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A Brief Review on Global Warming and Climate Change: Consequences and Mitigation Strategies

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ABSTRACT

This review article will offer compelling evidence that global climate change caused by global warming is already underway and is need of our immediate attention. Convincing evidence that the Earth's climate is undergoing significant and alarming, changes has accumulated rapidly in recent years, especially during the past three decades. The conclusion that there is substantial warming of the Earth's surface is not based primarily on theoretical models, although these models do succeed in replicating the existing database with growing success. Instead, global warming is a fact confirmed by an enormous body of observations from many different sources. Indeed, the focus of research has now shifted from attempts to establish the existence of global warming to efforts to determine its causes. Although the exact extent of damage from global warming may be difficult to predict now, it can be said with confidence that the harmful effects of global warming on climate will significantly outweigh the possible benefits. The probability is extremely high that human generated greenhouse gases, with carbon dioxide the major offender, are the primary cause of well documented global warming and climate change today. Much can be done now to mitigate the effects of global warming and the associated climate change. Difficulties in addressing the problem are not caused primarily by unavailable technology, but by the lack of sufficient incentives to implement the new technologies more aggressively.

Keywords: Global warming, Climate change, Carbon dioxide, Methane, Sea level rise.

1. INTRODUCTION

The environment has been influenced by human beings for centuries. However, it is only since the beginning of the industrial revolution that the impact of human activities has begun to extend to a global scale. Today, environmental issue becomes the biggest concern of mankind as a consequence of scientific evidence about the increasing concentration of greenhouse gases in the atmosphere and the changing climate of the Earth. Globally, temperature is increasing and the amount and distribution of rainfall is being altered [1]. Global warming and climate change has emerged as an important global concern cutting across geographical and national boundaries. The on-going over-production of greenhouse gases has meant that more and more heat is being trapped in the earth's atmosphere, so we are essentially heating up. This is what is known as global warming [2]. Since industrialization, the earth's temperature has risen by 0.7 degrees- if we do not take action soon, by 2100 temperatures could increase by as much as 5 degrees. This temperature increase will have a dramatic and devastating effect upon the world around us, leading to more extreme weather events and further widespread extinction of many animal and plant species [3]. Human activities have added greenhouse gases to the atmosphere: CO_2, mainly from deforestation and fossil fuel combustion, methane and nitrous oxides from agriculture and waste, and fluorinated gases from industrial processes. These additional greenhouse gases are responsible for the additional warming of the earth. This is the enhanced greenhouse effect. We can measure greenhouse gases in the atmosphere. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxides (N_2O) concentrations have gone up strongly since the beginning of the industrial revolution. CO_2 levels are now about 30% higher than before 1750, N_2O about 50% higher, and CH_4 approximately doubled. Rising fossil fuel burning and land use changes have emitted, and are continuing to emit, increasing quantities of greenhouse gases into the Earth's atmosphere. These greenhouse gases include carbon dioxide (CO_2), methane (CH_4) and nitrogen dioxide (N_2O), and a rise in these gases has caused a rise in the amount of heat from the sun withheld in the Earth's atmosphere, heat that would normally be radiated back into space. This increase in heat has led to the greenhouse effect, resulting in climate change [4].

II EVIDENCES OF CLIMATE CHANGE

Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. The main reason of climate change is the increase in the concentration of greenhouse gases in the atmosphere due to several natural and anthropogenic activities. Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture. The main characteristics of climate change are increases in average global temperature (global warming); changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and increases in ocean temperatures and ocean acidity – due to seawater absorbing heat and carbon dioxide from the atmosphere.

