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Global Climate Change: Challenges and Preventive Measures

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Abstract: *This review essay will demonstrate that global warming-induced climate change is already occurring and requires urgent response. In recent years, notably the last three decades, convincing evidence that Earth's climate is changing fast has collected. Theoretical models replicate the database with increasing success, but they do not prove that the Earth is warming. Global warming is verified by massive observations from numerous sources. The emphasis of study has changed from proving global warming to determining its causes. The precise magnitude of global warming's damage is hard to estimate, but its negative consequences on climate will far exceed its advantages. Human-generated greenhouse gases, especially carbon dioxide, are likely the main driver of well-documented global warming and climate change. Much can be done today to minimize global warming and climate change. Technology is not the main issue; a lack of incentives to apply new technologies more aggressively is.*

Keywords: Global Warming, Climate Change, Environmental Impact, Mitigation Strategies.

I. INTRODUCTION

The environment has been impacted by humans for ages. Human actions have only started to affect the world since the industrial revolution. Due to scientific evidence of rising greenhouse gas concentrations and changing climate, the environment is becoming humanity's primary worry. Temperature is rising and rainfall is changing globally [1]. Global warming and climate change are an international issue. Overproduction of greenhouse gases traps more heat in the earth's atmosphere, heating it up. This is global warming [2]. Since industrialization, the earth's temperature has increased 0.7 degrees; if we don't act quickly, it might climb 5 degrees by 2100. This temperature rise will cause more intense weather and the extinction of many animal and plant species [3]. Human activities have released greenhouse gases such CO2 from deforestation and fossil fuel burning, methane and nitrous oxides from agriculture and waste, and fluorinated gases from industry. Additional greenhouse gasses warm the earth. This is amplified greenhouse effect. Measure greenhouse gasses in the atmosphere. Since the industrial revolution, CO2, CH4, and N2O concentrations have increased significantly. CO2 is 30% greater, N2O 50% higher, and CH4 quadrupled since 1750. Rising fossil fuel use and land use changes are releasing greenhouse gases into the atmosphere. Increasing greenhouse gases including carbon dioxide (CO2), methane (CH4), and nitrogen dioxide (N2O) have retained more solar radiation in the Earth's atmosphere, which would ordinarily escape back into space. This heat rise has caused climate change via the greenhouse effect [4].

Evidences of Climate Change

IPCC defines climate change as any change in climate over time, whether natural or caused by humans. In contrast, the UNFCCC defines climate change as a change in climate caused by human activity that alters the global atmosphere and is in addition to natural climate variability over comparable time periods. Greenhouse gas concentrations in the atmosphere from natural and manmade activity are the major cause of climate change. Since 1750, human activities have boosted global atmospheric carbon dioxide, methane, and nitrous oxide concentrations, surpassing pre-industrial amounts from ice cores spanning thousands of years. Global carbon dioxide concentrations are mostly caused by fossil fuel usage and land use change, whereas methane and nitrous oxide are mostly caused by agriculture. Global warming; changes in cloud cover and precipitation, especially over land; melting of ice caps and glaciers and reduced snow cover;

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and increases in ocean temperatures and acidity due to seawater absorbing heat and carbon dioxide from the atmosphere are the main characteristics of climate change.

