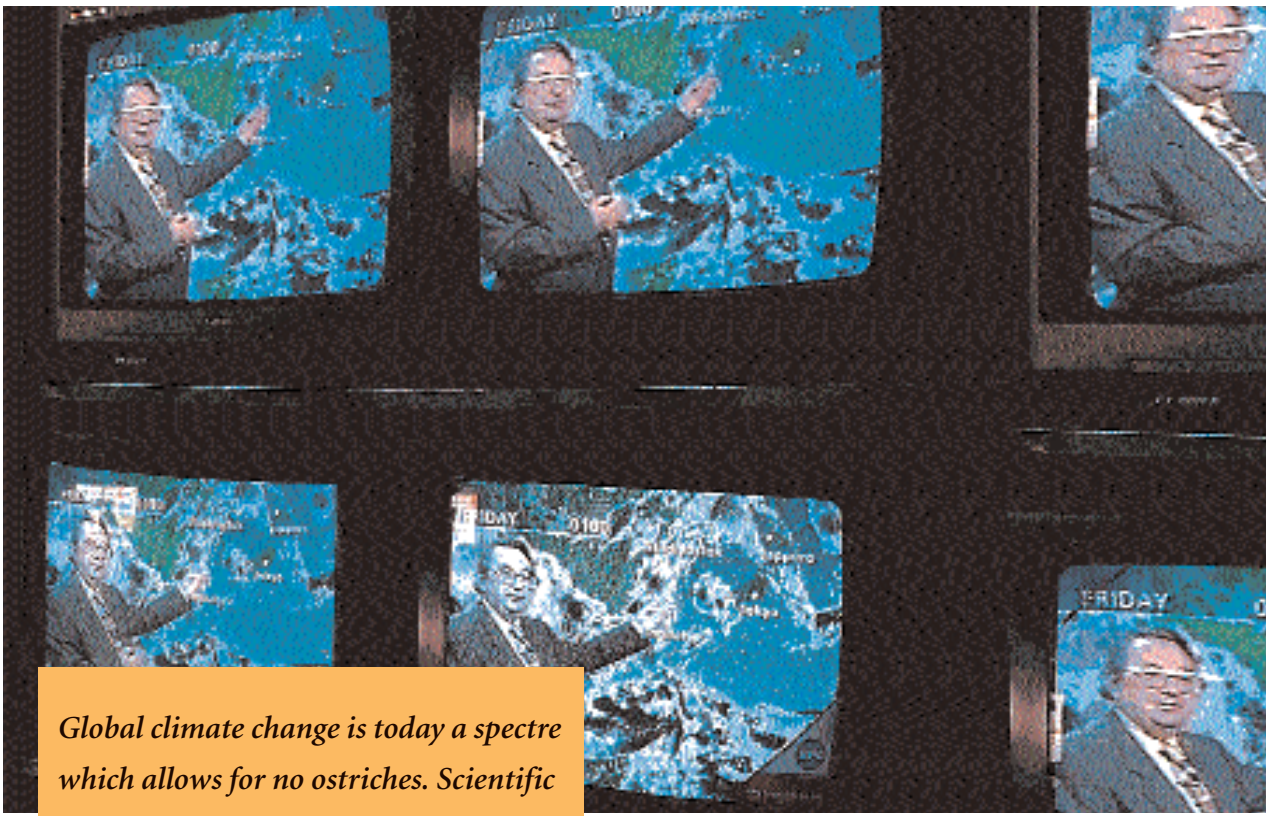
Hot and anxious



AMIT SHANKER / CSE

Global climate change is today a spectre which allows for no ostriches. Scientific data is piling up to indict human activity as the source of the current phase of warming. The debate is whether the affluent North or the developing South has been more responsible and who will be polluting more in the near future. This forms the basis of international wranglings about who pays for a cooler future. However, there is only so much that we understand about the cause and effects of global warming. It has thus become necessary for countries in South Asia to coordinatedly move towards a better scientific understanding of climate change

RAKESH KALSHIAN

DISCUSSIONS on weather and climate change once made for those mundane, boring generalities that adorn undistinguished conversations. For the cognoscenti today, however, talking about climate change is savvy. But it is certainly much more than just an important item on the intellectual menu. It figures prominently on the agenda of scientists, politicians, industrialists and environmentalists.

