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Global warming and climate changes: Trends and challenges

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Abstract
Global Warming describes a gradual increase in the average temperature on the earth's atmosphere and its oceans. Climate change is one of the main environmental challenges facing the world today. India is facing several problems. Climate change is associated with various adverse impacts on agriculture, water resources, forest and biodiversity, health, coastal management and increase in temperature. Decline in agricultural productivity is the main impact of climate change on India. A majority of population depends on agriculture directly or indirectly. Climate change would represent additional stress on the ecological and socioeconomic systems that are already facing tremendous pressure due to rapid industrialization, urbanization and economic development. This paper analyzes the impact of climate change and its various aspects in the Indian context.

Keywords: Climate change, greenhouse gas, kyoto protocol, forest, ecological sequence, forest protection, natural disasters

Introduction

The most important thing about global warming is this whether humans are responsible for the bulk of climate change is going on…. leave this planet in better shape for the future generations then we found it. Prof. Mike Huckabee Global warming and Climate change is emerging as a major global issue. It is already happening and represents one of the greatest environmental, social and economic threats facing the planet. The fourth Assessment Report of the Intergovernmental Panel on Climate Change shows that the Earth's average surface temperature has risen by 0.76° C since 1850. Most of the warming over the past 50 years is very likely to have been caused by emissions of carbon dioxide and other 'greenhouse gases' from human activities. This report is unequivocal both about the current warming of the climate system and that the cause of most of the observed increase in global average temperatures is attributable to increase in anthropogenic greenhouse gas concentrations. There is a broad scientific consensus that continued emissions at or above current rates will cause further warming and induce many changes in the climate system during the 21st century that will likely to be larger, with more adverse impacts, than those seen during the 20th century. Without action to reduce these emissions, the global average temperature is likely to rise by a further 1.8-4.0°C this century, and by up to 6.4°C in the worst case scenario, the IPCC projects. Even the lower end of this range would take the temperature increase since pre-industrial times above 2°C - the threshold beyond which many scientists believe irreversible and possibly catastrophic changes would become more likely. Global warming has become a major concern of humanity since the middle of the 20th century. It is a term that refers to the exploration of both the question of whether the climate of the entire planet might be changing, and why, and what the impact of those changes might be on investments in companies that may be affected by global changes in climate. It is almost more than thirty years passed that many scientists are now predicting that global warming could result in a future of powerful storms, rising sea levels, and widespread crop failures.

Impacts On Indian Climate Change

India being the nation that primarily depends on agriculture is undoubtedly one of those nations who are much vulnerable to be directly threatened by the growing menace of the climate change. The climate models for India predict a profile of rising temperature and changing rainfall patterns typical of other sub-tropical regions. The country's vast coastline is vulnerable to rising sea levels, and uncertain intensity and frequency of cyclones. Thus the storms, Tsunamis, crop failures, floods and droughts are now the common scene in the nation. Even in the recent times, till the end of the year 2014, we have witnessed the long list of cyclones at the eastern coasts in India, the chief of who were the Laila, Nilam, Phailin and Lehar cyclones.

The 2008 flooding in Bihar and 2011 flooding in Uttar Pradesh were described as the worst for 50 years, as was the failure of the summer monsoon in 2009, 2012and 2019 which caused drought conditions in nearly half of the country's districts. India's most respected plant scientist, Professor M.S.Swaminathan, then estimated that a one degree Celsius rise in temperature will reduce the wheat growing season by a week. Water resources are threatened by the retreat of Himalayan glaciers which currently account for 85% of the source water of India's 3 major rivers, in particular securing their flow in the summer months. Over 500 million people live in the catchment of the Ganges and Indus rivers.

The major earthquake of 2015 that spelled horrible disaster in a major part of Nepal and the eastern part of India has also the same in depth reason of the menace of climate change. The rapid but uncontrolled development and the growing urge for it has given birth to fatal catastrophes that includes the series of dreadful and horrendous shaking of earth which claimed for thousands of life and millions being affected.

In the late 1960s, India's most respected plant geneticist, Prof. M.S. Swaminathan, helped design and lead the Green Revolution, a huge development effort that in just a few years brought food self-sufficiency to India, which had

suffered from deadly famines for decades. The spread of high-yielding cereal varieties and the increased use of irrigation, fertilizers and pesticides caused grain production to soar, saving millions from starvation.

