

Climate Change: An Environmental Challenge

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Abstract—The abstract Climate change is one of the most important global environmental challenges, with implications for food production, water supply, health, energy, etc. Addressing climate change requires a good scientific understanding as well as coordinated action at national and global level. This paper addresses these challenges. The issue of highest importance to developing countries is reducing the vulnerability of their natural and socio-economic systems to the projected climate change. India and other developing countries will face the challenge of promoting mitigation and adaptation strategies, bearing the cost of such an effort, and its implications for economic development.

Keywords: Adaptation, Environmental Challenge, Climate Change, Mitigation, Vulnerability, Ecosystems.

1. INTRODUCTION

Climate change is one of the most important. Global environmental challenges are facing humanity with implications for food production, natural ecosystems, freshwater supply, health, etc. According to the latest scientific assessment, the earth's climate system has demonstrably changed on both global and regional scales since the preindustrial era. Further evidence shows that most of the warming (of 0.1°C per decade) observed over the last 50 years, is attributable to human activities. The Intergovernmental Panel on Climate Change (IPCC) projects that the global mean temperature may increase between 1.4 and 5.8 degrees Celsius (C) by 2100. This unprecedented increase is expected to have severe impacts on the global hydrological system, ecosystems, sea level, crop production, and related processes. The impact would be particularly severe in the tropical areas, which mainly consist of developing countries, including India.

The climate change issue is part of the larger challenge of sustainable development. As a result, climate policies can be more effective when consistently embedded within broader strategies designed to make national and regional development paths more sustainable. The impact of climate variability and

change, climate policy responses, and associated socio-economic development will affect the ability of countries to achieve sustainable development goals.

The pursuit of these goals will in turn affect the opportunities for, and success of, climate policies. In particular, the socio-economic and technological characteristics of different development paths will strongly affect emissions, the rate, and magnitude of climate change, climate change impacts, the capability to adapt, and the capacity to mitigate.

The UN Conference on Environment and Development (UNCED) in 1992 at Rio de Janeiro led to FCCC (Framework Convention on Climate Change), which laid the framework for the eventual stabilization of greenhouse gases in the atmosphere, recognizing the common but differentiated responsibilities and respective capabilities, and social and economic conditions. The Convention came into force in 1994. Subsequently, the 1997 Kyoto protocol, which came into force in 2005, reasserted the importance of stabilizing greenhouse gas concentrations in the atmosphere and adhering to sustainable development principles. The Protocol laid out guidelines and rules regarding the extent to which a participating industrialized country should reduce its emissions of six greenhouse gases – carbon dioxide, methane, nitrous oxide, chlorofluorocarbon, hydro-fluoro-carbons, and per-fluoro-carbons. It requires industrialized countries (listed as Annex B countries in the Protocol) to reduce their greenhouse gas emissions by

A weighted average of 5.2%, based on the 1990 greenhouse gas emissions. The reduction is to be achieved by the end of the five-year period, 2008 to 2012. The Kyoto Protocol does not require the developing countries to reduce their greenhouse gas emissions.

2. CLIMATE CHANGE PROBLEM AND THE CONTROVERSY

The Kyoto reduction, by itself, is inadequate to achieve a stabilization of climate change by 2100. A continual and larger reduction, similar to that stipulated in the Kyoto Protocol for the 2008–2012 periods, will be needed in the future in order to begin to stabilize long-term greenhouse gas emissions. Even if stabilization of greenhouse gases is achieved, global warming will continue for several decades and sea levels will continue to rise for several centuries. IPCC studies make it abundantly clear, however, that industrialized countries alone cannot achieve this reduction. Even if their emissions were reduced to zero in the near future, the current trends of growing emissions from developing countries alone could force the atmospheric concentration to exceed stabilization levels of 550 ppm. The participation of all countries, including the developing countries such as India, is essential for a successful worldwide effort to arrest the growth of greenhouse gas emissions.

