

The Recent National Initiatives In Earth Science

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Abstract | This article describes briefly the background to the significant new national initiatives taken with regard to the earth sciences in India.

1. Introduction

The ability to forecast atmospheric parameters on time and space scales varying from hours to the whole season and from a kilometer to the whole globe, and to foresee possible large-scale climate changes over even longer time scales to a century or so (the 'seamless prediction problem'), is one of enormous national and international importance and poses great scientific challenges. Major fundamental problems still remain in forecasting monsoons, earthquakes, cyclone tracks and intensities etc. Nevertheless, advances may be expected in numerical modelling, observation systems, information dissemination, and regional or sub-regional decision support systems for farmers, as general progress in science and technology provides powerful new tools and techniques. It is now well known that the problem is not one that concerns only the atmosphere: both land and oceans exert a strong influence on the Indian monsoons, and indeed on weather/climate systems elsewhere in the world. The oceans surrounding India have not been sufficiently well explored yet, either from the view-point of their enormous resources or of their dynamics. Land and water remain primary resources for the large majority of the people of India — from the poorest to the richest. Earthquakes in the country and its neighbourhood can not only result in severe natural disasters, but even those that occur far away can have terrible consequences, as we saw in the tsunami of 2004. It has become increasingly clear from the scientific work carried out in various parts of the world that land, ocean, atmosphere and the biosphere are strongly coupled to each other.

Furthermore, because of the increasing pressure on global resources and the possibility of global climate change, it is being widely appreciated that the 21st century is likely to be dominated by concerns over water, climate change, environment, land use, ocean resources, the biosphere and other related issues. It is therefore essential to take an integrated view of the earth system as a whole in order to be able to provide the best services that modern science and technology can offer to the people of the nation. The sciences associated with the earth system still face many unsolved fundamental problems of great scientific, social, economic and strategic importance.

2. Some History

It has been clear for sometime that the organization of research and practice in these sciences in India was too fragmented to permit significant cross-disciplinary work that tackling the problems of the kind mentioned above demand. Indeed, before 2006, the Indian effort in earth sciences was scattered among many different government departments and agencies. To list the major ones, the India Meteorological Department (IMD), established in 1875, was a subsidiary unit of various departments in its history; most recently it was with the Department of Science and Technology (DST) till 2006. Seismological observations in India began in the late 19th century. In 1948 IMD planned a programme in geophysics leading to the establishment of a Seismological Division. Magnetic observations started in 1840 and eventually led in 1971 to the establishment of the Indian Institute of Geomagnetism (also a unit of IMD) at Bombay.

A separate Department of Ocean Development was established in 1981. The Geological Survey of India (GSI, established in 1851) is in the Department of Mines. The Survey of India (SoI), established in 1767, is the oldest scientific agency of the Government of India, and is now a part of DST. The National Geophysical Research Institute and the National Institute of Oceanography are part of the CSIR system, as are the Centre for Mathematical Modelling and Computer Simulation, and the National Aerospace Laboratories. The Department of Environment and Forests is the official representative of India in international climate negotiations. And so on. These institutions were set up and grew in an age when distributed expertise was easier to build up, and the inter-connections among the different disciplines were not appreciated.

Many of these agencies, set up during the 18th and 19th centuries, did pioneering work, sometimes ahead of the rest of the world. Its early British leaders, such as Lambert and George Everest of SoI, Thomas Oldham of the GSI and Blanford and Gilbert Walker of IMD brought to bear, on the earth science problems of the to-them unfamiliar Indian subcontinent, the experience and knowledge that had developed as part of the scientific and industrial revolutions in Europe. The question that we need to ask ourselves is how these proud traditions can be harnessed to make earth science in India develop into a creative endeavour that is at the same time sensitive to the needs of all the people of this country. In the conditions prevailing in the 21st century, earth system science is increasingly becoming an exciting as well as crucially important area — for understanding the planet we inhabit, as also for finding solutions to the serious problems that have emerged during the last few decades.