Now, India's ability to feed itself is again threatened, Mr. Swaminathan warns — this time by global warming. At the 97th Indian Science Congress in January, 2011, Mr. Swaminathan said that yields from Indian wheat fed by rain could drop 44 percent by 2050 under warmer conditions forecast by climate models. Such declines would be devastating to India's poor, who already suffer from high rates of malnutrition. The rising price of the daily needs as the onion, milk and other vegetables can be best attributed to the Professor's fear.

Almost two-thirds of Indians derive their livelihood from farming, and about 60 percent of Indian farmland is fed by rain. Farmers with small holdings who are highly dependent on favorable weather will be the most vulnerable to climate disruptions. Mr. Swaminathan, who is regarded in India as the father of the Green Revolution, added a prominent voice to a growing chorus of experts warning that the effect on global grain production from rising temperatures would be far more severe than previously believed. Grain yields throughout South Asia and southern Africa are in particular danger, placing the food security of more than a billion people at risk, a number of recent studies suggest. One 2008 study in the journal Science estimated that countries in southern Africa and South Asia could see declines in the yields of their main crops of 10 percent to 30 percent by 2030 as a result of climate change.

Climate change is projected to have severe adverse effects on India's development as it compounds the pressures on natural resources and the environment associated with rapid urbanization, industrialization, and economic growth. The sectors that have the highest vulnerability to these impacts are water resources, coastal ecosystems, biodiversity, and agricultural productivity. The different areas where climate change will impact India most are given below

- **Water:** The most serious potential threat arising from climate change in Asia is water scarcity. The gross per capita water avail-ability in India is projected to decline from ~1820 m3/year (2001) to1.140 m3/year (2050). The per capita availability of fresh water in India is expected to drop from ~1,900 m3 (2007) to 1,000 m3 (2025). More intense rain and more frequent flash floods during the monsoon would result in a higher proportion of runoff and a reduction in groundwater recharge.

  Glacier melt in the Himalayas is projected to increase flooding and affect water resources within the next two to three decades. The implications of melting Himalayan glaciers and sharing of scarcer river-basin water resources will pose a formidable challenge, and lead to acute shortages of water for drinking and farming. If current warming rates are maintained, Himalayan glaciers could decay at extremely rapid rates, shrinking from the present 5,00,000 km2 to 1,00,000 km2 by the 2030s. This will also be reason for concern when considering Himalayan hydro-power as a partial solution to India's energy needs, as climate change will sharply reduce the effectiveness of the planned mammoth investments. River flow data is critical when planning hydropower projects. However, historical river flows will no longer be a good measure for future flows not only due to glacier melts, but also due to the changing patterns, duration and intensity of rainfall and the seasonal distribution of river flows.

- **Coastal Areas:** Coastal ecosystems will be affected by sea-level rise and temperature increases. Heavily populated mega-delta regions, in particular,will be at greatest risk due to increased flooding. The changes in the Godavari, Indus, Mahanadi and Krishna coastal deltas will potentially displace millions of people. Projected sea-level rise could damage aquaculture industries, and exacerbate already declining fish productivity.

Agriculture: Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall, but also by shifts in the timing of the rainfall. Higher temperatures reduce the total duration of a crop cycle, leading to a lower yield per unit area, especially for India's wheat and paddy crops. Soil erosion, increased numbers of pests and weeds brought by climate change will also affect agriculture in India. For instance, the amount of moisture in the soil will be affected by changes in factors such as rainfall, runoff and evaporation.

- **Biodiversity:** Climate change is expected to exacerbate threats to biodiversity resulting from land use/cover change and population pressure. Along the coastline, marine wetlands, tropical eco-systems and species such as mangroves and coral reefs are threatened by changes in temperature, rising sea levels and increased concentrations of CO_2 in the atmosphere.

- **Health:** Increasing temperatures and projected changes in the hydrological cycle will lead to an increase in temperature-related illnesses, vector-borne diseases, health impacts related to extreme weather events (particularly, floods and droughts), and health effects due to food insecurity. Increase in coastal water temperatures would exacerbate the abundance and/or toxicity of cholera.

- **Increased Temperatures and Extreme Events:** Climate change impacts will lead to an increased frequency of hot days, heat waves, droughts (declining water tables, crop failures, etc) and natural disasters resulting from cyclones.