III Climate Change Evidences from Physical systems

Rise in CO_2, CH_4, N_2O levels and atmospheric temperature: Carbon dioxide is the most important anthropogenic greenhouse gas. The global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005. The atmospheric concentration of carbon dioxide in 2005 exceeds by far the natural range over the last 650,000 years (180 to 300 ppm) as determined from ice cores. The annual carbon dioxide concentration growth rate was larger during the last 10 years (1995–2005 average: 1.9 ppm per year), than it has been since the beginning of continuous direct atmospheric measurements (1960–2005 average: 1.4 ppm per year) although there is year-to-year variability in growth rates. The primary source of the increased atmospheric concentration of carbon dioxide since the pre-industrial period results from fossil fuel use, with land-use change providing another significant but smaller contribution. Annual fossil carbon dioxide emissions increased from an average of 6.4 [6.0 to 6.8] GtC (23.5 [22.0 to 25.0] GtCO2) per year in the 1990s to 7.2 [6.9 to 7.5] GtC (26.4 [25.3 to 27.5] GtCO2) per year in 2000–2005. Carbon dioxide emissions associated with land-use change are estimated to be 1.6 [0.5 to 2.7] GtC (5.9 [1.8 to 9.9] GtCO2) per year over the 1990s, although these estimates have a large uncertainty. The global atmospheric concentration of methane has increased from a pre-industrial value of about 715 ppb to 1732 ppb in the early 1990s, and was 1774 ppb in 2005. The atmospheric concentration of methane in 2005 exceeds by far the natural range of the last 650,000 years (320 to 790 ppb) as determined from ice cores. Growth rates have declined since the early 1990s, consistent with total emissions (sum of anthropogenic and natural sources) being nearly constant during this period. It is very likely that the observed increase in methane concentration is due to anthropogenic activities, predominantly agriculture and fossil fuel use, but relative contributions from different source types are not well determined. The global atmospheric nitrous oxide concentration increased from a pre-industrial value of about 270 ppb to 319 ppb in 2005. The growth rate has been approximately constant since 1980. More than a third of all nitrous oxide emissions are anthropogenic and are primarily due to agriculture. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change [5] dispelled many uncertainties about climate change. Warming of the climate system is now unequivocal. Eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850). The updated 100-year linear trend (1906 to 2005) of 0.74°C [0.56°C to 0.92°C] is therefore larger than the corresponding trend for 1901 to 2000 given in the Third assessment Report of 0.6°C [0.4°C to 0.8°C]. The linear warming trend over the last 50 years (0.13°C [0.10°C to 0.16°C] per decade) is nearly twice that for the last 100 years. The total temperature increase from 1850–1899 to 2001–2005 is 0.76°C [0.57°C to 0.95°C]. Urban heat island effects are real but local, and have a negligible influence (less than 0.006°C per decade over land and zero over the oceans) on these values. New analysis of balloon-borne and satellite measurements of lower- and mid-tropospheric temperature show warming rates that are similar to those of the surface temperature record and are consistent within their respective uncertainties [6].

Increase in sea water temperature: Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system. Such warming causes seawater to expand, contributing to sea level rise. At the national level, increase of 0.4° C has been observed in surface air temperatures over the past century. A warming trend has been observed along the west coast, in central India, the interior peninsula, and north-eastern India. However, cooling trends have been observed in north-west India and parts of south India [6].

Melting of Mountain glaciers and Snow: Mountain glaciers and snow cover have declined on average in both hemispheres. Widespread decreases in glaciers and ice caps have contributed to sea level rise (ice caps do not include contributions from the Greenland and Antarctic Ice Sheets). New data since the Third Assessment Report now show that losses from the ice sheets of Greenland and Antarctica have very likely contributed to sea level rise over 1993 to 2003. Flow speed has increased for some Greenland and Antarctic outlet glaciers, which drain ice from the interior of the ice sheets. The corresponding increased ice sheet mass loss has often followed thinning, reduction or loss of ice shelves or loss of floating glacier tongues. Such dynamical ice loss is sufficient to explain most of the Antarctic net mass loss and approximately half of the Greenland net mass loss. The remainder of the ice loss from Greenland has occurred because losses due to melting have exceeded accumulation due to snowfall [5].

