NATIONAL SYSTEM FOR DISASTER MANAGEMENT

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ABSTRACT

Most part of the Indian landmass is prone to several natural disasters, with the East and West coasts being affected by severe cyclones, major river systems such as Ganges, Brahmaputra by large-scale flooding and the hilly tracts of Himalayas by major landslides. An ideal Disaster Management System needs to support the activities related to preparedness, prediction, damage assessment and rehabilitation. In recent years, the focus of disaster management community is increasingly moving on to more effective utilization of emerging technologies such as remote sensing, Geographic Information System, and Satellite Communication, enabling to prepare for and mitigate potential impacts. Several critical inputs are required in order to take preventive measures through vulnerability analysis, hazard zonation and prior risk assessment at regional and local levels and timely and reliable weather forecasts and advance warnings of severe weather to minimize loss of life and damage and facilitate timely and effective rescue, relief and rehabilitation of the affected population.

Under the existing framework in the country, the responsibility of undertaking rescue, relief and rehabilitation measures rests with the concerned State Government. The Central Government provides financial and logistic support in the event of major disasters. A Crisis Management Committee in the State with senior representatives from the Government departments and Central agencies located in the State oversees the disaster management actions. At the district level, District Plans are prepared in advance for implementation during a crisis with adequate powers for decision-making. A Calamity Relief Fund at the national level provides additional funds required for various actions.

The Central Relief Commissioner in the Ministry of Home Affairs is the focal point at national level and coordinates appropriate dissemination of warnings received from India Meteorological Department, Central Water Commissioner etc. and adequate financial support.

Based on critical assessment of the current system and technological advances, several new initiatives have been taken up and a paradigm shift in disaster management, emphasizing mitigation, prevention and preparedness has occurred. A roadmap has been drawn up drawing upon the strength of technology inputs and resilience building in communities. Institutionally, separate Disaster Management Authority is being set up in the States. At the national level, a National Emergency Management Agency (NEMA) is being established to coordinate all aspects of disaster management effectively.

Several actions have been initiated towards disaster mitigation. A Core Group on Earthquake Mitigation has been constituted with experts to prepare an action plan for implementation. States falling in high seismic zones (III, IV and V) have been advised to

change the bylaws incorporating essential building codes. Specific training programmes are planned for in-service engineers on seismically safe construction techniques. Stress is being given for non-engineering construction in rural areas to make them earthquake-proof. A project has been initiated for 38 cities falling in the high seismicity zones to prepare disaster management plan using appropriate technology, train personnel on relief/rescue and initiate mitigation actions.

A national level Cyclone Monitoring and Mitigation Group has been set up to look into the protocols for cyclone warning and dissemination and appropriate mitigation measures. The mitigation includes construction of cyclone shelters, coastal shelter-belt plantation for storm surge reduction, strengthening of warning systems, training and awareness creation programmes.

The collaborative programme on Disaster Risk Management taken up with UNDP support covers 169 multi-hazard prone districts in the country and envisages assisting the States to draw up plans for district/block/village levels to build up effective resilience to disasters. Grass-root level participation in the disaster management actions is envisaged.

A national Communication Plan has been drawn up harnessing the modern systems of communication for information flow, dissemination of warnings etc. A web-based inventory of specialist resources required for disaster management support has been operationalised.

The National Institute for Disaster Management is entrusted with developing training capsules, disaster management codes, human resource development, awareness creation programmes and education. The overall stress is to make the disaster management programme in the country more effective with appropriate technology inputs and grass-root level participation.

SPACE RESOURCES, OPERATIONAL SERVICES AND FUTURE PLANS

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ABSTRACT

Considering the vast potentials of Space technology to provide critical services towards disaster management, Indian Space Research Organisation (ISRO) has been pursuing concerted efforts for appropriate technology development. ISRO with a well-knit space infrastructure comprising of INSAT and IRS series of satellites, is uniquely placed to provide services related to Disaster watch, Warning dissemination, Data collection, Monitoring and damage assessment, Vulnerability mapping, Communication support etc. A synergistic use of IRS and INSAT capabilities is planned to address several critical issues related to disaster management in the country.