Climate Change of the Economics

Facing the rapid growing developmental process, it is tougher for the developing nations to get on the tune with the developed nations while the climate change issues are in the scene and for India, it is more tougher as compared to other for the poverty is a worst propellant to push it back. Coping with the challenges of global warming is a daunting task for both scientists and economists in India, who must understand future changes, and for policy makers, who must ultimately choose policies to balance risks and costs. Managing the Global Commons presents a unique effort to encompass economic, scientific, and policy aspects of this great geophysical experiment.

The analysis contains a number of methodological advances and major findings— most importantly the construction of a

small model to encompass the primary components of the climate and economic system within an optimization framework. Also included are new techniques and results concerning the role of uncertainty and the "risk premium" involved in policies to slow global warming. In addition, the analysis derives a set of uncertain representative scenarios that summarize the large number of potential outcomes into a manageable number to be used within an optimization framework and incorporated into a contingent-commodity framework.

Nordhaus examines several different approaches to climate-change policy: no controls, economic optimization, geoengineering, stabilization of emissions and climate, and a ten-year delay in undertaking climate-change policies. Among these, there is a modest advantage of an efficient policy over no controls or a ten-year delay, while the three stabilization options would impose significant net costs. Overall, Nordhaus observes, the analysis reveals that even with major technological breakthroughs and stringent controls, the momentum of past greenhouse gas emissions coupled with great inertia in climate change policy will lead to an inevitable rendezvous with massive climate change.

Greenhouse Effect from India

Climate change arising due to the increasing concentration of greenhouse gases in the atmosphere since the pre-industrial times has emerged as a serious global environmental issue and poses threats and challenges to mankind. Climate change is increasingly recognized as one of the potential critical factors in sustainable development trajectories and there is an emerging international literature that considers methodological issues and empirical results of studies that explore interlinkages, trade-offs and synergies between the different policy areas involved. Estimations of anthropogenic greenhouse gas emission inventories in India began in a limited scale in 1991 which were enlarged and revised, and the first definitive report for the base year 1990 was published in 1992.

The Compounded Annual Growth Rates (CAGR) of CO2 equivalent emissions from India between 1990 and 2000 show an overall increase by 4.2% per annum. On a sectoral basis, the maximum growth in emissions is from the industrial process sector (21.3% per annum), followed by the emissions from the waste sector (7.3% per annum). The energy sector emissions have only grown by 4.4% per annum with almost no increase in emissions registered from the agriculture sector. Significant increase in emissions from the industrial process sector can be attributed to the growth in cement and steel production in India over the decade. Similarly, increase in emissions from the waste sector can be attributed to increase in quantity of waste generated due to the large influx of population from villages to cities in 2000.

Effect on Water Resources

The general impacts of climate change on water resources have been brought out by the Third Assessment Report of the IPCC. It indicates an intensification of the global hydrological cycle affecting both ground and surface water supply. Changes in the total amount of precipitation, its frequency and intensity have also been predicted. Such changes, when on the surplus side, may affect the magnitude and timing of runoff but shall create drought-like situations when these are on the deficit side. Thus, climate change impacts are going to be most severe in the developing world, because of their poor capacity to adapt to climate variability. India also comes under this category. Gosain have used the HadRm2 daily weather data to determine the spatial-temporal water availability in the river system. The initial analysis has revealed that under the greenhouse gas scenario, severity of droughts and intensity of floods in various parts of the country may get deteriorated. However, there is a general overall reduction in the quantity of the available runoff under the greenhouse gas scenario. Luni with the west-flowing rivers Kutch and Saurastra which occupies about one-fourth of the area of Gujarat and 60% of the area of Rajasthan shall face acute water scare conditions. River basins of Mahi, Pennar, Sabarmati and Tapi shall also face water shortage conditions. River basins belonging to Cauvery, Ganga, Narmada and Krishna shall experience seasonal or regular water-stressed conditions. River basins belonging to Godavari, Brahmani and Mahanadi shall not have water shortages but are predicted to face severe flood conditions.

Automatic delineation of the river basins is done by using the Digital Elevation Model which represents a topographic surface in terms of a set of elevation values derived at a finite number of points. Table 4 presents the threshold values used on the DEM of the respective river basins during the process of automatic delineation. It also provides the number of sub-basins the river basin got sub-divided into as a result of this threshold. The total area of the river basin as obtained from the automatic delineation has also been provided.

