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Founder Editors: RAJ & ROMESH THAPAR

Global warming and India

ANAND PATWARDHAN

GLOBAL warming has emerged as one of the most important environmental issues ever to confront humanity. This concern arises from the fact that our everyday activities may be leading to changes in the earth's atmosphere that have the potential to significantly alter the planet's heat and radiation balance. It could lead to a warmer climate in the next century and thereafter, portending a potpourri of possible effects – mostly adverse.

International efforts to address this problem have been ongoing for the last decade, with the Earth Summit at Rio in 1992 as an important launching point, and the Conference of Parties in Buenos Aires in 1998 as the most recent step. Although India as a developing country does not have any commitments or responsibilities at present for reducing the emissions of greenhouse gases such as CO2 that lead to global warming, pressure is increasing on India and other large, rapidly developing countries such as China and Brazil to adopt a more pro-active role.

At the same time, the developed countries of the North are trying to limit the extent of their commitments for emission reduction. In this situation, the public and policy makers need to be aware of the ramifications and implications of the global warming problem, even if it is a problem that may manifest itself only sometime in the next century.

What is climate change? Climate change is a newcomer to the international political and environmental agenda, having emerged as a major policy issue only in the late 1980s and thereafter. But scientists have been working on the subject for decades. They have known since the 19th century that carbon dioxide (CO2) in the atmosphere is a 'greenhouse gas', that is, its presence in the atmosphere helps to retain the incoming heat energy from the sun, thereby increasing the earth's surface temperature. Of course, CO2 is only one of several such greenhouse gases in the atmosphere. Others include methane, nitrous oxide and water vapour. However, CO2 is the most important greenhouse gas that is being affected by human activities.

CO_2 is generated by a multitude of processes ranging from animal and plant respiration to the burning of any kind of fuel containing carbon, including coal, oil, wood and cow dung. For a long time, human activities that generated CO_2 caused only a small perturbation in the natural cycle of the gas. However, since the Industrial Revolution when our usage of fossil fuels increased dramatically, the contribution of CO_2 from human activities has grown large enough to constitute a significant perturbation of the natural carbon cycle.[1] Since the early '50s, as regular measurements of the atmospheric concentrations of CO_2 were started, it has been conclusively established that these concentrations are increasing rapidly, driven by human activities.

The concentration of CO_2 in the earth's atmosphere was about 280 parts per million by volume (ppmv) in 1750, before the Industrial Revolution began. By 1994 it was 358 ppmv and rising by about 1.5 ppmv per year. If emissions continue at the 1994 rate, the concentration will be around 500 ppmv, nearly double the pre-industrial level, by the end of the 21st century.

The concentrations of other greenhouse gases such as methane and nitrous oxide have also been rising at a fairly rapid rate. The effect is that the atmosphere retains more of the sun's heat, warming the earth's surface. Of course, not all man-made additions to the atmosphere increase warming. For example, aerosols, tiny particles of solid or liquid suspended in the air, which result from the emissions of soot and sulphur dioxide from power plants tend to reflect heat and diminish warming. But aerosols are mostly short-lived while the CO_2 released into the atmosphere will stay there for decades.

At the same time, concern about local air quality is driving many countries to impose stringent controls on emissions of substances such as sulphur dioxide. As a result, many scientists feel that even as these emissions decrease in the future, the full effect of the greenhouse gases will be unmasked, leading to an even more rapid warming pattern.

While the pattern of future warming is open to debate, it is indisputable that the surface of the earth has warmed, on average, 0.3 to 0.6 degrees celsius since the late 19th century when reliable temperature measurements began. Recent decades appear to be the warmest since at least 1400, according to the fragmentary information available.

It is against this backdrop of knowledge that the Intergovernmental Panel on Climate Change (IPCC) concluded in its second assessment report in 1995 that the current state of knowledge '*now points towards a discernible human influence on global climate*.' In this assessment report, the IPCC also concluded that under the existing scenarios of economic growth and development leading to greenhouse gas emissions, on a worldwide average, temperatures would rise by 1 to 3.5 degrees celsius by the year 2100, and global mean sea level by about 15 to 95 centimeters. It is likely that changes of this magnitude and rapidity could pose severe problems for many natural and managed ecosystems, as well as important economic sectors such as agriculture and water resources. Indeed, for many low-lying and deltaic areas and small islands, a sea level rise of one meter could threaten complete loss of land and extinction of habitation.

Scenarios of future climate change are usually developed using complex 3-dimensional models of the earth's atmosphere and oceans. However, while we have some degree of confidence in the gross or aggregate estimates for climate parameters (such as globally averaged surface temperature) from these models, there is a great deal of uncertainty with regard to regional details. In addition, most of the ill effects of climate change are linked to extreme weather events, such as hot or cold spells of temperature, or wet or dry spells of rainfall, or cyclones and floods. Predictions of the nature and distribution of such events in a changed climate are even more uncertain, to the extent that virtually no authoritative predictions exist at all. Despite these uncertainties, it is clear that even the *possibility* of changes in such extreme events is quite alarming.

