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EDITORIAL

Climate Change: Uncertain Science, Certain Controversy

Ever since the Nobel Peace Prize was conferred on Al Gore and the UN Intergovernmental Panel on Climate Change (IPCC) in 2007, there has been widespread acceptance of the fact that we are in the midst of rapidly changing weather patterns. The connection between rising carbon dioxide (CO_2) levels and global warming is now common knowledge. No area of science has captured the public imagination as quickly as the science of climate. CO_2 and methane, once limited to classes in chemistry, are now familiar substances, always in the public eye as discussions on 'greenhouse gases' are now commonplace. The connection between rising atmospheric CO_2 levels and global temperature rise is largely accepted as an established fact. A recent editorial in *Science* (2009, **325**, 1599) by Steven Chu, the US Secretary of Energy and a Nobel laureate in Physics begins emphatically: 'Overwhelming scientific evidence shows that CO_2 emissions from fossil fuels have caused the climate to change, and a dramatic reduction of these emissions is essential to reduce the risk of future devastating effects'. Several alarming scenarios have been widely projected; rising oceans that submerge low-lying coastal regions, melting glaciers, a slow loss of the polar ice cap, altered rainfall patterns, droughts and floods. The rise of disease, with malaria anticipated to be pre-eminent among the public health issues of concern in Africa, parts of Asia and Latin America in future, will be an inevitable consequence in these scenarios. Public interest in climate change issues is mounting and the impending summit in Copenhagen has further fuelled interest in this area. International treaties and protocols have been more honoured in the breach. Whether Copenhagen will be more successful than Kyoto, in achieving a global consensus in evolving a collective strategy, remains to be seen. In the build-up to the UN climate talks there is already an atmosphere of pessimism. A *Nature* editorial observes that 'the pessimism has spread so widely that it could be considered a global pandemic'. The price for the excesses of the twentieth century must be paid in the twentyfirst. Dramatic reductions in CO_2 emissions cannot be achieved without a substantial cost. There may be little support for a view that the developed nations, particularly the United States must drastically cut back on emissions, even while large developing economies like China and India continue to expand industrially, with an attendant increase in the overall share of global CO_2 emitted. The 'clean and green' energy technologies are still on the drawing board, with some strategies being prohibitively expensive, at present.

In the midst of all the concerns on global warming, a report released by the Ministry of Environment and Forests presents data to suggest that fears about receding Himalayan glaciers may be ill founded. The report is in sharp contrast to the 2007 IPCC report, which presented an exceedingly alarming picture, suggesting a complete disappearance of the glaciers in about three decades. The new report (Raina, V. K., Himalayan Glaciers: A State-of-Art Review of Glacial Studies, Glacial Retreat and Climate Change, 2009), specifically notes that the Gangotri and Siachin glaciers have hardly shown any abnormal retreat over the last several years. An interesting analysis of this report suggests that experts are divided on the data. Projections do not seem to be completely supported by observations. The analysis concludes on a predictable note: 'Forecasts hold little water, so only a robust observation campaign will reveal whether the third pole's resistance to climate change is durable or ephemeral (Bagla, P., *Science*, 2009, **326**, 924). Elsewhere in the Himalayas, glaciers seem to be melting. In a news feature under a section titled 'Road to Copenhagen', *Nature* carries a report that cites the IPCC study: 'Glaciers in the Himalayas are retreating faster than in any other part of the world and they could completely disappear by 2035'. The article suggests that Bhutan is at a special risk with its '983 glaciers and 2794 glacial lakes some of which have burst to produce deadly glacial lake floods' (Nayar, A., *Nature*, 2009, **461**, 1042). This grim assessment is based on research carried out over the last few years, triggering some effort in 'adaptation'. The resources for mitigating measures must presumably come from the Least Developed Countries Fund set up as a result of UN Climate Change talks in 2001. Difficult terrain is a major impediment in realizing technical solutions to minimize the effects of glacial floods. High resolution satellite imagery may be valuable in furthering studies of glaciers, but it is not clear whether the expenses for such

projects can always be met by the countries that may need the data the most. Are glaciers melting or not, elsewhere in the world? A recent study of Mount Kilimanjaro in Africa suggests that 'glacier loss on Kilimanjaro continues unabated' (Thompson, L. G. *et al.*, *Proc. Natl. Acad. Sci. USA*, 2009, online doi: 10.1073/pnas.0906029106). This analysis notes that 'of the ice cover present in 1912, 85% has disappeared and 26% of that present in 2000 is now gone'. Is this loss of ice cover directly related to global warming? The authors are cautious in drawing firm conclusions about the causes for the Kilimanjaro meltdown: 'Regardless of the contributions of various drivers, the ice fields atop Kilimanjaro will not endure if current conditions are sustained and adaptive action to minimize the potential impacts should be developed quickly'.

