Earth Observation: Gaps and Trends

India regularly witnesses devastating natural disasters that cause great human suffering and economic loss. The east and west coasts are affected by severe cyclones. In the Himalayan area, more than 650 earthquakes of a magnitude exceeding 5 have taken place over the past hundred years. The Himalayas, particularly the hilly tracts, are also vulnerable to landslides. The Rivers Ganges and Brahmaputra regularly flood the plains of north-east India, through which 60% of the country's river water flows. Not only is the sudden presence of abundant water a threat, but lack of water too; 68% of sown area is prone to drought. There are also recurrent forest fires that harm the vegetation dynamics of ecosystems, affecting tropical structure and contributing to an increase of greenhouse gases in the air.

Early-warning strategies may reduce risk. Earth observation from space (EO) can help to detect precursors of disaster, but EO also assists in monitoring the disaster area during relief and rescue efforts. Such imagery provides comprehensive real-time coverage of large areas at frequent intervals. Indeed, EO has proved of vital importance for disaster management. Today EO can provide high temporal, spatial and spectral resolution, stereo-mapping facilities and weather-independent capture (SAR), but not by the same satellite at a time. For example, the imagery from INSAT VHRR/CCD, METEOSAT and NOAA AVHRR have coarse spatial resolution but high temporal resolution. The Indian Remote Sensing Satellites, which are polar orbiting, have high spatial resolution but low temporal and spectral resolution.

Monitoring highly dynamic events in areas of limited extent, such as earthquake, landslide and cyclone, requires images of high spatial resolution captured on a daily basis. But individual systems with such characteristics are non-existent today. In contrast, events that change gradually over time, such as drought and land degradation, are easy to capture by today's EO systems. Any region on earth should be captured at least once per day at a high level of detail to enable quick response to highly dynamic disasters. Many tropical regions experience frequent cloud cover depending upon time of day, and the satellites providing high-level detail have optical sensors which are weather dependent and image at the same local time of day. Another limitation is that present EO satellites have been designed to meet many applications; the instruments are general-purpose and not tailored to suit disaster management.

A constellation of satellites operating in tandem, combining high spatial, temporal and spectral resolution, all-weather capacity (radar) and stereo-mapping abilities is needed to serve the needs of decision-makers before, during and after disaster. To achieve this countries are increasingly co-operating; an example is the Disaster Monitoring Constellation (DMC) formed through an international partnership involving Algeria, China, Nigeria, Turkey, UK, Thailand and Vietnam. The DMC satellites can operate alone or in tandem.

The concept of 'autonomous spacecraft and event-driven observation' is currently evolving. Integrated technologies onboard a satellite are able to detect and assess dynamic events autonomously and respond by directing sensors towards the area, processing the data onboard and disseminating the information to decision makers. This concept of intelligent and autonomous systems is exemplified by the US Navy Naval Earth Map Observer (NEMO), ESA's Project for On-Board Autonomy (PROBA), the EU Co-ordinated Constellation of User Defined Satellites (COCONUDS), and DLR's Bispectral InfraRed Detection (BIRD), DLR being the German Space Agency. The tendency is thus towards intelligent satellite systems able to integrate and process data from several onboard sensors and disseminate the results directly among emergency centres through high-speed network communications. The onboard systems will be able automatically to alter coverage area depending on the spatial progress of the hazard.

The success of EO in disaster management lies in harmonising EO characteristics of a great variety of current systems, such as spatial, spectral and temporal resolution, efficient data acquisition turnaround time, and development of standardised data products to properly serve decision makers. The feedback from users should trigger the development of appropriate EO products and services. With the above framework of needs and technological developments the Department of Space Govt. of India has launched a major programme for providing EO input for disaster-management support.

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