The science of climate change is frustratingly complex and still uncertain. Proponents of global warming may seize upon events like the breaking off of a huge iceberg in Antarctica as unambiguous warming signals, but these do not really allow for an unequivocal interpretation. The unusually severe winter in the US last year has been cited as an example by both proponents and opponents of global warming as evidence supporting their contentions. Besides, debates at international fora easily show that one reason behind this matter becoming bitter is that climate change is also a political issue: at the end of the day, it will boil down to the affluent Northern countries making drastic changes in their lifestyles and paying up for their past activities if the proponents of global climate change are proved right.

With more evidence pouring in, the dissenting voices are

becoming feebler. The scientific jury seems more or less persuaded that much of the current warming is engineered by human-generated greenhouse gases (GHG). The Geneva-based Intergovernmental Panel on Climate Change (IPCC), a UN body set up in 1988, has argued that current warming "is unlikely to be entirely natural in origin" and that the "balance of evidence suggests a discernible human influence on global climate".

Whether the globe is really becoming warmer is a fundamental doubt that will only be cleared with more evidence — there are several thorny issues that continue to thwart scientific understanding of climate change. It is this lack of conclusive scientific evidence that has spawned political, social, ethical and philosophical debates, ranging from who is more responsible and who should pay up for tackling the issue: the North or the South.

Naturally, there are no ready answers. Says N Sundararaman, secretary of the IPCC, "One cannot look upon climate change as a purely research issue. Nor can one look at it as a purely public policy issue. Every nation has a major stake in climate change, even perhaps as a matter of survival, as in the case of small island nations. Hence, public policy and scientific endeavour in collecting, analysing and sifting data, must go hand in hand, continually."

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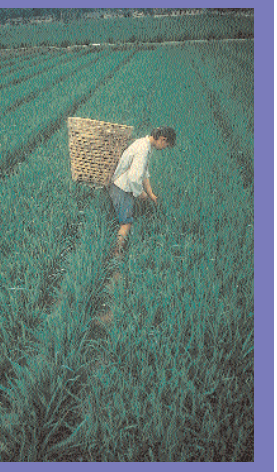
Impact of future climate change may affect developing countries like India and China, which have agriculture-based economies and are already stressed due to population increase and associated demands for basic facilities



The sleuths

The idea behind setting up the IPCC was to put together a team of leading scientists and experts to, firstly, prepare assessment reports on the science of climate change and its impact on human life; secondly, suggest ways to deal with it, including an assessment of the adaptation / mitigation options available and thirdly, assess the economic and social dimensions of climate change.

To quantify and assess climate change, various scientific organisations have since been set up. IPCC scientists use data from a number of experiments being conducted across the world, notably the International Geosphere-Biosphere Programme, the Global Climate Observing System and the Global Energy and Water Cycle Experiment. There are three major impressarios of these experiments — the Scientific Committee on Oceanic Research of International Council of Scientific Unions (ICSU), the Intergovernmental Oceanographic Commission of UNESCO and the World Climate Research Programme established by ICSU and the World Meteorological Organization.

To understand the problems of climate change and to initiate a mechanism for global action, the 1992 UN Conference on Environment and Development (UNCED) held at Rio de Janeiro in Brazil, launched the Framework Convention on Climate Change (FCCC). The first conference of the FCCC was held in March 1995 in Berlin where, for the first time, serious negotiations were initiated towards capping GHG emissions by individual countries.

Heat over Asia

The second IPCC assessment report envisages that a major share of future growth in GHG emissions will come from developing countries where increasing populations will require more and more energy, resulting in greater levels of GHG emissions. According to IPCC estimates, by the year 2025 68 per cent of the world's GHG emissions are likely to be from developing countries. This has made many experts feel that the impact of future climate change may affect, more severely, developing countries such as India and China, whose economies are largely dependent on agriculture and which are already under stress due to current population increase and associated demands for energy, fresh water and food.

