Building science society

The editorial on Winds of Change[1] rightly highlighted our ability to make a mess of opportunities. Areas like sports need remarkable skills coupled with perseverance. Due to lack of the latter, we missed many chances in winning games. Science demands right temper and patience. Emergence of China and Korea as competent science powers in the world puts additional burden on India, since we boast of heritage rather than ground reality. A projected optimism through a silent scientific repatriation is still a far cry. Sleeping giant China and to some extent Korea are happening countries in the East, since their marketing strategies are timely and have left many countries behind. Science can only be good or bad; mere scientometrics should not be used to measure success in science[2]. No doubt, establishment of National Science and Engineering Research Foundation (NSERF) augurs well for committed scientists, but political and economic compulsions may drive us to 'compulsive opportunism'. This pessimism may prove to be wrong if the current euphoria is considered. Winds of change are visible in every sphere of life and science is no exception. It has been demonstrated time and again that we do well in initial phases followed by spurts of abysmal agony. Availability of ample funds will help to purchase sophisticated instruments, but may not be visible in terms of good research[3].

Global trends influence participating player's game plan. Who wins is a mute question to answer! Tussle between university academicians and managers of National Institutes in controlling science in India may not reflect an encouraging outcome, as witnessed by the establishment of many National Academies. Even patriotic fervour of 1940 and 1950s had not helped our peers to reach a consensus on scientific resolutions. The system we live in is too fragmented, and to visualize a competent management of the proposed Science Foundation may prove to be a mirage. Change which occurs constantly reminds us of our past mistakes. Happenings of 21st century are bound to shape our destiny. What is foremost at present is to change mindset to develop a scientific society. Before venturing to make a mess of an idea, we should remember that we are known mostly as idol worshippers, rather than of an idea or ideal!

1. Balaram, P., *Curr. Sci.*, 2005, **88**, 1711–1712.
2. Sahni, A., *Curr. Sci.*, 2004, **87**, 851.
3. Unnikrishnan, M. K., *Curr. Sci.*, 2004, **87**, 1493–1494.

A. RAJANIKANTH

Birbal Sahni Institute of Palaeobotany,
53 University Road,
Lucknow 226 007, India
e-mail: annamraju_2000@yahoo.com

How emerging technologies can create jobs and advance the frontiers of geoscience

The history of science is replete with examples whereby advances in scientific theories led to technological developments, and the technological developments in their turn, have facilitated the investigation of new dimensions of nature. Thanks to GPS technologies, it is now possible to measure terrestrial movements precisely, such as the movement of Andaman–Nicobar Islands after the megathrust earthquake of 26 December 2004. As stated by McNutt (mcnutt@mbari.org), new technologies in the form of new platforms, sensors, control systems and data management systems, are enabling us to make *in situ* measurements of the earth processes as they happen, and sample hitherto inaccessible environments safely, accurately, quickly and affordably.

It is only through synergy between the earth (including the atmospheric and oceanic realms), space and information sciences that it is possible to address the complex issues involved in the management of the natural resources, and create jobs in the process. Satellite remote sensing has emerged as a powerful and cost-effective tool covering all aspects of natural resources management. The launching of dedicated satellite systems and platforms, development of new retrieval algorithms for remote sensing data and formatting them for ingestion into GIS packages, etc. have made application of several remote sensing data products commercially viable. The applications include water resources management (e.g. spaceborne precipitation estimates, surface water inventories, monitoring of fresh water from space, ecosystem dependence on water, groundwater mapping, airborne salinity mapping, mapping of snow and ice cover, irrigation management, monitoring of water rights, water clarity mapping, etc.), agriculture, forestry, wasteland reclamation, climate prediction, environmental mapping, disaster management, etc.

India would need an army of geotechnicians to prepare high-resolution DEMs (Digital Elevation Models) from Cartosat I data, and use them for a variety of socio-economic requirements of the clients, such as water resources management, design of transport networks, and housing colonies, urban planning, tourism, disaster preparedness systems, etc.

Marine microbes play a vital role in the oceanic biogeochemical cycles. The traditional practice has been to collect discrete samples and study the identification gene and gene products of the microbes in the laboratory. Sensing systems have been developed to detect water-borne micro-organisms remotely, in subsurface, in real time. Similarly, software has been developed for the identification of organisms in underwater videos by pattern recognition techniques, which makes it possible to detect and classify organisms at various depths continuously, without the necessity of taking discrete samples. Precision seafloor mapping to monitor the changing morphology of dynamic systems, such as submarine canyons and active slumps can now be undertaken autonomously.

To take advantage of the advances in grid computing and grid storage technologies, Orcutt (jorcutt@ucsd.edu) advocates the establishment of a broad, scientific, multipurpose system, to cover natural resources management and hazard warning and mitigation, on a global scale, on the lines of the not-for-profit National Lambda Rail system that is used in major cyberinfrastructure projects.