Climate Change Evidences from Physical systems

Increased CO2, CH4, N2O, and temperature: Carbon dioxide is the main human greenhouse gas. The worldwide carbon dioxide content rose from 280 ppm pre-industrial to 379 ppm in 2005. According to ice cores, the 2005 atmospheric carbon dioxide content surpasses the normal range of 180 to 300 ppm during the previous 650,000 years. The annual carbon dioxide concentration growth rate was higher in the last decade (1995–2005 average: 1.9 ppm per year) than since continuous direct atmospheric measurements began (1960–2005 average: 1.4 ppm per year), though growth rates vary. Since pre-industrial times, fossil fuel consumption has been the main cause of rising atmospheric carbon dioxide, with land-use change contributing less. Annual fossil carbon dioxide emissions grew from 6.4 [6.0 to 6.8] GtC (23.5 [22.0 to 25.0] GtCO2) in the 1990s to 7.2 [6.9 to 7.5] GtC (26.4 [25.3 to 27.5] GtCO2) in 2000–2005. Land-use change is expected to emit 1.6 [0.5 to 2.7] GtC (5.9 [1.8 to 9.9] GtCO2) per year in the 1990s, with high uncertainty. Methane concentrations rose from 715 ppb pre-industrial to 1732 ppb in the early 1990s and 1774 ppb in 2005. Ice cores show that 2005 methane levels exceeded the normal range of 320 to 790 ppb during the previous 650,000 years. Since the early 1990s, growth rates have reduced, indicating essentially constant total emissions from human and natural sources. The observed rise in methane content is presumably related to human activities, notably agricultural and fossil fuel usage, although the proportional contributions from various source types remain unknown. The worldwide atmospheric nitrous oxide content rose from 270 ppb pre-industrial to 319 ppb in 2005. Since 1980, growth has remained steady. Agriculture accounts for about a third of anthropogenic nitrous oxide emissions. The Fourth Assessment Report of the IPCC [5] clarified several climate change issues. Climate warming is confirmed. Eleven of the previous twelve years (1995–2006) are among the 12 hottest in the instrumental global surface temperature record since 1850. The revised 100-year linear trend (1906 to 2005) of 0.74°C [0.56°C to 0.92°C] exceeds the Third Assessment Report's 1901–2000 trend of 0.6°C [0.4°C to 0.8°C]. The linear warming trend over the past 50 years (0.13°C [0.10°C to 0.16°C] each decade) is roughly double that of the previous 100 years. From 1850–1899 to 2001–2005, temperatures rose 0.76°C [0.57°C to 0.95°C]. Urban heat island effects are genuine but limited, affecting these values by less than 0.006°C per decade over land and nil over seas. New study of balloon-borne and satellite lower- and mid-tropospheric temperature observations shows rising rates equal to the surface temperature record and consistent within their uncertainties [6].

Increase in sea water temperature: Since 1961, global ocean temperatures have grown to at least 3000 m and the ocean has absorbed more than 80% of climate system heat. Rising sea levels result from saltwater expansion due to warming. Surface air temperatures have risen 0.4° C nationally during the last century. West coast, middle India, inner peninsula, and north-eastern India are warming. In north-west and south India, cooling has occurred [6].

Melting of Mountain glaciers and Snow: Average mountain glaciers and snow cover have fallen in both hemispheres. Glacier and ice cap declines have raised sea levels (excluding the Greenland and Antarctic Ice Sheets). Since the Third Assessment Report, new data reveal that Greenland and Antarctica ice sheet losses likely contributed to sea level increase from 1993 to 2003. Some Greenland and Antarctic outlet glaciers, which drain ice from ice sheets, have accelerated. Thinning, decrease, or loss of ice shelves or floating glacier tongues typically increases ice sheet mass loss. Such dynamical ice loss may explain 80% of Antarctic net mass loss and half of Greenland net mass loss. Because melting has surpassed snowfall, Greenland has lost the last of its ice [5].

Sea Level Rise: The global average sea level climbed 1.8 [1.3 to 2.3] millimeters per year from 1961 to 2003. The pace accelerated from 1993 to 2003 to 3.1 [2.4 to 3.8] mm per year. The quicker rate from 1993 to 2003 may be decadal fluctuation or a longer-term trend. High confidence exists that sea level rise accelerated from the 19th to the 20th century. Estimated 20th-century rise: 0.17 [0.12 to 0.22] m. The climatic contributions from 1993 to 2003 match the observed sea level increase within uncertainties. Improved satellite and in situ data inform these estimations. Climate contributions are predicted to be less than sea level increase from 1961 to 2003. Third Assessment Report found a similar difference during 1910–1990. Since 1978, satellite data reveal that annual average arctic sea ice extent has declined by 2.7 [2.1 to 3.3] % each decade, with higher summer losses of 7.4 [5.0 to 9.8] %. Arctic top permafrost temperatures have risen by up to 3°C during the 1980s. Since 1900, the Northern Hemisphere's maximum seasonally frozen ground has reduced by 7%, with a 15% reduction in spring. Over the last century, arctic temperatures rose roughly twice as fast as world temperatures. Arctic temperatures vary greatly, and 1925–1945 was a warm period.The Gulf of Kutch and West Bengal coasts of India experience 0.4–2 mm/year sea level rise. Along the Karnataka coast, relative reduction has been seen [5].

