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Review Paper

Vulnerability and Issues in Global Efforts to Mitigate Climate Changes

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Abstract

The Earth is the only known planet in whole universe that supports life. The complex processes related to the evolution of life occurred on Earth only because of some unique environmental conditions that were present such as water, an oxygen-rich atmosphere, and most importantly a suitable surface temperature and only the Earth has an atmosphere of the proper depth and chemical composition. About 30% of incoming energy from the sun is reflected back to space while the rest reaches the earth, warming the air, oceans, and land, and maintaining an average surface temperature of about 15 ºC. But from past some time heavy addition of CO_2 by anthropogenic processes has caused severe worried to very existence to humanity on planet earth. The other thing which is causing panic like situation is the distrust between developed and developing countries. And now global warming is the most important science issue of the 21st century challenging the very structure of our global society. The problem of global warming is not just of scientific concern, but it encompasses economics, Sociology, geopolitics, local politics and Individual choice of life style. Present paper attempts to bring out some relevant issues and challenges related to Climate change mitigation that are especially relevant in the present global scenario by analysing data provided by IPCC and Various other International Agencies working towards mitigating the impact climate change on earth surface.

Keywords: Anthropogenic, climate change, adaptation, mitigation, geological history, Green House Gases (GHG's), carbon Footprints, Intergovernmental Panel on Climate Change (IPCC), Carbon Intensity, CO_{2e}, Developmental Goals, Climatic Models.

Introduction

Earth is a unique planet, not only among planets of solar system but in whole of universe. Uniqueness of earth lies in environmental conditions that are present on earth surface that are very essential for sustaining healthy life. It is earth's climate (especially its average temperature of 15˚C) which has helped life to flourish. Scientifically, temperature on earth's surface is determined by the balance between the influx of energy from sun (that is Solar Radiation) and the Re-radiation of the energy from earth (that is Terrestrial radiation). Earths uniqueness also lies in its temperature balance as earth has able to maintain its average temperature of 15˚C which is very crucial for the existence of life on earth surface. If earth would have no atmosphere or if it would have an atmosphere of different composition, average temperature would have gone to extreme ends in positive as well as negative side of scale and in that conditions life would have impossible. In this way earths uniqueness lies in 'Natural Greenhouse Effect' which may act *as a perfect balance between incoming/outgoing heats from earth systems.*

In earth's atmosphere there are certain gases which trap potential to long wave radiation and acts as transparent to short wave radiation. These gases have special heat absorbing characteristics and these are known as *'Green House Gases'* (GHG's). Historically, these gases have played very important role in maintaining optimum life sustaining temperature on earth[1]. But, after industrial revolution surplus pumping in GHG's in earth atmosphere by anthropogenatic causes has drastically altered the original composition of atmosphere. Combustion of fossil fuels, transformed land use, rapid Population growth and high levels of urbanization has caused drastic alteration. This alteration of atmosphere has potential of catastrophic consequences in the form of global climate change.

For present mankind climate change is a very complex issue, no country or no society is immune to it. At the same time no country alone can take on the interconnected challenges possessed climate change, including daunting technological requirements and far reaching global consequences[2]. Normally, earth's climate tends to changes over time largely owing to many natural causes and also partly due to human interference. These natural causes include, process internal to the earth, extra-terrestrial forces and more recently human activities. To understand the concept of 'Climate Change' and debate around climate change one must understand the logic, Issues and challenges in climate change mitigation. Present paper is an attempt to bring out core issues and challenges concerning climate change.

Understanding the concept 'Climate Change'

As per current usage, especially in the context of matters relating to environment the expression 'Climate Change' often

refers only to changes in modern climate, including the rise in average surface air temperature what is now ominously known as 'global warming'. It is most important to understand that present understanding of climate change is based on the presumption of *human causation*. Technically specking climate change reefer's to a statistically significant deviation in either the mean state of the climate or in its variability in terms of more than 30 years average. Burning of coal, oil, and natural gas, deforestation various agricultural and industrial practices are altering the composition of the atmosphere and contributing to it. These human activities have led to increased atmospheric concentration of a number of greenhouse gases, including carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and troposphere ozone in the lower part of the atmosphere. Study is divided into two different but coherent sections. Section I deals with issues related with climate change. Section II deals with challenges in climate change mitigation and ways to combat future climate changes respectively.