Global warming has often been described as one of the most serious environmental problems ever to confront humanity, as this problem is inextricably linked to the process of development and economic growth itself. Since greenhouse gases are generated by burning fossil fuels as in power plants, factories and automobiles, it is not easy to reduce emissions, since virtually every facet of our lives is intimately tied to the consumption of energy. Climate change is an unusually difficult issue for the people who make the decisions in democratic governments. First of all, the science is uncertain while governments have to make firm policy decisions, if only the decision to do nothing, long before these uncertainties can be resolved.

Political leaders are already beginning to overstate the clarity of the science in order to attract public support. A lot of money is now going into climate research, and new findings with varying political implications will continue to appear.

Any serious attempt to cut emissions will have clear and immediate costs, but the benefits may not appear for a long time. To the extent that the benefits may be disasters that didn't happen, they may never be obvious. But the costs will be. As the debate develops, much of it is being cast in terms of the restraint that the present generation owes to future generations.

Unlike many other environmental issues, such as local air or water pollution, or even stratospheric ozone depletion caused by chloroflourocarbons (CFCs), global warming poses special challenges due to the spatial and temporal extent of the problem – covering the globe and with decades to centuries time scales. Again, in this particular issue, science has played, and continues to play, a critical role in defining the structure and basis of the debate. The following three dimensions of the issue illustrate the vexing features of the science underlying the problem:

i) Cumulative effect of the historical emissions. The climate system acts as a large integrator, that is, the response of the system is a result of the *entire history* of the forcing being applied.

ii) Lags in the system. The response of the ocean-atmosphere system occurs several decades to centuries after the changes in the atmospheric greenhouse gas concentrations. As a result, even if emissions of greenhouse gases were stabilised immediately, it would take many years for the climate system to reach a new quasi-steady state, and some changes (such as sea level rise) would continue to happen.

iii) The actual consequences of climate change are likely to exhibit considerable spatial and temporal variability – thus some regions may actually experience a transition to a milder, warmer, wetter, and overall better climate regime. As a result, there are costs as well as benefits associated with climate change; although the scientific consensus is clearly that the overall effects are likely to pose a significant burden.

How have we tried to respond to climate change? Negotiations began in 1991 under United Nations auspices to formulate an international treaty on global climate protection. Those negotiations resulted in the completion by May 1992 of a Framework Convention on Climate Change (FCCC). The Convention was opened for signature at the Earth Summit in Rio de Janeiro in June 1992, and it entered into force in March 1994.

The Convention has few binding requirements. It calls for nations to limit carbon dioxide and other greenhouse emissions, by 'addressing anthropogenic emissions by sources and removals through sinks of greenhouse gases….' It does not set out specific targets or timetables for reducing emissions. It only requires the developed country signatories to formulate and adopt policies that aim at stabilising greenhouse gas emissions at 1990 emission levels, recognising that 'the return by the end of the present decade to earlier levels of anthropogenic emissions… would contribute to… modifying longer term trends in anthropogenic emissions consistent with the objective of the Convention… to achieve… stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.'

The Convention adopted the notion of *common but differentiated responsibility*, recognising that the global climate was a common resource and responsibility, but that there were clear asymmetries between the developed and the developing countries in terms of both the past and present contributions to the problem as well as the resources to respond to it. That is, the developed countries are, by far the largest emitters of CO2 and other greenhouse gases. At the same time, they also have the technical and financial resources to try and reduce their emissions. Two broad groupings of countries emerged after the Convention, the countries listed in Annex-1 of the Convention, or the developed countries, and the others. Countries such as Russia or Ukraine (parts of the former Soviet Union) although a part of the Annex-1 countries are placed in a special category as Economies in Transition.

At the time of the Rio Summit, proponents of more specific, legally binding targets and timetables for reducing greenhouse gas emissions successfully urged follow-on talks leading to future negotiation of a protocol or other legal instrument in order to strengthen the Framework Convention. In 1995, the Parties to the Framework Convention at their first meeting in Berlin, Germany, declared that commitments made in 1992 to reduce greenhouse gas emissions were inadequate to meet the objective of the Convention. So-called 'next steps' were needed to confront the potential of global warming in the post-2000 time frame. Consequently, the Parties agreed to a process, set forth in their 'Berlin Mandate', of analysis and assessment of just what next steps might be taken to limit greenhouse gas emissions.

This process resulted in the negotiation of a protocol, the final details of which were completed at the third meeting of the Conference of the Parties to the Framework Convention held 1-12 December 1997, in Kyoto, Japan. The Kyoto Protocol to the United Nations Framework Convention on Climate Change commits industrialised nations to specific, legally binding emission reduction targets for six greenhouse gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorinated compounds, and sulfur hexafluoride. The protocol was opened for signatures on 16 March 1998.

International political implications have proven significant. By far the majority of greenhouse gases are emitted by sources in industrial and transportation sectors (especially automobiles) that are concentrated in developed countries. These countries have shown concern not only about their own emissions, but about increased emissions from poorer countries as they expand their economies. Friction has been evident in the debates over which actions, by developed and developing countries should be undertaken, on what schedules, and which parties should pay incremental costs for mitigation measures. Developing countries generally have argued that the financial burden of change should be borne by developed countries, which are mainly responsible for current atmospheric change due to human activity.