Responses to Climate Change

Though many scientists agree that it is too late to stop some of the preliminary effects of climate change, almost all are in agreement that the process can be reversed by halting global warming. The only way for this to happen would be to stop releasing more carbon dioxide into the atmosphere than can naturally exit. It is predicted that this would take a worldwide reduction in greenhouse gas release of about 60% - an incredible amount considering the growth rates of developing countries like India and China, as well as the energy consumption of developed countries like the U.S. Governments all over the world are enlisting economists, politicians, and scientists to figure out how to prevent climate change; many governments around the world are instituting emissions caps, carbon trading schemes, and the use of clean, renewable energy sources like wind energy and solar power.

These solutions may force a restructuring of the energy market; traditional forms of energy, like coal and oil, are thought to be contributing to global warming. Reducing emissions means reducing worldwide energy dependency on fossil fuels - a difficult transition, since fossil fuels are far more cost-effective than current forms of renewable energy. With Europe, Japan, and California taking the lead in adopting new energy standards and pressuring the U.S. and the developing world to do the same, however, the energy market is slowly but surely beginning to shift.

Policy Options

After all these prolonged discussions, one thing is clear that construction of new policies as well as reforms in the present policy set up is now the inevitable need of the hour. India is known for having the people friendly policies from

long, dating back deep in to the history when even the today's developed world, particularly the west was only a food gatherer community. Acharya Chanakya or Kautilya, the main strategist of the Mauryan Kings has a famous treatise attached to his name called the Arthashastra or the book of Economic Policies. He has suggested numerous policies to be adopted by the state for the welface of the subject. Surprisingly he has put stress on the policies regarding the water and environment more than any other. He has intrepidly said that the foremost duty of a just king is to be careful for the water sources and this should be the parameter to measure the capability to be or to remain a king of any empire. Quite apart from anything to do with climate change, for decades India has been struggling to improve the weak performance of its electricity sector. A host of commissions and reports have argued for nationwide reforms to address energy and peak demand deficits by improving transmission and distribution efficiency, demand-side management programmes, reducing auxiliary consumption at power stations and establishing an independent regulator for coal mines to reduce the current inefficiency in the coal mining sector. To be sure in some cases such as increased efficiency of coal-based power plants, setting up ultra and super critical plants and a programme to improve the efficiency of existing plants, some investments will not be justified on pure cost and efficiency criteria unless subsidized by additional external resources. But in other cases such as more efficient cook stoves for rural households – which India has been struggling to deliver to its rural population – there is little excuse as to why it cannot design and implement an effective programme for more efficient cooking stoves to reduce local emissions with its associated health benefits at the household level and reduced soot emissions at the national level. The problem with the current programme is the ineffective (standardized, non-tailored) stove design produced by the government. Rhetoric notwithstanding the reality is that the needs of a rural housewife have little claim on the resources of the state.

Another key area is India's urban policies, given rapid urbanization trends. Argue that a paradigm shift in urban policies will be required. Preferences and social values will needs to be redefined, for instance, to wean the middle-class towards an effective public transport system. Urban design and construction will have to shift from the blind imitation of the west to Indian conditions. However, urban land has emerged as a major source of rents and created powerful constituencies that will not be easy to overcome.

Summing Up

The climate change is to be considered as the challenge before the entire humanity and not only for India. If this severe problem is ignored at the local level, it will prove as the most harmful and a fatal problem later in the global level. Climate change poses particularly difficult challenges for a developing country like India. On the one hand, India does not want any constraints on its development prospects. On the other, it also wants to be seen as an emerging global power. While the former may be best served by its current position, the latter will, however, require it to take a leadership role on key global issues with the climate change being a critical one. And it can either approach climate change as a "stand alone" global negotiation, or weave these negotiations into a "grand bargain" involving linkages with other international negotiations that also involve key Indian interests, be it reforms of the Security Council, World Trade Organisation negotiations, the financial architecture, etc. India being the nation most threatened by it needs to sharply deploy resources to augment domestic research capacity. It is easily noticeable that how much climate change has impacted India in the last century and predictions of how much it will impact the country in the current century are subject to vast amounts of errors. This uncertainly calls for sufficient preparation for adaptation to possible extreme weather change effects. This makes sustaining high rates of growth and poverty alleviation even more urgent. Currently, there is little definitive research on what the impacts of climate change will be on different sectors of the Indian economy and the people. India should approach its policies towards adaptation and mitigation, where the former refers to improved capability to protect against and respond to extreme natural events that occur and the latter to efforts aimed at capping the increases in the frequency and severity of the events themselves. A technically robust analysis is required to understand the feasibility and opportunities of low and continued high carbon growth paths, and the effects of mitigation mechanisms.

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