on their socio-economic conditions and livelihoods. The restoration phase can be initiated by strengthening the call for an adaptive management [4] style that focuses on transparency and learning. Such an approach needs to involve all stakeholders in decision making and implementation at the level of landscapes and seascapes. Coalitions, including governments and their agencies, NGOs, local communities and research institutions, can support immediate actions, plan for the medium term and establish key priorities for the longer term. Whether constituted at the regional [8], national or international level, these coalitions should aim to bring about change in environmental management strategy to accelerate the process of adaptation of ecosystems and their components to oscillating climate of the planet Earth.

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