But how well do we understand the processes of climate change in this part of the world? How much does the South Asian region contribute to GHG concentrations in the atmosphere? To understand the intricacies of climate change, three sets of data are necessary — reliable meteorological data (rainfall and temperature variations over time and space), inventories of GHG from various sources and their effect on temperature, and well-designed climate models that can realistically predict climate change and its associated effects, such as sea-level rise. While we have good weather data, GHG inventories and climate modelling leave much to be desired.

Superior-quality databases on GHG emissions and satellite pictures of cloud and rainfall behaviour, are notable growth

areas in India. The National Physical Laboratory (NPL), besides other institutions, has recently prepared an inventory of carbon dioxide (CO_2) emissions from fossil fuels, coal, petroleum products and natural gas usage in India. Methane emissions from paddy and animal sources have also been documented. Scientists at the Indian Institute of Technology (IIT), Delhi, are currently engaged in preparing an inventory of GHG emissions in the country. A modest beginning has been made in climate modelling and simulation studies at the National Centre for Medium Range Weather Forecast, Delhi, Indian Institute of Tropical Meteorology, Pune, IIT, Delhi, the Indian Institute of Science (IIS), Bangalore, and the Physical Research Laboratory, Ahmedabad.

These early efforts have yielded some interesting results. For instance, although the South Asian region is populated by 20 per cent of the world's people, GHG emissions are considerably lower here — around four per cent CO_2 (all sources), six per cent methane (all sources) and three per cent from burning fossil fuels (expected to rise to seven per cent in 2025 AD). This is calculated on the basis of a near doubling of per capita emission rates of all the countries in this region. Thus, GHG emissions are not a serious problem for this region, even after taking into account land-use changes. Nevertheless, on a per sq km basis, projected emission indices for CO_2 and sulphur dioxide look severe for India in 2025 AD.

RUSTAM VANIA

Forests are another carbon source that India need not worry about, concludes H Ravindranath, a climate researcher at the IIS, Bangalore. Forests are generally considered significant emitters of carbon but they also absorb a lot of CO_2. Till recently, experts thought the emissions were in excess of the uptake but a recent study by Ravindranath and his colleagues has revealed that the emissions are almost equal to the uptake. However, atmospheric sulphur dioxide loading from anthropogenic sources, is no longer negligible for this region. A matter of special interest is the large hydroxyl ion concentration in this region, indicative of a high rate of methane destruction. While climate data shows a significant warming — 0.4°C every century — it is difficult to interpret the changes in terms of cause and effect. It is likely that some of these changes are part of global climate variations. But it must also be mentioned that the NPL data has ruffled IPCC

Patchy patterns

With new evidence of the role played by aerosols, which act as localised coolants, scientists worry that their assessments of global warming may have been misplaced

The Intergovernmental Panel on Climate Change's (IPCC) argument that current global warming "is unlikely to be entirely natural in origin" and that "the balance of evidence suggests a discernible human influence on global climate" throws light on certain pointers. The chief human influence on climate is the general warming effect of the build-up of carbon dioxide (CO_2) and other greenhouse gases (GHG) — largely from burning fossil fuels. But the perplexing patchiness of the warming prevented scientists from passing a firm indictment of human activity. The IPCC report now argues that the patchiness is caused by a second human influence. In many parts of the world, including much of Europe and North America, warming has been partly masked by another form of pollution — aerosols of sulphates and soot that form a thin haze which reduces solar heating.

The IPCC concludes that aerosols have global cooling effect of about 0.5 watts per sq m, compared with the global warming from GHG of 2.5 watts. But because aerosols remain in the atmosphere for a few days, their cooling effect is concentrated over industrial regions. Crucially, those are places where warming has failed to happen.

The report predicts that the doubling of CO_2 levels in the atmosphere, as predicted, would raise the mercury worldwide by 1 to 3.5°C. This is half a degree less than IPCC's 1990 estimate, which had not reckoned the role played by aerosols. The error in prediction, say scientists, is largely because scientists do not know whether the world will become cloudier as it warms, and how those clouds will affect the climate.

However, aerosols introduce a major new uncertainty into the assessments of how global warming will influence climate in individual countries. The report suggests that effects of acid rain in Europe and North America will reduce aerosols over those regions, exposing them to the full brunt of global warming for the first time.