Sea Level Rise: Global average sea level rose at an average rate of 1.8 [1.3 to 2.3] mm per year over 1961 to 2003. The rate was faster over 1993 to 2003: about 3.1 [2.4 to 3.8] mm per year. Whether the faster rate for 1993 to 2003 reflects decadal variability or an increase in the longer term trend is unclear. There is high confidence that the rate of observed sea level rise increased from the 19th to the 20th century. The total 20th-century rise is estimated to be 0.17 [0.12 to 0.22] m. For 1993 to 2003, the sum of the climate contributions is consistent within uncertainties with the total sea level rise that is directly observed. These estimates are based on improved satellite and *in situ* data now available. For the period 1961 to 2003, the sum of climate contributions is estimated to be smaller than the observed sea level rise. The Third Assessment Report reported a similar discrepancy for 1910 to 1990. Satellite data since 1978 show that annual average arctic sea ice extent has shrunk by 2.7 [2.1 to 3.3] % per decade, with larger decreases in summer of 7.4 [5.0 to 9.8] % per decade. Temperatures at the top of the permafrost layer have generally increased since the 1980s in the Arctic (by up to 3°C). The maximum area covered by seasonally frozen ground has decreased by about 7% in the Northern Hemisphere since 1900, with a decrease in spring of up to 15%. Average arctic temperatures increased at almost twice the global average rate in the past 100 years. Arctic temperatures have high decadal variability, and a warm period was also observed from 1925 to 1945.In India sea level rise has been observed to increase by 0.4–2 mm/year along the Gulf of Kutch and the coast of West Bengal. However, relative decrease along the Karnataka coast has also been observed [5].

Shifting trends in precipitation: Long-term trends from 1900 to 2005 have been observed in precipitation amount over many large regions. Significantly increased precipitation has been observed in eastern parts of

North and South America, northern Europe and northern and central Asia. Drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Precipitation is highly variable spatially and temporally, and data are limited in some regions. Long-term trends have not been observed for the other large regions assessed. Changes in precipitation and evaporation over the oceans are suggested by freshening of mid- and high latitude waters together with increased salinity in low latitude waters. Mid-latitude westerly winds have strengthened in both hemispheres since the 1960s [5].

Incidence of Floods, Droughts, Earthquakes: As compared to the past, the frequency and intensity of natural disaster such as flood, drought, earthquake, super cyclone etc. have increased which led to the loss of property and lives. More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics. Increased drying linked with higher temperatures and decreased precipitation has contributed to changes in drought. Changes in sea surface temperatures, wind patterns and decreased snowpack and snow cover have also been linked to droughts. The frequency of heavy precipitation events has increased over most land areas causing floods, consistent with warming and observed increases of atmospheric water vapour.

Monsoon Unpredictability: Since last several years, the pattern of monsoon onset has become very unpredictable, uncertain and erratic. The observed monsoon rainfall at the all-India level does not show any significant trend, regional monsoon variations have been recorded. A trend of increasing monsoon seasonal rainfall has been found along the west coast, northern Andhra Pradesh and north-western India (+10% to +12% of the normal over the 100 years) while a trend of decreasing monsoon seasonal rainfall has been observed over eastern Madhya Pradesh, north-eastern India, and some parts of Gujarat and Kerala (–6% to –8% of the normal the 100 years).

Climate Change evidences from biological systems: Hundreds of studies were done on changes in fish, plankton, and algal populations, plants, sand trees, insects, and animals. Observations from these studies show a very strong correlation with the changes in climate. Populations shift their ranges to areas where the climate has become favourable and disappear from areas where the climate is no longer appropriate. Often this means pole ward movement of the ranges. Blooming occurs earlier. But it also means that mismatches are occurring between migratory bird breeding and availability of certain caterpillars or insects. The caterpillars or insects react to the higher temperatures by coming out earlier, but the migratory birds still arrive at the usual time and do not find the regular food for their young. In agriculture changes have already occurred in terms of earlier planting, leading to a longer growing season, but also in the form of crop failures due to changing rainfall patterns. In forest management changes in pest invasions and patterns of forest fires show a clear correlation with the changed climate[8].

Advance onset of flowering in trees: Trees are generally a very good bio-indicator of climate change as the flowering in perennial trees takes place as a result of completing the crop-specific required thermal unit/thermal period or degree-days. The very good examples could be the mango trees, which flower according to the thermal regime/period in different parts of the country. The mango tree generally flower in October-November in south India, in December-January in eastern and central India and middle of February-March in north India. But there has been some evidence of flowering of mango trees in December in north India in the year 2004, which was probably due to prevailing higher regime in December. Thus the flowering behaviour of mango, cherry, apple etc. could be used as a very good bio-indicator for climate change.