Objectives of the study

i. To study the basic challenges in global response to climate change mitigations. ii. To compare the change in quantum of green house gases in the world after 1990-2005.

Methodology

Present study is an attempt to look into the various issues concerning to present day climate change debate globally. Study is based on purely secondary data sources collected from varied data sources. *Reports of Intergovernmental Panel on Climate Change (IPCC)* and *World Bank* have served as main data sources. Apart from these sources many other studies have been referred to obtain relevant data from them. Study presents data with the help of various graphs and tables so that visual impression can be achieved.

Climate in Past Geological History

Climate change of the geological past has been reconstructed by analyzing a number of key indicators, including marine and lake sediments, ice core, cave deposits and tree rings. These evidences have proved that Earth has experienced alternately warming and cooling many times in the past. A rapid build-up of green house gases caused warming in early Jurassic period, with average rise by 5 degree Celsius. But, later on this released, CO_2 got trapped in 'rock cycle' reducing the level of CO_2 back to normal level. To comprehend the structure of world climate, one must understand its historical natural variations in a proper framework and for that fortunately reliable data on temperature measurements over periods on geological time scale is now available through many scientific and laboratory research across India and world. But when it comes to present day climate change many things are still not very clear and they are at the stage of debate. Most researchers prove that present climate is changing due to massive pumping of GHG's through human action. At present the issue of climate change is battling with following core issues and challenges in climate change mitigation for common reference point present study accepts that present day climate changes are anthrop-genetic in nature.

Issues related of Climate change

Is present climate change is 'Human Induced'?: Till very recently, one of the core issue related to climate change was that the present climate change is 'Natural Cycle' or 'Human Induced'. Many researchers proved that earth's climate in past geological history kept changing; there was time when earth's temperature was more that today's temperature. And at times there were many periods were when temperatures were substantially low (these periods are known as ice ages). But today a kind of consensus among scientific community has emerged in a number of detailed reports of Intergovernmental Panel on Climate Change (IPCC) that 'present climate change is Anthropogenic'. Created in 1988 by World Meteorological Organization (WMO) and United Nations Environmental Programme (UNEP), the IPCC's purpose is to evaluate the state of climate science as a basic for informed policy action, primarily on the basis of well established and published work. Various reports of IPCC have unequivocally stated that earth's climate is being badly affected by human activities. Report says that: "human activities are modifying the concentration of atmospheric constituents…that absorb or scatter radiant energy….most of observed warming over the last 50 years, is likely to have been due to increase in GHG'S concentration." Moreover, comparison of past data shows that there is marked increase in the concentration of GHG's in earth's atmosphere from pre-industrial to now (table-2).

Question of Who and How Much responsible for climate change?: "*The countries most vulnerable are least able to protect themselves. They contribute least to global emission of GHG's, without action they will pay a high price of the actions of others." (Kofi Annan, former General Sectary of UNO). Source: UNDP: Human Development Report 2007-08.*

Now, When it is proved beyond doubts that climate is changing and its origin is 'Anthropogenic activities'; now the question arises that who is responsible for climate change and how much burden of reduction of green houses gases on whom. Historical evidences shows that developed countries are main culprit in climate change. Their hunger for development has caused change in the concentration of earth's atmosphere. And now this is widely accepted that they should act to undo climate change. On other hand, developing countries are not historical polluters and their race of development has just begun and in no way they can be blamed for climate change. But on the basis of 'Common Responsibility' this can be said that developing countries have major role to play in climate mitigation. The philosophy of *'Common but Differentiated Responsibilities'* should act as a founding stone in terms of climate mitigation.