What is the best method to justly and equitably distribute the burden of stabilizing climate change among the countries? This issue lies at the heart of much of the ongoing negotiations under the auspices of the UNFCCC. India, the fifth largest emitter of greenhouse gases from fossil fuel in the 1990s, has suggested that the 'right' to pollute the atmosphere be apportioned to all countries based on their population. Using this gauge, China and

India, the only countries with populations in excess of a billion each, could legitimately emit greenhouse gases largely, than other countries with lesser population, for some decades. But, as their greenhouse gas emissions today are less than this proposed allocation, they could 'sell' some of the 'rights' to the industrialized countries.

Countries usually propose burden-sharing formulae that favour their economies, and other countries have suggested schemes based on inherited and future emissions, a country's contribution to temperature change, GDP, and land area, and other resource endowments.

In the global climate change debate, the issue of largest importance to developing countries is reducing the vulnerability of their natural and socio-economic systems to projected climate change. Their concerns include increasing food security, reducing freshwater scarcity, protecting the livelihoods of forest dwellers, dry land farmers, and coastal settlements and reducing health risks. Though there is a visible shift in the global discussions towards adaptation at the Climate Convention-related meetings, the focus continues to be on mitigation of greenhouse gas emissions. Adaptation can complement mitigation as a cost-effective strategy to reduce climate change risks.

The impact of climate change is projected to have different effects within and between countries. Developing countries

have to carefully evaluate the need for, and the roles of global and national institutions in promoting both mitigation and adaptation programmes. Mitigation and adaptation actions can, if appropriately designed, advance sustainable development and equity within, across countries, and between generations. The pervasiveness of inertia and the possibility of irreversibility in the consequences of the interactions among climate, ecological and socio-economic systems are major reasons why anticipatory adaptation and mitigation actions are beneficial.

Thus, the inertia and uncertainty imply that targets and timetables must be fixed for avoiding dangerous levels of interference in the climate system. A number of opportunities to exercise adaptation and mitigation options may be lost if action is delayed.

3. IMPACTS OF CLIMATE CHANGE: IMPLICATIONS FOR DEVELOPING COUNTRIES

Developing countries are faced with immediate concerns that relate to forest and land degradation, freshwater shortage, food security and air and water pollution. Climate change will exacerbate the impacts of deforestation and other economic pressures, leading to further water shortages, land degradation, and desertification. Increasing global temperatures will result in rising sea levels. Populations that inhabit small islands and/or low-lying coastal areas are at particular risk of severe social and economic disruptions from sea-level rise and storm surges that could destroy cities and disrupt large coastal livelihoods.

The widespread retreat of glaciers and icecaps in the 21st century will also lead to higher surface temperatures on land and increasing water stress. By 2025, as much as two-thirds of the world population, much of it in the developing world, may be subjected to moderate to high water stress. Estimates of the effects of climate change on crop yields are predominantly negative for the tropics, even when adaptation and direct effects of CO₂ on plant processes are taken into consideration. Ecological productivity and biodiversity will be altered by climate change and sea-level rise, with an increased risk of extinction of some vulnerable species.

Even though the ability to project regional differences in impact is still emerging, the consequences of climate change are projected to be more drastic in the tropical regions.

This is true for all sectors that are likely to withstand the worst of climate change – sea level, water resources, ecosystems, crop production, fisheries, and human health. The populations of the developing world are more vulnerable as their infrastructure is not strong and extensive enough to withstand a deleterious impact.

4. ROLE OF DEVELOPING AND INDUSTRIALIZED COUNTRIES IN ADDRESSING CLIMATE CHANGE: MITIGATION AND ADAPTATION

In the global climate change debate, the issue of largest importance to developing countries is reducing the vulnerability of their natural and socio-economic systems to projected climate change. Over time, there has been a visible shift in the global climate change discussions towards adaptation. Adaptation can complement mitigation as a cost-effective strategy to reduce climate change risks. The impact of climate change is projected to have different effects within and between countries. Mitigation and adaptation actions can, if appropriately designed, advance sustainable development and equity within, across countries, and between generations.