Climate change and shifting of temperate crops: It is quite interesting to see the spatial distribution of temperate crops especially chilling requiring crops viz., apple, apricot, cherry, plum, saffron, cauliflower, cabbage, pea etc., as affected by the climate change at their respective growing places during on as well as off seasons. The areas of temperate crops cultivation in India are mainly confined to higher latitude provinces such as Kashmir, Arunachal Pradesh, Uttaranchal, Sikkim, Himachal Pradesh. The crops grown in these areas may be severely affected as their optimum thermal regime for flowering is narrow in range.

Changing cropping pattern: There have been some indications of spatial changes in cropping pattern particularly in hilly mountain areas of Himachal Pradesh. Some apple grown areas have shifted to higher reaches as their traditional belts are exhibiting warmer weather and might become unsuitable for their cultivation. Successful cultivation of wheat in Kashmir during winter period and maize in Bihar are some more examples. Similarly apple in Kashmir region may experience decline in yield due to increase in winter temperatures in the past years as apple requires narrow range of optimum thermal regime. Pole wards expansion of arable land in the regions where low temperatures are limiting for crop cultivation mainly due to rise in temperature which may be conducive for crop cultivation[9].

1. Impacts of Global warming

Melting of Glaciers: Melting of glaciers in various parts of the globe may cause flooding followed by droughts in near future. Water availability may be another sever social and agriculture problems due to greater losses of moisture through evapo transpiration and more demand for drinking water, industry and irrigation. Coastal inundation due to sea level rise and water expansion may lead to greater loss of coastal biodiversity especially mangrove plant and animal species responsible for coastal ecosystem protection. In Kashmir valley Kohlai glacier has shrunk by almost 5% since 1960 (13 sq. miles to 11 sq. miles). Water level in almost all rivers in Kashmir valley has reduced by 40% in the last 40 years.

Impact on Agriculture: There is significant concern about the impacts of climate change and its variability on agricultural production worldwide. First, issues of food security figure prominently in the list of human activities and ecosystem services under threat of dangerous anthropogenic interference on Earth's climate. Second, each country is naturally concerned with potential damages and benefits that may arise over the coming decades from climate change impacts on its territory as well as globally, since these will affect domestic and international policies, trading patterns, resource use, regional planning and ultimately the welfare of its people. Current research confirms that while crops would respond positively to elevated CO_2 in the absence of climate change, the associated impacts of high temperatures, altered patterns of precipitation and possibly increased frequency of extreme events such as drought and floods, will probably combine to 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, because of the predominance of agriculture in their economies, the scarcity of capital for adaptation measures, their warmer baseline climates and their heightened exposure to extreme events. Thus, climate change may have particularly serious consequences in the developing world, where some 800million people are undernourished. Of great concern is a group of more than 40 'least-developed' countries, mostly in sub-Saharan Africa, where domestic per capita food production declined by 10% in the last 20years. According to Mendelsohn and Dinar (2009) [7], there is sufficient evidence to suggest that climate change will affect agriculture. They suggest an optimal climate range of temperature and precipitation exists for crop and livestock production. Mendelsohn and Dinar (2009) [7] also say there are factors that change the optimal range of growth and production with respect to climate, such factors are soil and water. For example, poor soil and not enough water will not allow crops to grow and produce at the level they could with better quality soil and more water. Plants have become specialized to optimize yields at particular temperature and humidity settings. The level of CO_2 and temperature in the atmosphere affect the rate at which a plant develops. With the increasing of temperatures and the concentration of CO_2 rising, the rate of development in plants changes, in turn affecting the growing period of the plant or crop. It is predicted that productivity of rice shall reduce by 10% for every 1% increase in growing season mean temperature between 30-40^0 C. the rise in the minimum temperature shall cause a greater reduction in rice grain yield as compared to negligible effect of rise in maximum temperature. The productivity of wheat shall reduce at the rate of 3-4% per 0^0C increases in mean atmospheric temperature. High temperature shall cause detrimental effect on reproductive organs such as pollen spikelets, while the growth of vegetative organs like leaf and stem is stimulated by high temperature. Both wheat and rice plants appear to be most sensitive to high temperature at anthesis as it induces high percentage of pollen and spike sterility. Greater loss expected in Rabi as compared to Kharif crops. Cultivation of wheat and other hypo-thermophilic crops like cauliflower, cabbage in Central India and temperate crops like cherry, apple, plum, peach in Northern India are likely to be threatened by global warming. Reduced frequency of frost damage in Northern India is expected. Sustainability of endemic crops like Basmati rice and litchi could be severely affected by global warming. Imbalance of food trade due to positive impacts on Europe and N. America and negative impacts on tropical and subtropical countries like India, Brazil and Mexico.