The build-up to Copenhagen in the most visible science journals has been impressive. Both *Nature* and *Science* have had special sections and several editorials and news reports. The positions of India and China are discussed in 'Opinion' pieces by R. K. Pachauri and Jiahua Pan, respectively (*Nature*, 2009, **461**, 1054 and 1055). Pachauri notes that sea level rises along the Bangladesh coastline and increasing frequency of cyclones 'could result in large numbers of migrants fleeing to India'. He adds: 'Equally serious are the problems associated with glaciers melting in the Hindu Khush region', arguing that this will lead to a 'decline in river flows' and consequently, water scarcity. Should these assessments be correct, we can anticipate a grim future. A National Action Plan on Climate Change (NAPCC) has been unveiled. It remains to be seen how plans translate into purposeful action and the extent to which economic development and mitigation measures can be balanced. The titles of the 'Opinion' pieces are a study in contrast. The article on India is entitled, 'India pushes for common responsibility', suggestive of a stand that we as a country may shoulder a significant burden. The Chinese piece is entitled 'China expects leadership from rich nations', suggesting that a greater price must be paid by those who have substantially contributed to the global climate problem, while developing at a rapid pace over the last century. The failure of the Kyoto Protocol to make a significant dent in global CO_2 emissions and the general air of pessimism about the outcome at Copenhagen have led to suggestions that it may be worthwhile to reexamine the Montreal Protocol model, which was successful in curbing the use of chemicals that depleted the ozone layer. It is twenty years since the Montreal agreements came into force. *Nature* notes editorially that there was an important difference at that time: '. . . the protocol was ready for signing just two years after the hole was discovered – in part because the threat was immediate, and because chemical alternatives to chlorofluorocarbons had already been developed' (*Nature*, 2009, **460**, 781). The situation with CO_2 emissions is dramatically different. There are no real, economically viable alternatives to fossil fuel and there are no readily applicable technologies for CO_2 sequestration. While energy research is a high priority it may take many years or even decades for 'clean' and 'sustainable' energy strategies to evolve into cost-effective technologies. Although the Montreal Protocol is advanced as a model for international cooperation, a pragmatic assessment may suggest that compliance was possible only because technological solutions were available. The recent special section in *Science* (2009, **325**, September 25) highlights many strategies for carbon capture and storage, all of which appear to be far from practical realization. Steven Chu's editorial appears wistful when he examines the ways in which CO_2 is produced, stored and used in the natural world. 'Can we enhance natural processes ("reforestation plus") or draw inspiration from nature for artificial capture? Similarly, nature provides proof that the energy penalty for releasing adsorbed CO_2 in post-combustion capture can be decreased: Through carbonic anhydrases our blood captures CO_2 created by cell metabolism and releases it in the lungs with no enthalpic energy penalty?' (*Science*, 2009, **325**, 1599).

Global warming and climate change issues appear to be addressable only by reducing the use of fossil fuel and cutting CO_2 emissions. While many scientific issues need to be resolved, including the extent to which doomsday scenarios are reliable, there is no doubt that energy usage must be both sustainable and 'clean'. In the absence of a clear alternative to fossil fuel, international negotiations seem to be the only way to secure global cooperation. For a country like India there are many pressures that need to be understood and neutralized. In an 'Opinion' piece in this issue (pp. 1414–1415), Dilip Ahuja rings the alarm bells. He draws attention to a well orchestrated campaign by the West to force India to accept policies which may not be entirely in the country's interest. His view must be read by all those who influence policy. He points out that high profile Western campaigners for climate change, 'whether in power or retired, come to Delhi wanting to talk to the Prime Minister on climate change. There is no real difference in the message between those from North America or the European Union'. His concerns about the comments of 'many analysts, both Western and of Indian origin' and the role of international NGOs and pliable media in undermining the Indian position merit attention. Copenhagen will soon be upon us. While the science of climate remains uncertain, it is a certainty that climate change negotiations will be contentious and controversial.

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