Figure 2 helps put in perspective the source of the some of the differences between the developed and the developing countries, by showing for about 10 selected countries the total and per capita emissions of CO2 in 1995. While some of the developed countries such as China and India do appear to have large emissions, on a per capita basis they are still negligible as compared to any of the developed countries.

As the Framework Convention (FCCC) states, the basic goal of the negotiation process is to return the concentrations of greenhouse gases to a level that prevents dangerous anthropogenic interference with the climate system. The simplest way of conceptualising this goal is to consider a target or limit for the atmospheric concentrations of the greenhouse gases set at a level that does not lead to unacceptable climate change.[2] Of course, since our ability to predict future climate change is very limited, the notion of what is 'unacceptable' is itself quite imprecise and fuzzy. In this conceptualisation, the economic activities in different countries that lead to greenhouse gas emissions correspond to this limit or resource being used up.

The entire negotiation process then may be regarded as an effort to address the following three questions: (*i*) What exactly is the limit, and how should it be defined? (*ii*) What is the basis that ought to be used for the manner in which different countries can use up this resource? (*iii*) What are the instruments that could be used to divide up and actually distribute this resource to the different countries once the allocation basis has been determined?

The first question centres around the level of atmospheric concentrations that would be considered acceptable in view of the possible consequences of climate change. A related issue is whether the limit would be specified individually for each greenhouse gas, or whether some sort of a 'basket' approach could be used where countries could trade-off amongst the different gases. This issue depends critically on whether the effects of the different gases could be made commensurate with each other through a set of equivalences[3] and if greater flexibility or economy would be obtained. It has also been suggested that rather than concentrate on the greenhouse gas concentrations, it may be better to focus on the sinks for these gases – which is primarily the terrestrial biosphere and the oceans.

The second question centres around the basis for the allocation and is currently the subject of much debate. Large, populous developing countries like India and China would clearly favour a per capita basis, as it gives them the greatest scope for increasing emissions further in their development processes.

The final question deals with the approach to be followed once the allocations have been determined. A large variety of market based instruments such as taxes and tradable permits have been deployed for conventional pollutants such as sulphur dioxide and there is much research on their applicability in the climate context. However, the key issue to recognise here is that any instrument will necessarily have to address large scale technology and monetary transfers since developing countries could, in principle, 'sell' their allocations to the developed countries.

For India, the climate change issue has several ramifications: First, although India does not currently have any obligations under the Convention to reduce its greenhouse gas emissions, international pressure will keep increasing in this regard. It is therefore important for us to develop a clear understanding of our emission inventory. We also need to document and analyse our efforts in areas such as renewable energy, wasteland development and afforestation – all of which contribute towards either reducing CO2 emissions or increasing CO2 removal from the atmosphere. Considering that these efforts may often be undertaken for a variety of reasons not directly related to global warming, but yet have benefits as far as climate change is concerned, we may be able to leverage such efforts in the international context.

Second, we need to develop a clear and well articulated position on each of the three basic questions indicated earlier. This position needs to be supported by appropriate analysis. The Indian research community could contribute substantially in this regard.

Finally, we need to recognise that even if countries do undertake immediate and rapid action to reduce their emissions, some degree of climate change is inevitable. If we consider the fact that we have very limited abilities to deal with weather extremes in the present day, the situation may get worse in the future. Therefore, we need to significantly improve our ability to plan and adapt to extreme events such as floods, droughts, cyclones and other meteorological hazards. Any robustness that we build into the system in this regard will always stand us in good stead, no matter what climate change actually transpires.

Footnotes

1. For example, over 700 billion tons of CO2 cycle annually through the biosphere. The anthropogenic contribution in this cycle is around 24 billion tons. Though the natural cycles are finely balanced, this is still a significant perturbation as it leads to an accumulation of CO2 in the atmosphere.

2. For example, a value for long term atmospheric CO2 concentration of 500-550 ppmv has often been used

in the discussions. This value then defines the size of the resource that can be ‘used up’.

3. Equivalences have indeed been suggested in the form of ‘global warming potentials’, an index that attempts to capture the ability of each gas to cause changes in the climate system. However, since different gases have different lifetimes in the atmosphere, and since the entire history of forcing is important, this becomes a fairly complex problem.

References

Authoritative reviews of the science underlying the climate change issue are provided by the Intergovernmental Panel on Climate Change (IPCC). See, for example:

J.T. Houghton, et. al. eds., Climate Change 1995: the science of climate change. Cambridge University Press, 1996; and, James P. Bruce, et. al., eds., Climate Change 1995: economic and social dimensions of climate change. Cambridge University Press, 1996. The IPCC also maintains a website at www.ipcc.ch.

A good introduction to the costs of reducing emissions is provided by Robert Repetto and Duncan Austin, The Costs of Climate Protection: a guide for the perplexed, World Resources Institute, Washington, 1997.

The Framework Convention secretariat operates a website at http://www.unfccc.de/, which provides very complete information on the entire negotiation process, as well as the actual Convention and Protocol documents.