But it is not only the fragmentation of the Government agencies in earth sciences that has been responsible for the many sources of dissatisfaction on the state of earth science in the country, but also (till very recently) the conspicuous absence of the higher academic institutions with strong programmes in even one branch of earth science. (There have of course been a few pioneering programmes like the ones at the Roorkee College of Engineering (now IIT Roorkee) started in the mid 19th century, and the efforts in Andhra, Banaras, Mysore and other universities to study meteorology or geology.) What has in recent years come to be called 'Earth System Science' attempts to take an integrated view of the earth system as a whole: atmosphere, land, oceans, the biosphere, hydrology and ecology. It is basically a physico-chemical science whose recent development has been greatly

assisted by computer and space technologies, among many others. Earth system science is emerging as a major new subject that will play a dominant role in the 21st century.

If I may be permitted to reminisce about the beginnings at the Indian Institute of Science, I recall discussions with Prof S. Dhawan, in the late 1960s and early 70s, trying to persuade him that it was extraordinary that virtually nothing was being done in the higher institutes of learning in India on such an important and fascinating problem as the monsoon: surely (I suggested) it is the most important fluid dynamical problem facing the country. These arguments seem to have made an impression on him, and he repeated them at various times. Finally he agreed to appoint one meteorologist on the faculty provided the people who were arguing for it would agree to host the person in one their departments. This was how Prof M. Sankar Rao joined the Department of Aeronautical Engineering in the early 70s. Prof Sulochana Gadgil similarly joined the Centre for Theoretical Studies around the same time. The group of interested scientists slowly grew till it became the Centre for Atmospheric (and now Oceanic) Sciences.

I also recall that Prof. B. S. Ramakrishna, then at the Department of Electrical Communication Engineering, and I made a proposal to the Review Committee chaired by the late Prof T. S. Seshadri, urging that the Institute should take a major initiative in earth science. The Committee was sympathetic but I think that it did not consider it a matter of great priority.

3. The 1976 and 2002 Reviews of IMD

About a century after IMD was established there was national concern about whether its general structure and administration were in tune with the greater demands being made on it by the country, and with the advances that had meanwhile taken place in the science and practice of meteorology. A committee under the chairmanship of the late Dr. Raja Ramanna, well-known nuclear scientist, was set up in 1976 to consider the issue. The many recommendations made by the Committee included one which proposed a Council of Meteorology and Earth Sciences, recognizing the need for interaction among government agencies and academic and research institutions involved in different branches of earth science. While many of the recommendations were accepted (including one that two centres of atmospheric sciences be set up in the country), Government's final decision was in favour of a Council of Meteorology and Allied Sciences.

A second review committee under the chairmanship of Dr. K. Kasturirangan, well-known space scientist and former chairman of ISRO, also considered the issue of a new structure that integrates oceanic and atmospheric services (as in NOAA in the US). Although the Committee considered that this would be in the best interests of the country in the long term, it made no recommendation as it was outside its terms of reference.

4. The New Initiative

In light of these discussions it is gratifying that, thanks to the efforts of the Scientific Advisory Council (SAC) to Prime Minister Manmohan Singh, chaired by Prof. C. N. R. Rao, the Government undertook a major restructuring of a considerable part of the earth science activity in India, following a report submitted by SAC in 2005. The recommendations of the report were largely accepted by the Government of India, although the integration was limited to the atmosphere and the oceans, with seismology and geomagnetism added. During the period July 2006 to January 2007 Government established three new but inter-related entities: a ministry of earth sciences, a department of earth sciences and an earth commission. This undoubtedly represented a historic step in restructuring a science that is now becoming more central to the future of this planet.

After it was first mooted in SAC, discussions were held with many distinguished scientists in the country about the proposal. The Atomic Energy and Space Commissions had demonstrated that a certain kind of organization that was in the nature of a mission agency, with substantial empowerment of an eminent scientist as head of the agency, could be an effective model in India. The head of the agency was at one and the same time both the administrative secretary of the Department and the Chairman of the policy-making Commission — in some cases also the Chairman of an executive arm, like the Indian Space Research Organisation in the case of space. The proposal made by SAC had this model in mind when it was submitted to the Government

The new structure was intended to focus on providing the nation with the best possible services in the following areas.