But in countries that are industrialising now, including India and the countries of South-East Asia, some models project an overall cooling beneath a shroud of local pollution by the year 2050. Climate models suggest that if global warming is considered alone, the South Asian monsoon will become more intense, causing floods. But if the models include the impact of aerosols, it shows that less rain will fall during the monsoon, triggering droughts.

feathers, since the Indian inventory shows much lesser possibilities of emissions and thus our responsibility for warming in the coming years.

Scientists generally agree to disagree over models and insist that no two models ever agree with each other. Recently, M Lal of IIT, Delhi, simulated the combined effects of CO_2 and aerosols on India's future climate, concluding that, contrary to earlier modelling results cited in IPCC reports and elsewhere, monsoon rainfall over India is likely to decline (about 0.5 mm / day) through the 2040s. Further, this model projects a pronounced surface warming of more than 2.5°C from increased levels of CO_2 only and just 1°C from aerosols. Another notable finding is that warning signals of GHG-induced warming over India may not be clearly discernible above the natural climate variability for the next 50 years.

Climate research in the South Asian region is still at an incipient stage. Firstly, there are very few climate researchers. Secondly, climate modellers do not have the data to compute long-term projections. Thirdly, no country in the region has a coordinated national climate programme like that of the US, that maintains inventories of GHG emissions from all the sources, including aerosol levels in the atmosphere. Fourthly, there is little interaction between the South Asia Association for Regional Cooperation (SAARC) nations.

To get to the bottom of such issues, the Centre for Science and Environment (CSE), New Delhi, had organised a workshop in November, 1995. Experts at the workshop agreed that detection of climate change at the national and regional levels is very important. Towards this process, it is important for scientists to not only project national / regional scenarios of future GHG and aerosol emissions, but also study changes in the monsoon circulation and in extreme weather events like cyclones. It was felt that experts should devise an appropriate methodology for making national GHG inventories, particularly with respect to methane from rice fields, cattle raising and land-use change.

What this means

The climate change issue has serious implications for the economy. It is one of the first truly global policy issues that will force us all to consider new approaches on environment, energy, economics, international regulation and competitiveness. The ongoing international negotiations on climate change issues could lead to policies that address trade alliances, growing population pressures, scientific and technological innovations as well as the ability of developing countries to achieve improved standards of living.

Assessing the impact of climate change is fraught with problems. Says Sundararaman, "Most systems are sensitive to the magnitude as well as to the rate of climate change. But impacts are generally difficult to quantify because projections of climate change on regional scales are not yet available and data on impacts in many sectors is either sparse or non-existent."

Not surprisingly, therefore, we know precious little about how future climate change will affect people and economies. As of now, there is just one impact assessment of sea-level rise done in India by the department of ocean development's all-India coordinated programme on sea-level rise. The impact assessment was based on a one metre sea-level rise scenario and covered most coastal states.

In terms of the land lost, the state most at risk was expected to be Goa, which would lose possibly about 4.6 per cent of its area. Other states at risk included West Bengal (1.88 per cent) and Gujarat (0.92 per cent). The country would lose about Rs 184,767 crore, equal to 43 per cent of India's 1988 gross national product (GNP). However, if the land loss is not included, the cost amounts to Rs 32,027 crore which, if spread over a period of 40 years, is 0.18 per cent of the 1988 GNP. The writers of the impact assessment, however, cautioned that the loss may be an underestimate, subject to changing economic variables such as inflation rate.

The effect of climate change on agriculture is bound to be

For a cooler world

Some very urgent steps need to be taken to ensure a less warm, more congenial world where the island and coastal peoples will live without fearing the Deluge. The workshop organised by the Centre for Science and Environment drew up a proactive plan for South Asian countries. The plan emphasises:

- Detection of climate change at national and regional levels
- Projections of national and regional scenarios of future emissions of greenhouse gases (GHG) and aerosols
- Building regional climate models, with a special emphasis on the monsoons
- Projecting regional scenarios of climate change for South Asia
- Applying these scenarios to derive impact scenarios on agriculture, water supply, forestry, human health
- Methodology for national GHG inventories, particularly with respect to methane from rice fields, livestock and land-use change
- Promoting the development and implementation of national and international energy efficiency standards
- Creating common computer facilities for the South Asian countries
- Establishing E-mail connectivity between South Asian nations
- Sharing information and collaborating with fellow scientists from other nations on mutually beneficial projects
- Disseminating results of climate research from this region to the outside world
- Bringing in the human dimension while assessing the impact of climate change and suggesting adaptation measures
- Studying the impact of climate change on forests
- Estimating regional levels of deforestation

most significant. Virtually, any form of agriculture is sensitive to changes in climate. Physiological processes in plants (photosynthesis or transpiration) may respond to increased levels of CO_2 in the atmosphere.