'Around the shores of the Indian Ocean, 300,000 people are dead today because the world's governments have not grasped the need to use our understanding of the Earth more effectively. Earth scientists are concerned that their knowledge of the Earth, which could save lives and livelihoods, is underused.' (preamble of the brochure of the project, Planetearth – Earth Sciences for Society). At the instance of IUGS and UNESCO, UN is about to proclaim 'The International Year of the Planet Earth'. The Science programme and the Outreach programme of Planet Earth are based on eight socially-relevant, multidisciplinary themes: groundwater, hazards, health, climate, resources, deep earth, ocean and megacities. Earth science institutions in India could participate in the programme by making proposals (see www.esfs.org for details).

A new international programme called The Electronic Geophysical Year (eGY), 2007–2008, on the lines of the International Geophysical Year, 1957, has been launched at the time of the Joint Assembly, New Orleans, USA. We are on the threshold of a new revolution in our standing of the Earth and geospace. This has been made possible by the dramatic increase in the number of observation networks on the ground, in the oceans, in the atmosphere, and in space, and advances in digital communications and information management methodologies. eGY seeks to promote multidisciplinary research through establishment of virtual observatories that will allow diverse data from several places to be combined through a single portal. Teachers in the geoscience departments in India could get connected to these virtual laboratories for getting instructional materials, virtual seminars, computer-based animations and interactive simulations, student assessments, etc.

The only way for the geoscience departments in India to get over the inadequacies in quality of the faculty, library and laboratory facilities, is to go in for interactive instruction through being linked to virtual facilities, as mentioned above. Time was when it was adequate for a geology student to have a hammer, hand lens and clinometer-compass. Now, additionally, every geoscience student needs to have access to a computer with Internet connection.

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U. ASWATHANARAYANA

Mahadevan International Centre for Water Resources Management, Hyderabad 500 033, India
e-mail: uaswathanarayana@yahoo.com

Early warning of natural hazards using satellite remote sensing

In the last one decade, numerous satellites with multi-sensor operational capability in the broad electromagnetic spectrum (visible, infra-red and microwave) were launched by NASA, ESA, CNES, ISRO, Brazil and Chinese space agencies and a few private industries. These multi-sensor satellites have capability of monitoring land, ocean, atmosphere and ionosphere globally during day and night and also during cloudy and clear sky conditions. The recent information[1] on Global Earth Observation Systems (GEOSS) gives a hope to the scientific community for better capability for monitoring land, ocean and atmosphere at higher spatial and temporal resolutions in the next 20 years. In the last decade, multi-sensor satellite data have shown a great potential in monitoring and mapping damages caused by various types of natural hazards (earthquakes, landslides, floods, volcanoes, cyclone/hurricanes, harmful algal blooms, water quality, oil spills, dust storms, droughts, etc.). Recently, on 20 October 2004, UN Outer Space Commission in its General Assembly of the UNISPACE III proposed a possibility of creating an international entity (Disaster Management International Space Coordination – DMISCO) to provide coordination for and optimizing the effectiveness of space-based services for use in disaster management.

MAGSAT satellite launched by NASA operated since 1979/80 and has provided data related to variations in the magnetic field for the past 20 years. These data have been useful in deducing internal structure of the earth down to length scales that was previously inaccessible. With the recent launch of the Danish Oersted satellite, 20 years after the 1979/80 MAGSAT, two data sets at two different epochs are now available and are being used to construct high-degree spherical harmonic models of the geomagnetic field. These two (Oersted and Magsat) satellite data have provided small-scale structure of the geodynamo and understanding of the geodynamo model.

Following the success of MAGSAT and Oersted missions, efforts are being made for the early warning of natural hazards using satellite remote sensing data. Among all natural hazards, earthquakes are one of the most devastating ones. Over several decades, efforts have been made to study precursors on the ground to predict an earthquake. Efforts are also being made by scientists to monitor geological plate motion and to use such information to estimate stress accumulations in various regions.

Scientists have also found great potential of INSAR in monitoring surface deformation due to volcanoes, landslides, subsidence, mass movements in earthquake, and rockslide prone regions. The satellite and airborne remote sensing data have shown a great potential in damage assessment after various catastrophes. Efforts are also being made to get early warning information about an impending earthquake using numerous types of remote sensing data. Seismo-electromagnetic studies have been made over a few decades and ionospheric anomalies associated with earthquakes have been investigated[2] since 1980. Soon after the Gujarat earthquake (26 January 2001), various land, ocean and ionospheric anomalies associated with the earthquake were found[3,4].

Seismologists and solid earth scientists have strong reservations about the precursors being observed from satellites-remote sensing data, since they do not find existing theoretical models to explain satel-