Shifting trends in precipitation: Many big locations have seen precipitation changes from 1900 to 2005. Eastern North and South America, northern Europe, and northern and central Asia have had increasing precipitation. Southern Africa, the Mediterranean, the Sahel, and southern Asia have dried. Data on precipitation is scarce in certain areas and very changeable. No long-term patterns have been seen in other big areas. Freshening of mid- and high-latitude waters and higher salinity in low-latitude waters reflect oceanic precipitation and evaporation changes. Since 1960, both hemispheres have seen stronger mid-latitude westerlies [5].

Incidence of Floods, Droughts, Earthquakes: Floods, droughts, earthquakes, super cyclones, and other natural disasters have become more frequent and intense, causing property and life losses. Since the 1970s, tropical and subtropical droughts have intensified and lasted longer. Higher temperatures and less precipitation have caused drought. Droughts are connected to sea surface temperature, wind patterns, and lack of snowpack and cover. Most land regions have seen more heavy precipitation events, creating floods, consistent with warming and atmospheric water vapour increases.

Monsoon Unpredictability: In recent years, monsoon onset has grown unexpected, uncertain, and irregular. The all-India monsoon rainfall does not indicate a trend, however regional variances have been detected. Over the past century, monsoon seasonal rainfall has increased along the west coast, northern Andhra Pradesh, and north-western India (+10% to +12% of the normal), while it has decreased over eastern Madhya Pradesh, north-eastern India, and some parts of Gujarat and Kerala (–6% to –8%).

Climate Change evidences from biological systems: Numerous research examined changes in fish, plankton, algal, plant, sand tree, insect, and mammal populations. These studies demonstrate a substantial association with climate change. Populations migrate to climate-friendly places and vanish from unsuitable ones. This often involves range poleward migration. It blooms early. But it also implies that migratory bird nesting and caterpillar or insect abundance are mismatched. The caterpillars or insects come out early due to warmer temperatures, but the migrating birds arrive at the customary time and don't find food for their young. Agriculture has seen earlier planting, a longer growing season, and crop failures due to shifting rainfall patterns. Forest management pest infestations and fire patterns are linked to climate change [8].

Advance onset of flowering in trees: Trees are useful bio-indicators of climate change since perennial trees blossom when they reach the crop-specific thermal unit/thermal period or degree-days. Mango trees, which bloom according to the country's temperature regime, are ideal examples. In south India, mango trees bloom in October-November, in eastern and central India in December-January, and in north India in February-March. However, in 2004, mango trees in north India bloomed in December, perhaps because to the higher regime. So mango, cherry, apple, etc. blossoming behavior may be a useful climate change bio-indicator.

Climate change and shifting of temperate crops: The geographical distribution of temperate crops, particularly chilling-requiring crops like apple, apricot, cherry, plum, saffron, cauliflower, cabbage, pea, etc., as influenced by climate change during on and off seasons is fascinating. India grows temperate crops mostly in higher-latitude provinces like Kashmir, Arunachal Pradesh, Uttaranchal, Sikkim, and Himachal Pradesh. The restricted heat regime for blooming in these places may significantly impact crops.

Changing cropping pattern: Hilly mountain regions of Himachal Pradesh have seen agricultural pattern alterations. Some apple-growing sites have moved up since warmer weather may make their typical belts unworkable. Successful winter wheat and maize production in Kashmir and Bihar are examples. Apple yields in Kashmir may have declined owing to rising winter temperatures, since apples need a restricted thermal regime. Polewards growth of arable area in places with low temperatures that restrict agricultural production owing to rising temperatures that may be favorable [9].

Impacts of Global warming

Melting glaciers may trigger floods and droughts in the future. Evapo transpiration and increased demand for drinking water, industry, and irrigation may cause water supply issues in society and agriculture. Due to sea level rise and water expansion, coastal biodiversity, particularly mangrove plant and animal species that safeguard coastal ecosystems, may

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decline. Kohlai glacier in Kashmir has reduced by about 5% from 1960 (13 sq. miles to 11 sq. miles). The water level in practically all Kashmir valley rivers has dropped 40% in 40 years.

