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GUEST EDITORIAL

Earth Sciences for societal and economic benefits

Established in 2006, the Ministry of Earth Sciences (MoES), Government of India holistically addresses all the five components of the earth system, viz. atmosphere, hydrosphere, cryosphere, lithosphere and biosphere and their complex interactions to provide services for weather, climate, ocean, coasts, hydrology, seismology and natural hazards; to explore and exploit marine living and non-living resources in a sustainable manner, and to explore the three polar regions (Arctic, Antarctic and the Himalaya).

Over the past decade, the quality of services provided by the Ministry has substantially improved due to systematic efforts to augment observations, develop adequate modelling strategy, conduct cutting-edge research and invest in human resource development. The services provided by the Ministry are being effectively used by different agencies, stakeholders and governments at all levels – state, district, city, for social and economic benefits, including saving of human lives and minimizing damages to life and property due to natural disasters.

At present, weather forecasts have a good skill for about 4–5 days. There is a need to push the present skill beyond this to meet the requirements of users. Quantitative precipitation forecast is an essential component for decision making for water resource management and flood forecasting. However, prediction models are known to have large errors in predicting the quantum of rainfall, especially higher amounts. Problems exist in predicting tropical cyclone intensity, heavy rainfall associated with its landfall and tracks of recurving cyclones. There is a great challenge in predicting increasing number of severe weather events like heavy rainfall and associated flash/urban floods, severe convective storms and heat waves. There is also scope for further improving skill of monsoon forecasts both on extended range and seasonal timescales to help different sectors like agriculture contribute better to society and the economy.

The observational network with India Meteorological Department is to be augmented further to improve the accuracy of weather forecasts. Ideally, an atmospheric observational network at 25×25 km grid and upper air observations at 100×100 km, complemented by multi-platform satellite and aircraft-based profiler observations, Doppler radars, wind profilers, radiometers, lightning detectors, and lidars are required.

Since users, especially farmers, require weather forecasts at block level, an advanced weather prediction system with high resolution (12 km) global model will be implemented soon. The present district-level advisories for farmers will be extended to block level and disseminated through 660 district centres, which will be set up by 2019.

The Ministry will implement a new modelling and observational strategy for generating probabilistic forecasts for severe weather events more accurately with ample lead time for effective disaster management. Further, research will be initiated on monsoon variability, especially its linkage to the Indian Ocean/polar regions and to improve prediction on extended to seasonal timescales. This will need improvement of current coupled climate models, especially their fidelity in correctly simulating the Indian Ocean linkages. To meet the requirements of climate change assessments, it is planned to develop an advanced earth system model for regional climate change scenarios.

Other future initiatives proposed are strengthening of the present climate services for various societal applications in areas such as agriculture, water resources, health and energy, development of research testbeds and climate reference stations and process studies, services for renewable energy sector, initiation of an urban meteorology programme, and study of regional hydrological cycle, including development of flood-warning systems for major river basins.

Considerable progress has been made in providing useful ocean services during the last decade. However, there are several new challenges to tackle for the oceanographic community in the country. The large population of India, living along 7516 km of its coastline is exposed to several hazards from the oceans, which need to be addressed.

Planned dense ocean observations and high-resolution ocean models are urgently required over the Indian Ocean to meet the challenges in providing improved ocean services to the nation. For strengthening the on-going ocean services, the present ocean observing system should be sustained and expanded by including robotic observing systems. The data buoy system will be further strengthened with newer platforms and more specific sensors. Further, experiments such as observation system evaluation and observation system simulation experiments are required for planning optimal observational networks/programmes.

The present-day ocean models with finer horizontal and vertical resolution are adequate to simulate most of the variability and processes in the oceans. However, accurate simulation of abrupt changes in ocean parameters due to less understood processes and extreme events is yet to be achieved. The present ocean services will also be extended to cater to the needs of different regions.

In view of the importance of coastal processes, a Centre of Excellence for Coastal Research is envisaged. Other projects being planned are to develop beach tourism, specific forecast products and ocean biogeographic information system and census of marine life. Since the Indian Ocean is warming at a higher rate than other oceans, substantial efforts are required to understand the causes of rapid warming and its impact on monsoon variability and sea level.