One approach to balancing the attention on adaptation and mitigation strategies is to compare the costs and benefits of both the strategies. If adaptation of climate change could be carried out at negligible cost then it may be less expensive, at least in the short-term, than any alternate strategy. Of course, there are complications in establishing the benefits of adaptation policies and consequent avoided damages. Further, there are significant co-benefits of many mitigation and adaptation measures, which need to be estimated. The co-benefits could play a critical role in making decisions regarding the adoption of any mitigation or adaptation strategy.

The impact of mitigation will only be felt in the long run by the future generations. However, the impacts or benefits of adaptation measures are immediate and felt by the implementers of the measures. The regions implementing the mitigation measures could be different from the regions experiencing its impacts. The current generation of industrialized countries may invest in mitigation measures and the main beneficiaries may be the next generation largely in the developing countries. The choice between mitigation and adaptation strategies has spatial (geographic) and temporal (different generations) dimensions.

An optimal mix of mitigation and adaptation strategies may elude the climate negotiations due to the spatial and temporal dimensions, as well as the differing perceptions of industrialized and developing countries.

5. WHY SHOULD INDIA BE CONCERNED ABOUT CLIMATE CHANGE?

India is a large developing country with nearly 700 million rural population directly depending on climate-sensitive sectors (agriculture, forests, and fisheries) and natural resources (such as water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods.

Extremes in maximum and minimum temperatures are also expected to increase and similarly extreme precipitation shows

substantial increases, particularly over the west coast of India and west central India.

Some of the projected impacts of climate change in India are as follows:

5.1 WATER RESOURCES

The hydrological cycle is likely to be altered and the severity of droughts and intensity of floods in various parts of India is likely to increase. Further, a general reduction in the quantity of available run-off is predicted.

5.2 AGRICULTURE

Simulations using dynamic crop models indicate a decrease in yield of crops as temperature increases in different parts of India. However, this is offset by an increase in CO₂ at moderate rise in temperature and at higher warming; negative impact on crop productivity is projected due to reduced crop durations.

5.3 FORESTS

Climate impact assessments using BIOME-3 model and climate projections for the year 2085 show 77% and 68% of the forested grids in India are likely to experience shift in forest types under A2 and B2 scenario, respectively.

Indications show a shift towards wetter forest types in the northeastern region and drier forest types in the northwestern region in the absence of human influence. Increasing atmospheric CO₂ concentration and climate warming could also result in a doubling of net primary productivity under the A2 scenario and nearly 70% increase under the B2 scenario.

5.4 COASTAL ZONE

Simulation models show an increase in frequencies of tropical cyclones in the Bay of Bengal; particularly intense events are projected during the post-monsoon period. Sea level rise is projected to displace populations in coastal zones, increase flooding in low-lying coastal areas, loss of crop yields from inundation and salinization.

5.5 HUMAN HEALTH

Malaria is likely to persist in many states, new regions may become malaria-prone, and the duration of the malaria transmission windows is likely to widen in northern and western states and shorten in southern states.

It is important to note that the climate-sensitive sectors (forests, agriculture, coastal zones) and the natural resources (groundwater, soil, biodiversity, etc.) are already under stress due to socio-economic pressures. Climate change is likely to exacerbate the degradation of resources and socio-economic pressures. Thus, countries such as

India with a large population dependent on climate-sensitive sectors and low adaptive capacity has to develop and implement adaptation strategies.