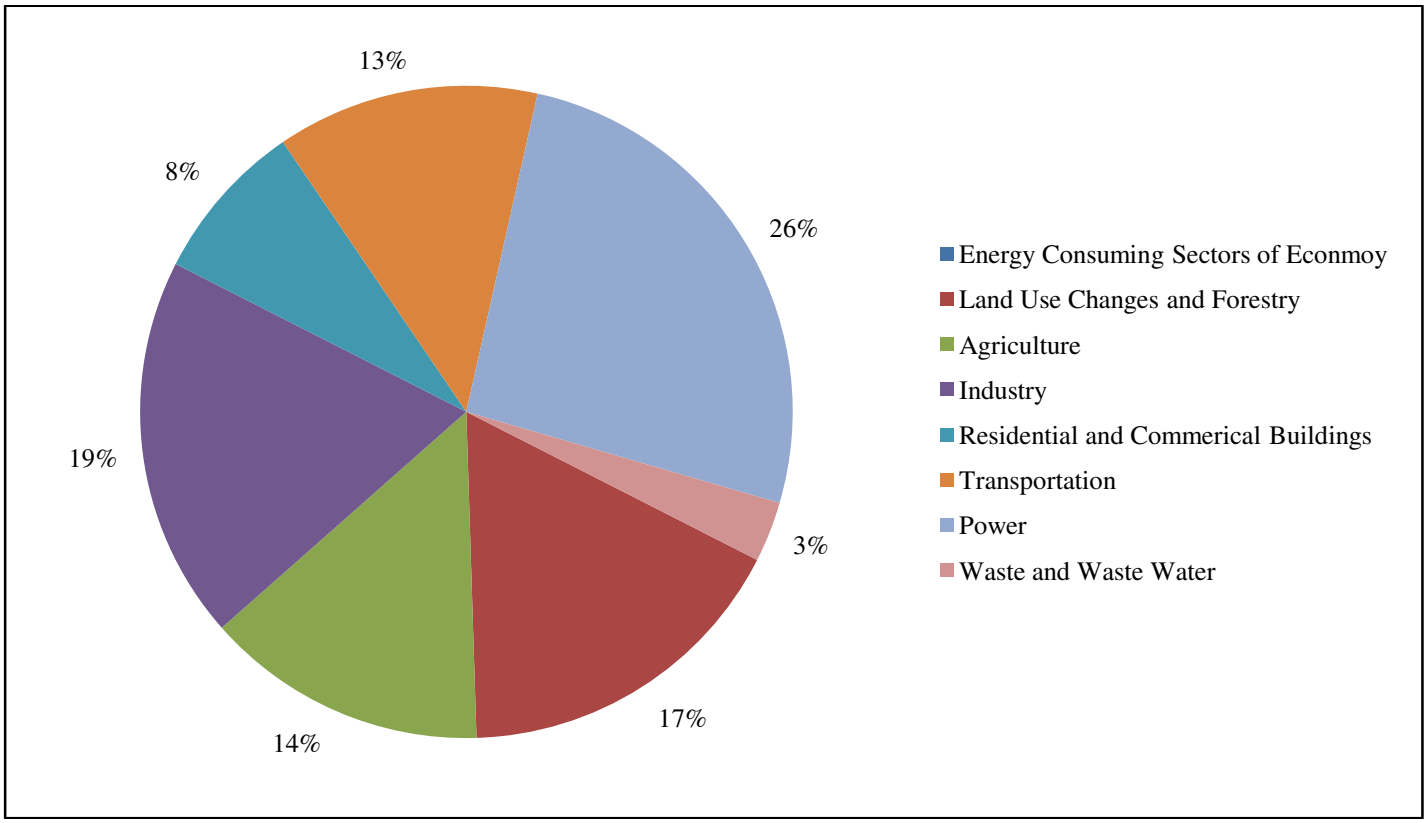

Figure-1
Global CO_2 by Different Sector[3]

The question of 'Responcibilty' has two corelatted dimensions one is related to polluting sectors of econonmy and other is most ploouting country. In general assumption it is many atimes beleved that industries are most polluting and agriculture is clean sector. But figure-1 clearly shows that there is not much difference between industry and agriculture sectors. But when we look into the combined impact of sectors that are mainly related to developed countires (i.e. Industries, Transportation, Power Land Use changes) these covers around 75 % of total emission is produced by only developed nations. Where as, in developing countiries where agriculture is still dominating only contributes remaining 25%.