Impact on Agriculture: Concerns exist concerning how climate change and variability may affect global agriculture. Food security is among the human activities and environmental services threatened by hazardous anthropogenic climate change. Second, each country is naturally concerned about the potential damages and benefits of climate change impacts on its territory and globally in the coming decades, which will affect domestic and international policies, trading patterns, resource use, regional planning, and human welfare. Current research shows that while crops would respond positively to elevated CO2 in the absence of climate change, high temperatures, altered precipitation patterns, and possibly increased frequency of extreme events like drought and floods will likely depress yields and increase production risks in many world regions, widening the gap between rich and poor countries. A consensus has emerged that developing countries are more vulnerable to climate change than developed countries due to their agricultural economies, lack of capital for adaptation, warmer baseline climates, and increased exposure to extreme events. Thus, 800 million undernourished individuals in the developing countries may be especially affected by climate change. More than 40 'least-developed' nations, predominantly in sub-Saharan Africa, had a 10% drop in per capita food output in the previous 20 years. Mendelsohn and Dinar (2009) [7] found enough evidence that climate change would damage agriculture. They indicate a suitable temperature and precipitation range for agricultural and livestock productivity. Mendelsohn and Dinar (2009) [7] also note that soil and water affect climate-optimal growth and productivity. Poor soil and little water will prevent crops from growing and producing as well as they might. Plants have specialized to maximize yields at certain temperatures and humidity. Plant growth depends on atmospheric CO2 and temperature. Plant growth rate fluctuates with rising temperatures and CO2 concentrations, altering crop growth. Rice production will drop 10% for every 1% rise in growing season mean temperature between 30-400 C. The lowest temperature increase will reduce rice grain yield more than the maximum temperature increase. Wheat production will decrease by 3-4% each 00C rise in mean ambient temperature. High warmth stimulates leaf and stem development but harms reproductive organs like pollen spikelets. Temperature during anthesis affects wheat and rice plants most, causing excessive pollen and spike sterility. Rabi crops will lose more than Kharif. Global warming may harm wheat and other hypo-thermophilic crops like cauliflower and cabbage in Central India and temperate crops like cherry, apple, plum, and peach in Northern India. Northern India should have less frost damage. Global warming might threaten Basmati rice and litchi harvests. Positive affects on Europe and N. America and negative ones on tropical and subtropical nations like India, Brazil, and Mexico cause food trade imbalance.

Adaptation to climate change

Adaptation involves changing biological and non-biological mechanisms to help organisms survive, thrive, and adapt amid new environmental challenges. However, organisms can only adapt so much. Most organisms can adapt their biological systems to deal with external challenges and survive and reproduce. In addition to inherent adaptation of organisms, including agricultural plants, several man-made coping mechanisms may reduce climate hazards. In developing nations like India, adaptation means helping vulnerable people during climate disasters and enabling them to create their lives and deal with climate threats. In this setting, numerous Indian social-sector policies prioritize livelihood security and welfare of the poor.

Below are some natural and man-made adaption mechanisms:

Natural adaptation: Different crops and animals may adjust to warming by altering their optimal temperature range, fleeing, avoidance, thermal cooling, stomatal closure, cutinization, waxination, heat shock protein production, osmoregulation, etc.

Genetic adaptation: developing heat-tolerant crops using traditional and contemporary methods. Selecting heat-tolerant crop genotypes and exploiting favorable genes from warmer-adapted germplasm.

Non-genetic adaptation: Dates of planting, frequent irrigation, larger chemical fertilizer doses, crop variety, green manuring, etc. might lessen climate change sensitivity. Identification of agricultural genotypes for quicker grain development and delayed leaf withering at higher temperatures.

Biotechnological approaches: Donor-selected gene transfer without substantial genetic alterations.

Crop insurance: Insurance reduces agricultural yield climate risk.

Credits and cheaper support: Better agricultural support prices and bank loans are needed for crop sustainability and climate change adaption.

