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EDITORIAL

The science of the earth

The United Nations has declared 2005 as the International Year of Physics, commemorating the passage of a century after Albert Einstein's miraculous year in 1905, when he produced insights which forever transformed physics. I had intended to begin the year reflecting on the unreasonable influence exercised by physics (and physicists) on the public perception of science globally, and in India in particular. I was standing in Chennai on 26 December, a typically calm and placid morning, when even this normally hot and humid city seemed cool and pleasant, thinking about a column on physics. I noticed some activity outside the building as people seemed to rush about in some excitement, but nothing really registered in my mind. A few minutes later everyone was talking about the tremors that had been experienced. The shock of the great Sumatra earthquake had been felt over two thousand kilometers away. But no one was prepared for what was to follow. A couple of hours later the sea rose across the Andamans and the Nicobar islands, the southeastern coast of India and across much of Sri Lanka, sweeping thousands of people to an instant death. In the days that followed, the loss of life across the affected regions of Asia climbed to a staggering 1,50,000, Indonesia being the hardest hit, followed by Sri Lanka. The word 'tsunami' had entered our vocabulary.

Tsunami is a Japanese word; in literal translation its meaning is given as a *wave in port* or a *harbour wave*, conveying little of the menace and ferocity that we have now come to associate with the waves of 26 December. Tsunamis have been widely studied and generally considered to be a phenomenon of great interest and concern in the Pacific Ocean. The Indian Ocean states have had little cause for worry until the recent disaster. Tsunamis can be triggered by major undersea earthquakes and by every count the Sumatra upheaval must rank as one of the great earthquakes of all time, some estimates placing it as high as 9.0 on the Richter scale. Once in motion, a tsunami can travel with surprising speed, up to 700 km/h, the wave height increasing as land approaches, even as the speed decreases. Tsunamis can be tracked, modelled, simulated and, in principle, a warning system can be put in place. In the aftermath of 26 December, a greater focus on tsunamis will undoubtedly become inevitable. It is of course debatable as to how quickly warning systems can be translated into administrative action on the ground, in evacuating those at the greatest risk. In poor and populous countries, the logistics of evacuations in the face of impending natural disasters, is formidable.

The tsunami tragedy has brought forth a remarkable public response in terms of relief efforts; a clear sign that in India the participation of non-governmental bodies is growing in strength. The reactions have been spontaneous and substantial. There have, of course, been the inevitable discussions. How much of the tragedy was avoidable? Would a warning system have been effective? Could quicker action have saved more lives? Are there purposeful strategies to mitigate natural hazards? In the many tutorials on tsunamis that have appeared, in the last fortnight, it is clear that the physics of tsunami waves is well understood. However, the prediction of earthquakes remains beyond the reach of modern geophysics and seismology. This is a factor that seems inadequately appreciated, as witnessed by the false alarms of new seismic disasters in the days after 26 December. Inevitably, there were unhappy moments for the government departments, which had difficulty in assessing warning data received from overseas institutions. The reactions in the days that followed the tsunami underscored a known fact; the coordination between ministries and science departments in Delhi is almost non-existent and any emergency exposes this unfortunate state of affairs.

In many ways the discussions that have begun resemble those that followed the Bhuj earthquake of 26 January 2001. The Prime Minister used the inauguration of the 92nd Indian Science Congress at Ahmedabad on 3 January 2005 to ask if 'the country could have made better use of science and technology to alleviate, if not prevent, human suffering'. In calling for a 'better understanding of the natural phenomena that led to such disasters and of human activities that aggravated them' he was indeed echoing sentiments expressed after each brush that we have with the forces of nature. As with Bhuj, the enormity of the Sumatra earthquake and the accompanying tsunami waves will fade quickly from public consciousness, as the world moves on. But these natural upheavals are a sharp reminder that the Earth and our environment are subjected to strains and pressures, which are sometimes relieved in cataclysmic fashion.

Understanding the science of the earth, oceans and atmosphere must of course be a high priority and the disciplines of physics, chemistry, biology and mathematics must contribute in substantial measure. However, at present the study of earth sciences in India is at its lowest ebb. Geology is a subject that is taught classically and traditionally in many places, dull, descriptive and untouched by the excitement of modern science. These courses have few takers, students coming towards the earth sciences only after many other options have been exhausted. While science courses in universities have been generally struggling, I suspect the plight of earth sciences is particularly poor. There are national laboratories that have a mandate to do research in earth and ocean sciences; the National Geophysical Research Institute (NGRI), Hyderabad and the National Institute of Oceanography (NIO), Goa, both constituents of the CSIR. There are also institutions of the Department of Ocean Development. But, a hard look at the output of research in earth sciences (and I use the term in its broadest sense to cover the atmosphere and the oceans) will undoubtedly reveal a published record that is limited both in terms of quality and quantity. Earth scientists contribute quite substantially to this journal and in my years at the editorial desk, I have developed some feeling for the issues they address. My, admittedly prejudiced, view would be that most often the work carried out does not seem in tune with mainstream activity of the international community of earth scientists.

The depressed situation of the earth sciences in India must be a matter of serious concern in circles which consider science and academic policy. The community has very limited presence in most major institutions. There are very few research groups that appear to be training a new generation of students in oceanography, geophysics, geochemistry or seismology. The quantum of hard scientific research that emerges from India in these areas is not commensurate with their importance to the surroundings. Much of the discussion in the area of atmospheric sciences and climate change seems driven by conference agendas and international pressures. Even in these areas there is limited effort at hard data collection and analysis. The softer option of discussing policy issues based on international data seems to be the preferred alternative. The earth sciences have suddenly become the meeting ground for a diverse array of interest groups – environmentalists, policy makers, climate change activists and a host of others who wish to influence global policies to their advantage. In this rather confused scenario it is necessary to have a generation of well informed, thoughtful earth scientists, who specialize in diverse technical issues. For this to happen a concerted attempt to revitalize some of our major earth science departments and also the starting of new and modern programs in some of our best institutions may be a step worth considering. India has benefited enormously from its investments in the Indian Space Research Organization. A similar commitment to earth science may pay rich dividends in the future. In considering the science of the earth my attention was drawn to a recent issue of *Nature* (23/30 December 2004), which reproduces comments on oceanography that appeared 50 years earlier: '… the change of emphasis in oceanography from exploration and survey to research directed towards the precise understanding of the basic physical and biological processes makes it necessary to devote more effort to theoretical and experimental work…. It would no doubt be wrong to suggest that oceanographers took up the subject because they found the mathematical and physical sciences too difficult and unattractive; but they have been rather slow in applying the precise techniques of these sciences to marine research…. To increase our knowledge the subject must be made attractive to men who do not mind facing up to the difficulties of fluid mechanics (*Nature*, 25 December 1954)'.

Nearly four years ago in the aftermath of Bhuj I wrote: '…modern earth science is a melting pot of disciplines; our own institutions are notably insular. At the level of basic research the earth sciences maintain a low profile. In the hierarchy of desirable professions, science itself ranks low; the earth sciences (and this may be a prejudiced view) appear to be even less sought after than sister disciplines' (*Current Science*, 2001, **80**, 317). Now in the aftermath of another major disaster, I can only say that nothing has changed for the better. The earth science scenario in India remains bleak.

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