When it comes to most polluting countries table-1 clearly reflects that low income group counties only contributes 2.6 percent of total global emissions where as OECD countries produces around 49 % of GHG's annually. At the same time USA followed by China, Russia, India are four top polluting counties with 22.02, 19.06, 5.81, 4.33 % share in global emission of CO_{2e} . One more interesting aspects which comes out from table 1 is that in terms of per captia emission in 2005, USA followed by Austrilia, canada, Saudi Arabia are most polluting. In this category Indias place in top 20 polluting countries is last with only 1.1 Million tons per year per person. Table-1 also resembles that carbon intensity of top 20 polluting counties has not improved as much as it was expected between the time period of 1990 to 2005.

How much time we have to act?: On climate change front due to business as usual global temperature have already increased by approximately 0.6°C (1°F) over the last century, and the Intergovernmental Panel on Climate Change (IPCC) concluded that the majority of warming over the past 50 years is likely the result of human activities[4]. In addition, the IPCC projects that average global temperatures will increase by 1.4 to 5.8°C (2.5 to 10.4°F). Scientists believe that ones the rate of temperature increase is above certain level climate system would become 'irreversible'.

Table-2 shows the concentration of GHG's in our atmosphere from pre-industrial to 2005, which clearly reveals that emission of all GHG's has went up in between selected times periods. Human sources such as use of fossil; fuel, rice cultivation and various industrial processes has contributed very richly in adding more and more GHG's in atmosphere. In the selected time period concentration of CO_2 has increased by 30 % and CH_4 has increased by 250 %. And if this rate continuous without any check me have lift with very little to check global warming.

Table-1
Energy related emissions and carbon Intensity of Various countries[2]

Countries	CO_2 Emission Metric tons (Million)		Change (%)	Per Captia Emission		% Share in total World Emission	Cumulative emissions since *	Carbon Intensity	
	1990	2005		1990	2005			1990	2005
Australia	260	377	45	15.2	18.5	1.42	12.5	2.97	3.17
Brazil	195	334	70.8	1.3	1.8	1.26	8.8	1.4	1.54
Canada	433	552	27.5	15.6	17.1	2.08	23.8	2.07	2.02
China	2211	5060	128.9	1.9	3.9	19.06	94.3	2.56	2.94
Germany	968	814	-15.9	12.2	9.9	3.06	117.8	2.72	2.36
India	597	1149	92.6	0.7	1.1	4.33	28.6	1.87	2.14
Indonesia	151	349	131.7	0.8	1.6	1.31	6.8	1.46	1.98
Iran	178	431	142.3	3.3	6.2	1.64	8.6	2.58	2.73
Italy	398	454	14	7	7.7	1.71	17.9	2.69	2.44
Japan	1058	1214	14.8	8.6	9.5	4.75	46.1	2.38	2.3
S. Korea	227	449	97.6	5.3	9.3	1.69	9	2.43	2.11
Saudi Arabia	169	320	89.6	10.3	13.8	1.21	7.4	2.75	2.28
Mexico	293	393	33.9	3.5	3.8	1.48	12.5	2.38	2.22
Poland	349	296	-15.3	9.2	7.8	1.11	22.8	3.5	3.19
Russia	2194	1544	-29.3	14.8	10.8	5.81	92.5	2.5	2.35
South Africa	255	331	29.9	7.2	7.1	1.25	14.1	2.79	2.59
Spain	208	342	64.7	5.3	7.9	1.29	10	2.28	2.36
Ukraine	681	297	-56.4	13.1	6.3	1.12	22.6	2.68	2.07
U.K	558	533	-4.4	9.7	8.8	2.01	68.1	2.68	2.63
USA	4874	5841	19.9	19.5	19.7	22.02	324.9	2.53	2.49
World	20693	26544	28.3	4	4.2	100	169.1	2.39	2.35
Low Income Countries	549	707	28.9	0.7	0.6	2.6	24	1.38	1.26
Middle Income Countries	9150	12631	38	2.6	3	47.59	395.1	2.41	2.49
High Income Countries	10999	13207	20.1	11.8	12.7	49.75	750.1	2.44	2.32
European Countries	3122	3271	4.8	8.6	8.5	12.35	284.8	2.36	2.11
OECD	11121	12946	16.4	10.7	11.1	48.77	764.7	2.46	2.33