India with approximately 3.2 million sq. km exclusive economic zone has a vast potential of living and non-living resources, which can substantially contribute to the economic development of the country and enhance societal benefits. Societal and economic benefits that could accrue from ocean based resources are energy (both non-renewable and renewable), water, minerals, food and other living resources. Survey and exploration of minerals, renewable/non-renewable energy resources and technology development for extraction of the above are the key areas where the efforts are being directed.

As India's economy grows, it is necessary to contribute to global blue economy by active participation in generating renewable energy from the oceans, resource utilization and protection, while keeping sustainability as a key issue. The Ministry has been carrying out ocean technology development activities for the last two decades and now proposes to develop a national strategy for the next 15 years to ensure reasonable returns on the investments in ocean research, exploration and all marine operations.

Major projects envisaged during the next 15 years to boost blue economy are development of relevant technology for utilization of living and non-living resources like water, energy, minerals, etc. low temperature thermal desalination (LTTD) plants in thermal power stations, self-powered LTTD-based desalination plants using ocean thermal energy conversion in islands, offshore wind platforms, extraction of biofuel from micro-algae, large-scale cage culturing, manganese nodule mining system development, exploration of sulphides, and autonomous coring systems are planned to be taken up.

It is also envisaged to develop various types of underwater vehicles, including manned submersibles, procure new ships, set up a sea-front facility at Nellore in Andhra Pradesh, establish a model fishing harbour, and develop environmental-friendly coastal protection, to name a few other initiatives that have been proposed. A Centre for Deep Sea Research is also on the anvil. Marine biota being diverse has good potential for its utilization in many technological activities. Marine biotechnology should make an important contribution to economic benefits. Efforts are being made in the areas of deep-sea microbial isolation for medicine, marine algal technology for energy and offshore cage culture for food. Other research initiatives are studies on zooplankton, coastal pelagic species, harmful algal blooms and ornamental fish culture. Studies on coastal erosion, multi-hazard coastal vulnerability mapping and monitoring of water quality will also be taken up.

Variability in polar environment has a large global impact. The changes in ice cover, snow, etc. have a perceptible influence on global water cycle. The climate anomalies generated in the polar regions and their surrounding oceans may also influence the low latitudes, including the Indian monsoon by modification of ocean and atmospheric dynamics. The ice beneath the surface holds important clues to the past climate and its variability. Polar regions are the least studied components of the earth system due to the paucity of observations, remoteness and extremely challenging field conditions.

Among the large number questions identified, temporal changes in the extent of sea ice and their influence on atmospheric and oceanic circulation is a prime area of knowledge gap. We need to understand and document these changes and examine their possible effects on Indian climate using observations and models. The on-going scientific activities at Antarctic, Arctic and the Himalaya will therefore be further strengthened. To investigate the dynamics of the Himalayan glaciers, a research station – 'Himansh' – was recently established, and a few more stations are to follow.

Occurrence of earthquakes in different parts of India and its adjoining regions, and their impact on the society have posed a challenging task to the Indian seismological community. State-of-the-art techniques in the geosciences have been used to identify regions of high seismic potential and investigate the principal causes of earthquakes. Seismic hazard microzonation maps for a few cities have been generated to identify the areas of large damage in case of any earthquake.

For monitoring the seismic activity accurately, it is important to augment the observational network of seismic observations. The project is being implemented in two phases to cover a total of 114 stations. It is proposed to develop a decision support system for earthquakes by augmenting the seismological network optimally over the country and in the neighbourhood, so that earthquakes of magnitude 3.0 and above are detected with improved accuracy of location and dissemination of details within 5 min of occurrence. Research projects will be initiated to understand earthquake precursors and processes using observations and modelling.

To implement these proposed activities successfully, both additional funding and trained manpower are required. Investment in earth science services will reap more financial benefits in many sectors in addition to saving thousands of lives.

Through the implementation of this vision, MoES dedicates itself for high-quality services for the societal and economic benefits of the country.

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