2.Adaptation to climate change

Adaptation refers to the modification of biological and non-biological mechanism or measures, which help the organism to cope with the new sets of environmental stresses following upon their exposure for their survival, growth and development. But there is a limit of adaptation to what extent and magnitude the organism are flexible to modify them. Almost all organisms have the ability to modify their biological systems in order to cope with the environmental stresses to varying extent for their survival and production. Apart from natural adaptability of organism including crop plants, some of the man-made coping strategies could also be practised/implemented to minimize the climatic risks. For developing countries like India, adaptation requires assisting the vulnerable population during adverse climate events and empowering them to build their lives and to cope with climate risks in the long term. In this context, several of India's social-sector schemes emphasize livelihood security and welfare of the weaker sections.

Some of the natural and man-made adaptation mechanisms are discussed as below:

Natural adaptation: crops and animals show varying ability to adapt them to warming through different adaptive mechanism such as shifting their optimum thermal range, escaping, avoidance, thermal cooling, stomatal closure, cutinisation, waxination, development of heat shock protein, osmoregulation etc.,

Genetic adaptation: breeding crop varieties for heat tolerance through conventional and modern breeding techniques. Screening heat tolerant crop genotypes followed by exploitation of desirable genes mainly from the germplasm adapted to such warmer condition.

Non-genetic adaptation: agro-physiological manipulation such as dates of sowing, frequent irrigation, higher dose of chemical fertilizers, crop diversification, green manuring etc. to reduce vulnerability to climate change. Identification of crop genotypes for faster grain growth rate with delayed leaf senescence under higher thermal regime.

Biotechnological approaches: Selective gene transfer from donor without major changes in genetic makeup.

Crop insurance: Reducing climatic risk of crop productivity through crop insurance.

Better support price and credits: Better support price of agricultural produce is and bank credits are essential for crop sustainability and to meet the additional adaptation cost of climate change.

Some of the programmes successfully promoted by the Indian government that assist the communities in coping with climatic variability include:

- Developing watersheds in rain fed areas.
- Implementing drought-proofing measures.
- Developing drought-resistant varieties.
- Promoting crop diversification.
- Promoting on-farm water-efficient technologies.
- Introducing a system of credits and loans to farmers.
- Promoting the National Agricultural Insurance Scheme.
- Encouraging RCTs (resource conserving technologies) for crop production.

3. Mitigation strategies

Mitigation involves all human interventions which reduce the sources of greenhouse gases and which embrace the sinks of theses GHG's. Some of the strategies are as below:

- **Reduction of greenhouse gases through:**

The Energy Conservation Act (2001) empowers the government to prescribe and ensure compliance with standards and norms for energy consumers, prescribe energy conservation building codes, and require energy audits. The act requires major commercial consumers to submit energy audits (verification, monitoring and analysis of energy use; technical reports and cost–benefit analysis; and action plans to reduce consumption) prepared by accredited energy auditors.

Standards and labelling programme for manufacturers of electrical appliances is expected to lead to savings of 11,689 million kW annually in the first 5 years of its operation.