India is a large developing country with diverse climatic zones. The livelihood of vast population depends on climate-sensitive economic sectors like agriculture, forestry, and fisheries. The climate change vulnerability and impact studies in India¹⁸ assume high degree of uncertainty in the assessment due to ‘... limited understanding of many critical processes in the climate system, existence of multiple climatic and non-climatic stresses, regional-scale variations and nonlinearity ...’. The costs of not addressing climate change or to adapt to it are very uncertain, but their welfare consequences are enormous. Early actions on adaptation therefore are prudent and consistent from the viewpoint of ‘precautionary principle’.

The future regime architecture can reduce the climate burden by giving greater emphasis to adaptation, e.g. via an Adaptation Protocol, whereby mandatory funding by industrialized countries could support adaptation activities in developing countries. Additional policy options like

6. CONCLUSION

The first commitment period of the Kyoto Protocol ends in 2012. Given the relatively short period to its termination, participating countries have been engaged in several dialogues within the UNFCCC auspices and elsewhere about post-2012 commitments on emissions reductions and adaptation measures. The discussion at these dialogues ranges from mandatory economy-wide targets to sector-specific ones on all countries, to bilateral and/or multilateral agreements to voluntarily reduce GHG emissions.

Industrialized countries, except notably US and Australia, already have agreed to adhere to economy-wide targets, and they are keen to continue such an approach post-2012. Others have proposed sector-based approaches that require adoption of voluntary carbon intensity targets for the energy and major industry sectors in all countries.

For developing countries, enhancing the economic well being of their citizens remains an urgent and pressing goal. To the extent the new climate architecture would be perceived as a barrier to this, it would be resisted and would fail to garner wide support so necessary for economic efficiency and co-ordination to derive multiple benefits. For coming decades, the GHG emissions per citizen from most developing countries would remain significantly below those in industrialized countries. For most developing countries, this is the century when majority of their citizens are likely to first experience economic prosperity. The next climate regime would succeed to the extent it would create instruments that align to sustainable development goals, activities and processes in these nations.

India has completed four nationally coordinated assessments of climate change projections, impacts and mitigation; the first being the climate change studies supported by the Asian Development Bank, the second being the

ALGAS (Asian Least-Cost Greenhouse Gas Abatement Study) supported by the Global Environment Facility (GEF), the third being climate impact assessment study conducted under the Indo-UK collaborative project and the latest being the National Communications supported by the GEF. Interestingly, the Ministry of Environment and Forests coordinated all the collaborative efforts. The National Communications was one of the successful national level coordinated efforts involving 131 teams from research and educational institutions, covering all the three aspects of climate change; climate projections, impacts and adaptation, and mitigation. The National Communications project has promoted a network of research teams and institutions in India, to address various aspects of climate change.

Large developing countries such as India should have long-term Research and Development (R&D) groups working on various aspects of climate change science, particularly the modeling aspects of GHG emissions scenarios, climate projections, climate impacts, integrated assessments, adaptation, and mitigation. Some of the critical scientific issues that need to be addressed include the following:

- Many uncertainties continue to limit the ability to detect, attribute, and understand the current climate change and to project what future climate changes may be, particularly at the regional level. Further, there is a need to link physical climate-biogeochemical models with models of the human system in order to provide better understanding of possible cause– effect–cause patterns linking human and non-human components of earth systems.
- Improved understanding of the exposure, sensitivity, adaptability, and vulnerability of physical, ecological, and social systems to climate change at regional and local level.
- Evaluation of climate mitigation options in the context of development, sustainability, and equity at regional, national, and global level in different sectors (energy and non-energy).
- To develop sustainable and equitable international protocols, mechanisms and financial arrangements to promote mitigation and adaptation to achieve the goals of Article 2 of the UNFCCC.

India is a large developing country with nearly two-thirds of the population depending directly on the climate sensitive sectors such as agriculture, fisheries, and forests.

The projected climate change under various scenarios is likely to have implications on food production, water supply, biodiversity, and livelihoods. Thus, India has a significant stake in scientific advancement as well as an international understanding to promote mitigation and adaptation. This requires improved scientific understanding, capacity building, networking, and broad consultation processes.

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