- Offering extensive data resources and setting up appropriate decision support systems to serve the interests of the common man whose primary resources are land and water,
- Supporting agriculture-related and all other industrial and scientific activities (including aviation, engineering industry, water resources, aquaculture etc.) through authentic, adequately processed earth system data of various kinds, made accessible to scientists and the general public much more liberally than at present,
- Working closely with other agencies, both public and private, to provide them with S&T support and to assist in ensuring adequate preparedness for handling natural disasters and managing their consequences, and
- Supporting well-coordinated national and international programmes of research and development in earth system science, and enlarging the national human resource base through special funding and other promotional programmes for academic institutions.

When it was finally implemented the Government basically decided to replace the Department of Ocean Development by the Department of Earth Sciences. This had the big administrative advantage that no additional special department needed to be set up: the organization now in place covers atmospheric science, ocean science and technology and certain parts of the science of the solid earth such as seismology. However GSI continues with the Department of Mines, and SoI with the Department of Science and Technology. The chief reason for doing this appears to have been the consideration that the new Ministry should not, in its initial phase, be burdened with a gigantic increase in its size, as the problems of reorganization may become so overwhelming that they would keep it preoccupied at the expense of attention to pressing scientific problems.

The fact that the sciences of the solid earth have not been included in a Ministry of Earth Sciences has attracted dissatisfaction and criticism from some geologists and geophysicists. It is to be hoped that as DES settles down to a body that has successfully integrated atmospheric and oceanic programmes in the country, it will be in a better position to turn its attention to at least some of the many branches of solid earth science that are necessary to understand the earth system.

A similar issue concerns water. There is no doubt that water is one of the most important areas of concern in India, and one fraught with many problems. The Central Ground Water Board and the problems of hydrology (and to a certain extent ecology) would seem to be natural additions to the province of DES.

The restructuring of the met-ocean programmes has already helped in many ways: more advanced facilities are being set up, the Indian Institute of Tropical Meteorology is seeing a substantial expansion, numerical modelling is more widely studied and practised, IMD has much modern equipment, and so on. Nevertheless there is still much to be done. For example the Earth Commission, intended to oversee MoES 'with full executive and financial powers modeled on the lines of the Atomic Energy Commission and the Space Commission', according to a Government Resolution of 9 January 2007, has not fulfilled those expectations. Administrative integration does not automatically lead to really interesting earth *system* science, of which there are still not many examples. Here I think the lead should come from academic institutions.

However one of the heartening features of this new initiative of the Government of India is a certain resurgence of interest in earth sciences in Indian academia. Surely IISc is at the forefront with a minor boom in earth science studies on the campus, and the establishment of the Division of Earth and Environmental Sciences as the sixth scientific division of the Institute. CAOS is now joined by the Centre for Earth Sciences, the Divecha Centre for Climate Change, the Department of Civil Engineering, two centres in sustainability science and technology and others in the new Division. This can be a powerful combination leading to a new movement in education and research in the country. Many IITs are also taking the initiative to set up new earth science centres.

5. A Vision for the Future

It seems clear that the earth sciences are bound to emerge as a major S&T enterprise worldwide. It is therefore a strong candidate for a visionary programme for the 21st century, as atomic energy and space became in the 1950s and 60s, and the life sciences and computer technology more recently.

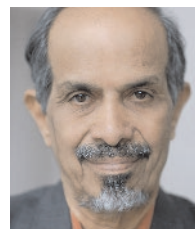
A vision for the future of earth science in India should include at least two elements. First, it should provide first rate services for the common man based on the best S&T (as communication

has done, for example). Secondly, India should aim to be leaders in earth science, especially in everything that concerns the tropics — after all we are the largest tropical economy in the world as also the most advanced in science and technology. India has several advantages: the longest reliable climatological records in the tropics, some centres of excellence in education, research and development; a vigorous and effective programme in satellite technology; strong programmes of sponsored research and field programmes particularly in atmospheric and oceanic sciences; and a proud legacy going back to the 18th and 19th centuries. We need a modern, vibrant earth science programme that is at one and the same time driven by and coupled to the national developmental effort and internationally competitive research and science. As we globalize, can we at the same time recover that sense of wonder that the first poets of this ancient and ever-fascinating land had about our mountains and rivers and rain and cloud, and similarly the European observers who, equipped with the fruits of the scientific and industrial revolutions, set up our first scientific agencies and took the first steps in understanding the new science of this part of the world?

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