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The Past, Present, and Future of Earth's Climate: Causes and Solutions

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ABSTRACT: Climate change has become a major threat to the existence of our planet Earth and the various biological and plant species that inhabit it.Climate change is a complex global issue that poses significant challenges to human societies and ecosystems. It is caused by a combination of natural and anthropogenic factors, including the burning of fossil fuels, deforestation, and industrial processes. The consequences of climate change include rising temperatures, sea level rise, extreme weather events, and loss of biodiversity. This paper provides an overview of the history, factors, and policy measures associated with climate change. It examines the scientific evidence for climate change, the historical context of human activities that contribute to it, and the various policy measures that have been implemented to mitigate its impacts. The paper concludes by highlighting the need for urgent and decisive action to address the threat of climate change. This paper elucidates policy measures to stop this change at the global level by defining climate change, explaining its history, factors, theory, and effect.

KEYWORDS: Atmosphere, Weather, Climate, Climate Change, Temperature Rise, Heat Budget

I. INTRODUCTION

Climate change is a complex and multifaceted phenomenon that has been the subject of extensive research and public discourse in recent decades. It is a global environmental issue that is caused by a combination of natural and human factors, including greenhouse gas emissions from industrial activities, deforestation, and changes in land use patterns. The impacts of climate change are wide-ranging and include rising temperatures, sea-level rise, and more frequent extreme weather events such as heatwaves, droughts, and floods.

This paper provides an overview of the history, factors, and policy measures related to climate change. The first section traces the historical development of the science of climate change, from the early observations of naturalists to the modern era of global climate research. The second section examines the key drivers of climate change, including human activities and natural factors such as solar variability and volcanic eruptions. The third section discusses the policy measures that have been proposed and implemented to address climate change, including international agreements such as the Paris Agreement, national and regional policies, and technological solutions such as renewable energy and carbon capture and storage.

Overall, this paper aims to provide a comprehensive understanding of the nature and causes of climate change, as well as the various policy measures that are being pursued to mitigate its impacts. It is hoped that this information will help to inform public discourse and decision-making on this critical issue.

II. HISTORY OF CLIMATE CHANGE

Climate change is not a new phenomenon. Cyclical changes in global climate have been continuous throughout Earth's 4.5-billion-year history. The historical sequence of climate change is called climochronology. It is discussed in the perspective of spatial scale and temporal scale. Earth's atmosphere was dry in the Hadean Era (450-380 million years ago). Oxygen levels were low and carbon dioxide and methane levels were high. The estimated temperature of the earth was between 30 to 50°C. In the Archean era (Archean Era 380-250 million years ago), there was no free oxygen in the atmosphere as in the present atmosphere. The atmosphere was made up of methane, carbon dioxide and hydrogen. In the Proterozoic Era (250-54 million years ago), the amount of oxygen in the Earth's atmosphere increased and in the second half of this era the climate changed to the ice age. In the Paleozoic Era (54-25 million years ago), atmospheric oxygen reached present levels and stratospheric ozone was formed. In the initial period of this era, the climate was hot but later the climate changed, and the entire polar region turned into an ice field. This time is called the Carboniferous Period. At the beginning of the Mesozoic Era (25-6.5 million years ago), the global

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climate was tropical. At this time the supercontinent Pangea split into Laurasia and Gondwana Land. The Crustacean Era was a time of extremely warm climate when the average global temperature was 6° to 8°C higher than at present. The present continents were born in the Cenozoic Era (65 million years to the present). In the initial period of this era, the climate was hot and later it became cold and dry. The low temperature gave birth to a new ice age. The climate alternated between winter and summer during the late Cenozoic era. The last great glaciation occurred about 0.18 million years ago in the Quaternary Era.