Note * Change since 1850- 2005

Table-2
Concentration of main Greenhouse Gases in Earth's atmosphere by their Volume[1]

Greenhouse Gases (GHG's)	Chemical formula	Pre- Industrial Concentration	Concentration in 2005	Change in Percentage*	Human Sources
Carbon Dioxide	CO_2	278 PPMV	379 PPMV	30 % increase	Fossil-fuel, Land use changes
Methane	CH_4	700 PPBV	1774 PPBV	250 % increase	Fossil fuel, rice cultivation, live stocks
Nitrous Oxide	N_2O	2 75 PPBV	319 PPBV	15 % increase	Fertilizers, Fossil fuel, Industrial Process
CFC-12**	CCl_2F_2	0	0.538 PPBV	----	Coolants
HCFC-22**	$CHClF_2$	0	0.169 PPBV	----	Coolants
Water vapors	$H_2O \uparrow$	Variable	Variable	----	Heating of water

PPMV: Parts Per Million by Volume; PPBV: Parts Per Billion by Volume, Concentration change in percentage is from pre-industrial to 2005 levels. These gases do not exist naturally and is human totally generated.

Accuracy of various climate change Models: With the development of knowledge concerning climatic variables, Model building has also changed. Now with the help modern technological advances climatic models are now based on many variables and are far more accurate than the earlier ones. DICE, FAIR, MESSAGE, MiniCAM, PAGE, and REMIND are Peer-viewed models which attempts to predict future climate based on scientific calculations. There are many models also but from last some time people are raising the questions about the accuracy of prediction[1]. Different models predict different future of earth but at the same time they are not unanimous about 'What will happen' like questions and there is a type of uncertainty about what will happen now. At the same time future prediction in a phenomenon which is highly variable and dependent on so many other variables is very hard nut to crack. Nevertheless, if we accept that whatever these climate change models are predicting is true than in mitigating climate changes following challenges must be taken care off.

Challenges in Mitigation

The climate change is going to endanger the very existence of the human race on the planet. And scientists believe that the only solution is in mitigation and adaptation efforts. Climate change mitigation is measures or actions to decrease the intensity of radiative forcing in order to reduce global warming. Mitigation is distinguished from adaptation, which involves acting to minimize the effects of global warming. Most often, mitigations involve reductions in the concentrations of greenhouse gases, either by reducing their sources or by increasing their sinks. Following are the core challenges in climate change mitigation:

Challenges of Technology Transfer: Technological innovations and its related institutional adjustments are keys to managing climate change at a reasonable level; use of non-polluting renewable sources of energy is one of them. Strengthening national innovation and technology capacity can become a powerful catalyst for development[5]. Climate change can be minimizing by adopting climate friendlily green technology[3]. These green technologies are available but only with developed countries. And, ironically they are not willing to lose their technological superiority by transferring or sharing technology. If we believe scientific views than, technological solutions are imperative in meeting the challenges of climate change. A critical factor in greenhouse gas emissions, technology is also fundamental to enhancing existing abilities and lowering the costs of reducing these emissions. Broad diffusion/ Sharing of current technologies and transition to new ones, is expected to improve efficiency in energy use, introduce less carbon-intensive sources of energy, and further develop renewable energy sources. Indeed, the transition to a low-carbon economy, as all previous energy transitions in history, will be driven by cycles of technological discontinuities and innovations. In this context, the UNFCCC and the Kyoto Protocol require Parties to promote and cooperate in the development and diffusion, including transfer, of technologies that control, reduce or prevent GHG emissions. Enhanced action on technology development and transfer will also be central in enabling the full, effective and sustained implementation of the UNFCCC beyond 2012, as also recognized in the Bali Action Plan.