Wheat and rice are the two most important staple foods around the world. For India, the model study suggested that combined greenhouse and sulphate aerosol effects, resulting in a decline in monsoon rainfall, will lead to an overall decrease in soil moisture. Scientists at the New Delhi-based Indian Agricultural Research Institute (IARI) suggest that a temperature rise of 3°C will result in a loss of 15-20 per cent in wheat yield. Malaysian scientists have reported a 19 per cent decline in yields for both transplanted and direct-seeded rice under doubled CO_2 conditions. India has witnessed a 25 per cent increase in CO_2 levels in the atmosphere between 1900 and 1980 and a decrease in the productivity of rice has been reported.

The study of the impact of GHG-induced climate change on agriculture is complicated by the physiological effects of atmospheric CO_2 on crop growth and water use. Although the direct effects of high CO_2 have been observed under controlled experimental conditions (yield increases of 54 per cent in cucumber fruit weight, 37 per cent in *Chrysanthemum* dry weight and 20 per cent in tomato weight have been reported due to CO_2 enrichment), their magnitude and significance in the open field are still uncertain, especially with respect to largescale climatic effects. Preliminary assessments indicate that in a high CO_2 world, yields of C3 plants will increase, while that of C4 species (cotton and groundnut, among others) will show little improvement.

Says Y P Abrol of the IARI, "While the yield of some crops may increase in a high CO_2 world, the nutritive quality of the crops will go down because of decreased uptake of nitrogen." He raises the interesting issue of consumption of fertilisers, which has been increasing at an alarming rate already. "The figures for 1994-95 are 13 metric tonne for nitrogen, phosphorus and potassium. In high CO_2 conditions, the use of fertilisers is bound to go up significantly." Furthermore, scientists say that a rise in surface temperature may create conducive conditions for pest infection and hence, loss of crops.

An important resource likely to be affected by climate change is water. Recent model projections indicate a decline in monsoon rainfall over the northern and central plains of India in a high CO_2 world

Another major issue concerning rainfall is the occurrence of climate calamities like flash floods and landslides. For instance, extreme rainfall in the Himalaya may cause widespread landslides

Limits of data

Another important resource likely to be affected by climate change is water. Recent model projections indicate a decline in monsoon rainfall over the northern and central plains of India in a high CO_2 world. During winter, however, no significant change in rainfall is likely, says Lal. While no change in surface runoff is expected during winter, considerable decline in surface runoff is likely over the central plains during the monsoon. In general, the projected changes in rainfall, soil moisture and surface runoff, could have significant impact on our water resources.

Scientists say the global warming poses an additional threat to our mountainous regions. Unfortunately, however, the present models are not good enough to make reliable projections for a complex Himalayan ecosystem. But a group of Indian scientists is working in collaboration with their German counterparts on alternate climate change scenarios for this region. Results are expected in another two years. A limited number of climate studies of this region, however, suggests that over a 50-year period, increasing temperatures due to enhanced GHG concentrations could contribute an 11 per cent increase in runoff.

Another major issue concerning rainfall is the occurrence of climate calamities. Preliminary results suggest more frequent rainfall over north-east India in a warmer atmosphere which may cause severe flash floods. Extreme rainfall in the Himalaya could be the cause behind widespread landslides.

Despite these projections, it must be admitted that impacts are difficult to quantify and the existing studies are limited in scope. As a last word, it must be said that the science of climate studies is still an enigma to scientists. Given its complexity, scientists have no alternative — unless they want to be dictated by the self-interests of the developed nations — but to gather their own data, devise their own models, create their GHG inventories and come up with their own policies on how best we can deal with this imminent danger. n