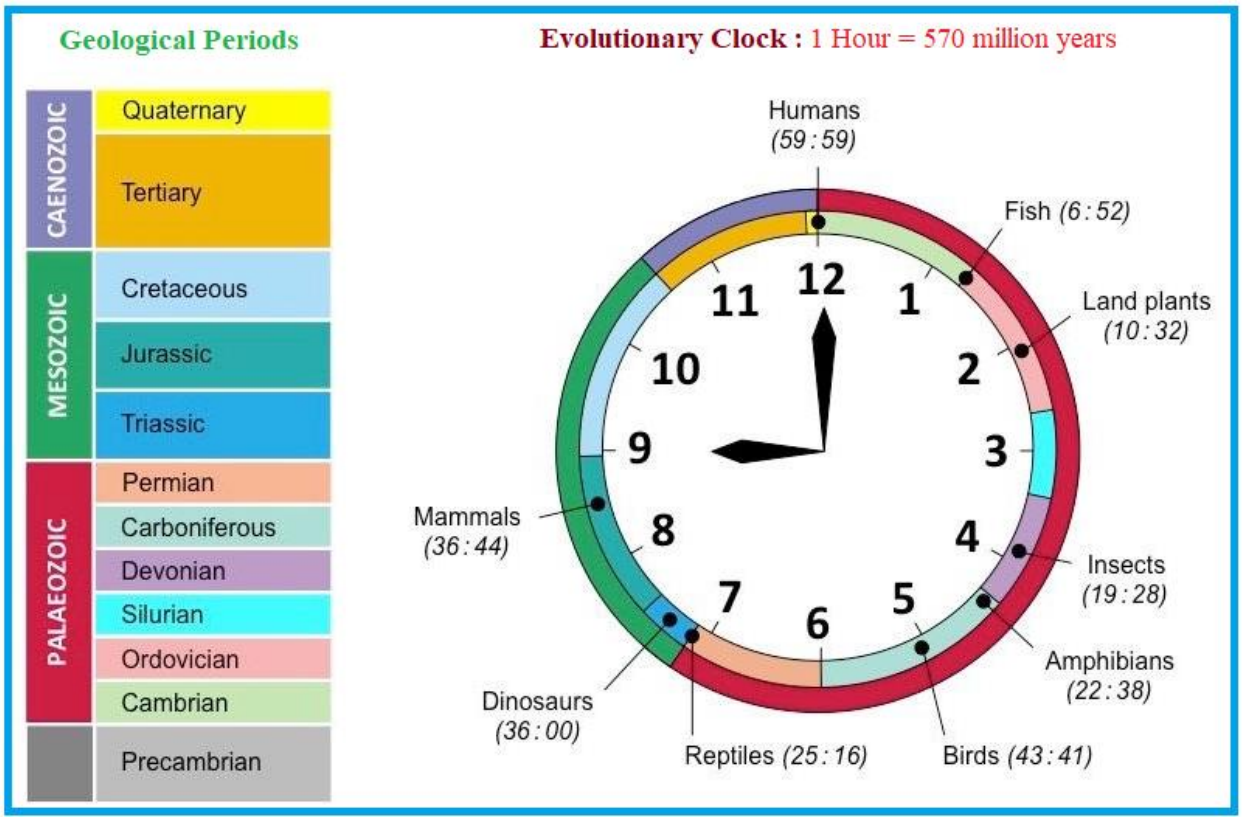

Figure number 1: Geologic clock

There have been five major ice ages since the origin of the Earth in its 450-million-year history. The oldest ice age occurred in the Paleoproterozoic Era, 24 to 25 million years ago. This is called Huronian Glaciation. The Cryogenian Glaciation in the Neoproterozoic Era in the Precambrian Period, 71 to 640 million years ago, was the most extensive ice age yet. The Andean-Saharan Glaciation lasted from the late Ordovician Period to the Silurian Period, about 46 to 43 million years ago. It was from the remains of the Talcher Glaciation of the Permo-Carboniferous Era, 300 million years ago, that the Continental Drift Theory was propounded and the hypothesis of the supercontinent of Pangea developed. The Quaternary Glaciation was the last ice age in the Neogene Period of the Cenozoic Era. In this era, large-scale changes took place in the environment, which had an impact on the global landscape and life. Ice accumulation occurred on continental ice sheets and mountain peaks in most regions of the globe. In the middle of this ice age, there were short-lived warm states. This last ice age occurred about 18,000 to 20,000 years ago when ice covered more than half of the Earth's surface and ended 11,000 years ago.

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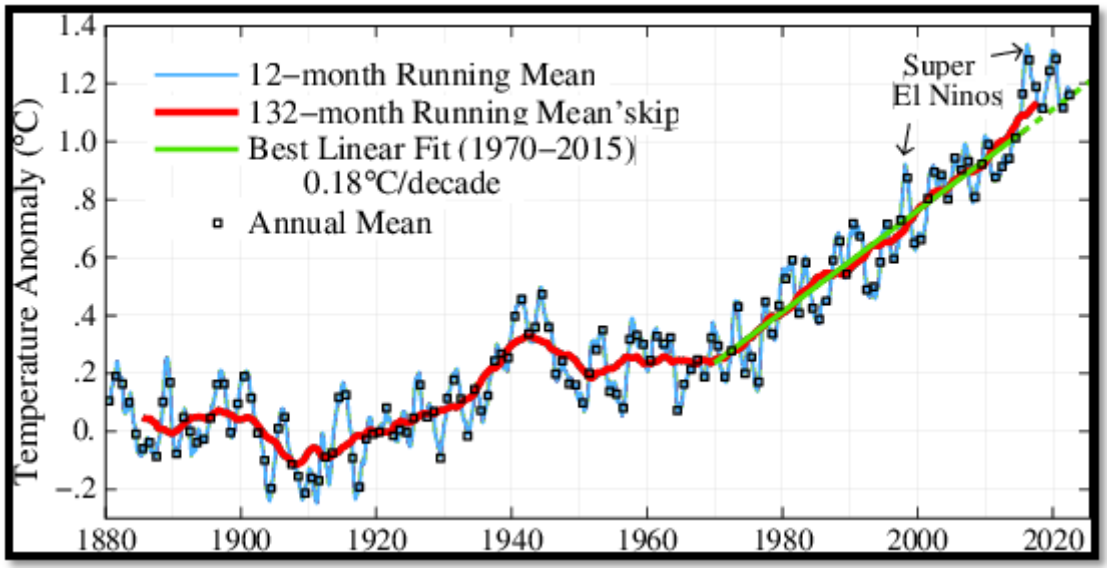