Some effective Indian government programs that help communities cope with climate fluctuation include:

Create watersheds in rain-fed places.

Implementing drought-proofing strategies.

Developing drought-resistant cultivars.

Encourage crop diversity.

Encouraging water-efficient technology on farms.

Implementing credit and lending systems for farmers.

Promoting the National Agricultural Insurance Scheme.

Promote resource conserving technologies (RCTs) in agricultural production.

Mitigation strategies

All human efforts that minimize greenhouse gas sources and embrace sinks are mitigation. Below are some strategies:

Reduction of greenhouse gases through:

The Energy Conservation Act (2001) allows the government to set energy consumer guidelines, energy conservation building requirements, and energy audits. Accredited energy auditors must verify, monitor, and analyze energy usage, write technical reports and cost–benefit analyses, and create action plans to minimize use for significant business customers under the act.

Electrical appliance manufacturers' standards and labeling initiative is estimated to save 11,689 million kW annually in the first five years.

Energy efficiency performance contracting projects in nine government buildings by the Bureau of Energy Efficiency (BEE) and the Central Public Works Department (CPWD) are expected to save 30 GWh per year with a payback of less than two years.

Green rating for integrated habitat assessment (GRIHA), the Ministry of Environment & Forests (MoEF) technical manual for environmental appraisal of buildings, and the Energy Conservation Building Code cover green rating of buildings. MN&RE is also developing an indigenous green building grading system.

Under the National power Policy (2001), the government must provide power to all villages and hamlets by 2012 using decentralized RE (renewable energy) technology. The Rs 180 billion Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) plan targets poor families with 90% subsidies to electrify 1, 25,000 unconnected villages.

The Ministry of New & Renewable Sources (MNRE), IREDA, and other institutions promote renewable energy through a broad program covering all new and renewable energies. The 11th Five-Year Plan plans to enhance renewable electricity (excluding big hydropower) capacity by 14,500 MW, 20% of utility-based capacity (78,577 MW).

National Mission on Bio-diesel seeks to build biodiesel (jatropha) plantations in 26 states in the first (demonstration) phase and produce enough biodiesel to mix 20% of vehicle fuel in 2011/12 in the second phase. Recent fuel price increases may encourage biodiesel production.

The National Urban Transport Policy prioritizes public transportation and non-motorized modes above cars. The Delhi MRTS extension and Bangalore Metro Bus project are part of its execution. The strategy also promotes CNG and greener technology R&D.

An Environment Protection Act notice requires coal-based thermal power stations beyond 1000 km from pit-heads or in urban, environmentally sensitive, or severely contaminated regions to use beneficiated coal unless they use clean-coal technology [10].

Reforms in the electricity industry aim to harness private resources for capacity expansion. Since the reforms created the Central electrical Regulatory Commission (CERC) and state electrical regulatory commissions (SERCs), plant load factors, heat rates, transmission and distribution losses, etc. have improved.

Promotion of renewable energy

India will continue to rely on fossil fuels, particularly coal, but renewable energy might lessen its carbon footprint. Hydropower (big, medium, and small projects) provides instant advantages. Solar, wind, bio-mass, and other renewable energy sources offer long-term potential to reduce India's fuel imports and boost energy security.

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Transportation

A move from road to rail transport, more dependence on public transport over private motor cars, and efficiency improvements may limit the unavoidable growth in transportation sector emissions.

- Plantation of potential sequestration species to increase vegetation cover or green belt.
- Managing livestock nutrient and manure to reduce methane emissions.
- Water conservation, rainwater collection, and waste water reuse.
- Adoption of organic agriculture.
- Effective disaster management.
- Planting around roads, industrial complexes, and residential areas.
- Increasing C sinks via deforestation containment.

II. CONCLUSION

Active government intervention is needed to solve this situation.

Only a strong commitment by the government and stakeholders to proactively address climate change is likely to spur business and industry to go beyond current practices. We think that what people desire and how our governments react will decide how quickly global warming and climate change can be handled. Rational politicians of both liberal and conservative orientations can solve this enormous worldwide issue if the people want it, given the numerous lucrative economic prospects on many levels. Education and politics appear to be our biggest challenges. One hopes future generations will think we made good decisions.

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