Funding for mitigation efforts: As developed countries are 'Historical Polluters' they must take the leading role in financing combating climate change. But climate change will neither effective nor efficient without the active participation and abatement efforts in developing countries. So an equitable approach to limiting global emissions of GHG's has to recognize that developing counties have legitimate development needs and their development may be jeopardized by climate changes and that they have contributed little, historically to the problem[2]. The contribution of countries to climate change and their capacity to prevent and cope with its consequences vary enormously. The UNFCCC and the Kyoto Protocol therefore foresee financial assistance from Parties with more resources to those less endowed and more vulnerable. Developed country Parties shall provide financial resources to assist developing country Parties implement the Convention. To facilitate this, the Convention established a financial mechanism to provide funds to developing country Parties. Dearth of funds is also hampering climate mitigation very hard. Funds are required for technology development, enhancement of adaptation mechanism, capacity building and scientific researchers at meso and micro level. In developing countries like India, climate change could spell an additional stress on ecological and socio-economic systems which are already facing tremendous pressures due to rapid urbanization, industrialization and economic development so they would require additional funds to manage normal way of life. But, current climate agreements do not provide binding commitments for adaptation funding. Funds available for adaptation through the GEF (Global Environment Facility) are relatively small, have been disbursed slowly, and will need to be increased substantially to make any meaningful contribution to climate change adaptation in developing countries (UNFCCC). In terms of funding there was slight development in Copenhagen, here developed nations have pledge to build a climate research and mitigation fund.

Adaptation Mechanism of all human act: Adaptation mechanism and strategies present a complementary approach to those of greenhouse gas mitigation. Efforts that limit or reduce climate-driving forces (i.e., mitigation or reduction of greenhouse gas emissions) tend to reduce the degree and likelihood that significantly adverse conditions will result. Actions that can reduce this likelihood are thus reasonable and prudent, and to a large measure have been the primary focus of public attention and policy efforts on climate change. However, recognition that the climate system has a great deal of inertia is increasing, and that mitigation efforts alone are insufficient to protect the Earth from some degree of climate change. Even if extreme measures could be taken instantly to curtail global emissions, the momentum of

the Earth's climate is such that additional warming would still happen. Although essential for limiting the extent of rapid and severe climate change, mitigation is not-and this report argues, should not be-the only protective action in society's arsenal of responses. This report explains the concepts of vulnerability and adaptation in the context of climate change. It illustrates selected successes and failures of reactive adaptation to analogous changes in environmental or socioeconomic conditions, and it explores the challenges and potential benefits of deliberately stoking the nation's adaptive capacity with proactive policies in anticipation of climate change.

Economics of Climate change Mitigation: The funding required for mitigation as well as adaptation and technology development is very massive. In developing countries mitigation could cost $ 140 to $ 175 billion a year over next 20 years); moreover, the period of 2010 to 2050 adaptation investment could average $30 to $ 100 billion a year (IPCC, 2007). Yet efforts to raise funds for these efforts have been woefully inadequate which stands at less than 5% of projected needs[2]. In climate change mitigation funds are required for two basic purposes one dealing to development of technology and other one is related to mitigation. Many are of the opinion that climate change mitigation is very less but if we do not act today the cost may jump many a times higher[1]. Table-3 shows that how different models of climate change predict expected cost of climate change by 2100. Models are unanimous that a substantial share of World economic earning would go for fighting against climate changes. But most alarming picture is that all models predict that by 2100 developing countries would have to spend more than the double amount as of developed nations. MiniCAM and PAGE models predicts that if climate change continuous developing nations would have to spend 1.2 % of their GDP in mitigating climate change.

Table-3
Expected Cost of Climate Change Mitigations[2]

Models[1]	**Present Value of Mitigation costs to 2100 for 450 PPM CO_{2e}(% of GDP)**	
	World	**Developing Countries**
DICE	0.7	----
FAIR	0.6	----
MESSAGE	0.3	0.5
MiniCAM	0.74	1.2
PAGE	0.4	0.9
REMIND	0.4	----

Conclusion

Climate on earth keeps on changing owning natural causes and partly due to human activities. Climate change has put question mark on the very existence of man on earth. If rising sea levels, melting of glaciers, frequent flood and droughts, violent storms are considered as signs of changing climate. It can have disastrous impact on human life and properties. But, this can be minimized by collective human action. Collective action of all developed and developing nations towards saving humanity on earth will play very important role. Question of diffusion of green technology, financing should be solved in keeping future on mankind on earth, because it is like 'Act now or never' situation. If we don't act now**,** we will leave a much larger problem to future generations. The good news is that, if we all join in to stop climate change, we can reduce its impact on our planet earth. Nurturing the nature of climate conciseness is the need of hour.

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