Figure number 2: World average temperature cycle

We are currently living in the interglacial warm age. The earth is getting warmer, and the average temperature too is increasing. The temperature has increase in the 19th and 20th centuries. According to the United Nations Intergovernmental Panel on Climate Change (IPCC), by the year 2050, the average temperature of the earth is expected to increase from 1.5 to 6.4 degree Celsius.

III. FACTORS RESPONSIBLE FOR CLIMATE CHANGE

Climate change is caused by changes in atmospheric heat balance, humidity, cloud cover and precipitation patterns. These changes have been explained by the geographer through various theories and factors.

1. Orbital Theory: Russian scientist Milanovich has proposed the Orbital theory of climate change. Due to the inclination of the orbit of the Earth onits axis, the inclination of the Earth's orbital plane to the Sun's horizontal plane and the rotation of the Earth on its axis, the amount of incoming solar radiation to the Earth keeps changing, and due to this change the availability of solar energy in summer and winter seasons keeps on changing, which affects the climate.
2. The theory of solar heat variation assumes that the amount of heat stored in the Sun varies from time

to time, causing variation in solar energy emissions. Magnetic storms in the solar system and the Sun's size and number of black spots keep on changing: Due to this, there is also a change in the solar heat coming on the earth. This Solar heat transfer also becomes a factor of climate change.

3.Atmospheric Structure Theory: The number of gases in the composition of the atmosphere is changing. Due to factors like human activities, industrialization, burning of fuels, deforestation, the amount of greenhouse gases like Carbon dioxide, carbon mono oxide, chlorofluorocarbons, methane in the atmosphere is increasing. Due to this the average temperature of the atmosphere is also increasing Similarly, the dust particles that dissolve in the atmosphere at thetime of volcanic emissions, reflect the solar radiation into the space and cause climate change by changing the atmospheric temperature by stopping the heat waves coming on the earth.

4. Effect of El Nino and La Nino: Due to El Nino, global environment and weather are changing. - Like the monsoon. El Nino - La Nino also brings worldwide change in the environment and weather conditions.
5. Cosmic Phenomena: Due to various celestial phenomena, there is a transfer of energy from the universe, the effect of which is also visible on the Earth's climate. Asteroids and comets moving in the universe affect the heat budget of the earth and cause changes in the Earth's climate.

6. Due to continental displacement and expansion of the earth's surface, there is a change in the expansion of hydrosphere, atmosphere, and lithosphere. The relative positions of different continents and poles changes, which also changes the climate on a global scale.

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7 Global Ocean Circulation- The hydrosphere is spread over three-fourths of the earth's surface. Its depth at different places differs. Different ocean currents always flow on the ocean surface and in the depth in the oceans of the whole world, thereby distributing the temperature on the globe. This becomes a major reason for the change in the weather of the earth. Therefore, global ocean circulation is also a major factor in climate change.
8. Human Activities and Occupations: For their technical and economic development, human beings have continuously done overexploitation of natural resources. Increase in amount of greenhouse gases due to forest destruction, industrialization, urbanization, change in land use, burning of fossil fuels and nuclear energy, pollution of natural elements and population growth have happened. This is a major cause of atmospheric temperature increase. Increase in atmospheric temperature affects the global heat budget and it becomes a factor of climate change.

Climate change can be short-term as well as long-term. Human-caused factors are responsible for short-term weather and climate change. Natural factors are often responsible for long-term climate change.

IV. EFFECTS OF CLIMATE CHANGE

Tampering with Nature has imbalanced the complex system of climate. Due to change in climate, there will be a change in energy exchange between the lithosphere - Atmosphere - hydrosphere. Different biotic and abiotic systems at regional and global level will have an adverse effect on their internal energy and heat movements.