Energy efficiency and conservation programmes being implemented by the Bureau of Energy Efficiency (BEE) and the Central Public Works Department (CPWD) include energy efficiency performance contracting projects in nine government buildings with an estimated annual savings of approximately 30 GWh with a simple payback of less than two years.

Green rating of buildings is covered by several schemes including the Indian chapter of the Leadership in Energy and Environmental Design (LEED) and the indigenous systems, namely 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 (ECBC). The Ministry of New and Renewable Resources (MN&RE) has also taken up development of an indigenous rating system for green buildings.

The National Electricity Policy **(2001)** requires the government to supply electricity to all areas including villages and hamlets by 2012 primarily through decentralized RE (renewable energy) technologies. Accordingly, the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme, with an outlay of Rs 180 billion, aims to electrify about 1, 25,000 un electrified villages across the country, targeting poor households through 90% subsidies.

Promotion of renewable energy is ensured by the Ministry of New & Renewable Sources (MNRE), together with a specialized financial institution, namely Indian Renewable Energy Development Agency Ltd (IREDA), and other institutions by implementing a broad programme covering the entire range of new and renewable energies. The 11th Five-Year Plan aims to increase the installed capacity for renewable power (excluding large hydropower) by 14,500 MW, i.e. 20% of the overall increase in installed utility-based capacity (78,577 MW).

National Mission on Bio-diesel aims in the first (demonstration) phase to establish biodiesel (jatropha) plantations in 26 states, while the second phase will lead to the production of sufficient biodiesel to enable a 20% blend in vehicle diesel in 2011/12. Recent increase in petroleum prices may help accelerate the biodiesel programme.

National Urban Transport Policy emphasizes extensive public transport facilities and non-motorized modes over personal vehicles. The Delhi MRTS expansion and other mass transit systems, such as the Metro Bus project in Bangalore, are steps in its implementation. The policy also favours cleaner fuels like CNG and encourages R&D for commercialization of cleaner technologies.

Use of beneficiated coal is mandatory for coal-based thermal power plants located beyond 1000 km from pit-heads or in urban or ecologically sensitive or critically polluted areas by a notification under The Environment Protection Act unless the plants are based on clean-coal technologies [10].

Reforms in the power sector seek to mobilize private-sector resources for additions to power-generating capacity. As part of the reforms, the Central Electricity Regulatory Commission (CERC) and the state electricity regulatory commissions (SERCs) were constituted, which has led to improvements in plant load factors, heat rates, reduction in transmission and distribution losses, etc.

- **Promotion of renewable energy**

While India will remain heavily dependent on fossil fuels (in particular, coal) for the foreseeable future, renewable energy has the potential to reduce India's dependence on carbon-emitting fuels. Hydropower (comprising large, medium and small projects) offers substantial immediate benefits in this respect. New and renewable energy (solar, wind power, bio-mass, etc.) have promising long-term prospects and could contribute to energy security by lowering India's dependence on fuel imports.

- **Transportation**

The inevitable rise in emissions from the transportation sector can be moderated in three ways: (a) a shift from road to rail transport; (b) greater reliance on public transport compared to private motor vehicles; and (c) improvements in efficiency standards.

- Increase of vegetation cover or green belt by plantation of the potential sequestration species.
- Nutrient and manure management in the livestock to cut down methane emissions.
- Conservation of water, rain water harvesting and reuse of waste water.
- Adoption of the organic agriculture.
- Effective disaster management.
- Plantation around road sides, industrial complexes and in residential areas.
- Containment of deforestation to increase C sinks.

4.CONCLUSION

The need of the hour is active government involvement in addressing this problem.

Only major dedication by the government and stakeholders to address the problem of climate change aggressively seems likely to stimulate business and industry to move significantly beyond the inertia of established ways today. We believe that the speed with which the problems of global warming and climate change can be addressed will be largely determined by what the people want, and how our governments respond to their wishes. Given the many opportunities for addressing this major global problem through profitable entrepreneurial activities on many levels, there is no reason why rational politicians of both liberal and conservative orientations cannot find solutions to these problems, if the people will have it. It would seem that we are confronted with a major challenge on two fronts, educational and political. One hopes future generations will say that ours made the right choices.

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