- Changes in the heat budget will bring changes in the average temperature in regions on the globe. According to meteorologists, by the year 2050, an increase in the average temperature of the earth is possible from 1.5 degree to 45 degree Celsius.
- Due to the increase in temperature, the air pressure will decrease, and the global air pressure system will change. There will be a change in the format and extension of pressure belts and wind belts. This will increase the frequency and severity of tropical cyclones.
- There will be a change in the pattern and distribution of rainfall. The intensity of rainfall will increase but the total number of rainy days will decrease: This will lead to heavy rains, cloud bursts and floods in some areas and lack of rainfall and drought in other areas.
- Due to the increase in world temperature the rate of melting of snow has started increasing and the size of glaciers is continuously decreasing in length and width. Snowfields and glaciers are also helpful in global temperature control.
- Melting glaciers will increase sea level. Their melting will also affect the surface water flow system. Due to the increase in the amount of water in the perennial rivers, there will be an increase in the number of floods.
- Due to the reduction of glaciers, the sources of fresh water will decrease, and many annual rivers will be converted into seasonal and tiny rivers.
- Due to changes in rain behavior, groundwater recharges are also reducing. This will lead to a shortage in groundwater availability.
- Sea level is rising. Due to this many islands and coastal regions will be submerged.
- Intensity and frequency of sea storms will affect life in the coastal areas.
- Climate change will increase natural disasters like floods, droughts, landslides, avalanches, forest fires, tsunamis. This will cause destruction and damage of the property and life in the affected areas and will adversely affect their social and economic structure.
- Drought, flood, landslides will increase the amount of soil erosion and soil depletion. Soil moisture and productivity will decrease. Evaporation will increase due to an increase in temperature, due to which the salinity and alkalinity of the soil will also increase.
- Decrease in underground water level will also adversely affect soil fertility. The decomposition rate of organic matter will decrease, and the biodiversity of the soil will also decrease.
- Agriculture production will decrease due to disorganized soil fertility. Use of chemical fertilizerswill increase fertility. This will increase the chemical pollution of the soil and cause depletion. Soil erosion will reduce the quality of the land.
- Wastelands and deserts will expand, and the amount of desertification will increase.
- There will be adverse impact on terrestrial and marine ecosystems. The reproduction, growth and nutrition cycles of regional flora and fauna will be affected.
- Biodiversity will be destroyed. Mountain, marsh, coastal ecosystems will be disorganized.
- Coral reefs will also be destroyed.
- Due to changes in natural habitats, many biological and plant species will become extinct and new species will emerge.

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- There will be a change in the rate of transpiration and evaporation from vegetation. This will require more water for irrigation.
- The present production areas of crops will change, and the cropping pattern will also change.
- Climate change will also bring changes in agriculture pattern and methods. Soil erosion will adversely affect the production capacity of the land and the fertile areas will become barren.
- New species of insects will disease the crops. Due to decrease in productivity, the use of chemical fertilizers and pesticides will increase. This will increase the number of pollutants in the soil, air and water, which will harm the living beings through the food chain. There is also the danger of a global food crisis.
- Global climate change may have harmful effects on human health. Respiratory diseases, skin diseases, cancer will increase. Also, the frequency of various infections will increase.
- Climate change will lead to depletion of the ozone layer, the protective shield for the earth. The ultraviolet rays of the Sun reaching the Earth will unbalance the global heat budget.
- With the change in crop production pattern, the international trade pattern will also change at inter - regional, intra - regional and international level.
- Due to climate change, water and food crisis will lead to starvation and diseases. The social and economic problems arising out of this will increase disputes at the global level and the difference between developed and developing countries will increase.
- This will bring changes in the foreign policies of the nation's due to which national, state international geo-politics will also change.

V. PREVENTION AND CONCLUSION

Climate change is a natural sequence, and it cannot be stopped, but it is also true that the way human beings have overexploited Nature for their so-called development and progress, the natural ecosystem has been badly harmed. After the Industrial Revolution, the rate of climate change accelerated. Through human intervention, Strict policy measures are required to prevent the adverse social and economic conditions arising out of it. Climate change should be assessed in regional, national, and global boundaries. After assessing its impact on the entire mankind, technical and industrial activities should be conducted in accordance with environmental quality and environmental protection. Carbon emissions can be reduced by intensive plantation and reforestation. Changes in the use of energy and development of alternative energy sources will have to be made. It is very necessary to develop the concept of sustainability and sustainable development by changing the lifestyle of the human community. Special policies, plans and programs will have to be formulated and implemented for this purpose. Accordingly social, economic, and technical development will have to be done. The whole world must unite to fight the menace of climate change. Only through these measures and ways, we will be able to keep our earth safe and protect the existence of the human species, the earth'secosystem, and our biosphere.

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