Over the past decade, innovative use of communication and meteorological capability of INSAT system is being operationally used towards tracking, monitoring and prediction of cyclones. The recent achievements include inundation mapping of all the major floods in the country, drought severity assessment using satellite data on fortnightly/monthly time scales, landslide zonation of pilgrimage routes in Himalayas, monitoring of cyclones and damage assessment. The capability of Geographic Positioning System (GPS) to precisely determine the position of a location is being used to measure ground movements associated with plate tectonics.

ISRO has developed communication capabilities in mobile telephony, MSS reporting terminal and VSAT based communications, which are useful in providing emergency communication in disaster, affected areas. INSAT based locale-specific unattended Cyclone Warning Dissemination Systems (CWDS) installed along the vulnerable eastern and western coasts of the country, in 250 locations, have proven their immense value in providing timely warning on cyclones since the last 10 years. ISRO is also providing satellite-aided Search & Rescue services on an operational basis through participation in the COSPAS-SARSAT international programme, with a wide user base of Shipping, Airports Authority of India, Coast Guard, Defence (Army, Navy, Air force), Mountaineering expeditions.

ISRO has closely worked with the Central and State agencies to integrate and internalise the space data with conventional expertise and existing practices, through the phases of experimental demonstration, semi-operational and operational applications. To demonstrate the operational feasibility of space systems, pilot-scale study of Bramhaputra floods was taken up. The pilot project amply demonstrated the compatibility of space applications with conventional systems and enabled better quality of information in terms of spatial scale (upto village level using high resolution satellite data) and temporal scale (turn-around-time of few hours).

A prototype Disaster Management Support has been conceived based on synthesis of appropriate GIS database, high-resolution remote sensing imaging, modelling framework, networking and multi-agency interfaces. The inadequacies in the current syatem could be

assessed in terms of reliable and timely information of disaster affected area, hazard zonation, inadequate communication support and lack of multi-agency interface.

ISRO has proposed an innovative disaster management support mechanism through establishing a Decision Support Centre (DSC). The DSC will encompasses several capacity building measures viz., organizing the infrastructure for the real time and the conjunctive use of aerial and satellite services, supportive R & D efforts and interfacing with National/State disaster management systems. The important components of the Decision Support Centre (DSC) of ISRO will include:

Satellite/aerial data acquisition strategy
Turn-around-time for data analysis and output generation
User required information and formats
Dissemination to users and networking
Support facilities such as digital database, hazard zonation, modelling, query-shell etc.

The main objective of this service is to provide timely information meeting the user needs in terms of information content, turn-around-time and format. Such information will be disseminated to the State and Central User agencies. The DSC aims at networking the knowledge based institutions for effective use of the ground observations and data in conjunction with Space data, to derive updated information on disaster events and provide decision support. DSC will be expected to evolve as single-window information service provider, with a long-term vision of diffusion and internalization of Space applications in various facets of disaster management.

Under the Disaster Management Support Programme of ISRO it is proposed to network the National and State Emergency Operations Centres to the DSC and also link to the Emergency Resource Centres being set up in the multi-hazard prone districts in the country. The DSC will also be linked to the knowledge centres namely India Meteorological Department, Central Water Commission, National Informatics Centre etc. towards exchange of vital data and forecasts during disaster phase. A study team has been set up to assess the observation requirements for disaster management and work out a constellation of satellites and sensors to meet the same.

Remote Sensing applied to earthquake Hazards in India

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In roughly100 million years the Indian continent will have completely disappeared beneath the Tibetan plateau. The weight of the plateau currently depresses its northern edge a prodigious 20 km below sea level and causes a 450 m elastic bulge to rise some 2-300 km south of the Ganga plains in central India. This so-called "hidden range" first described by the Survey of India in the 1920's, results in a corresponding depression some 300 km to its south where the Indian plate dips 40 m into the mantle. This apparently insignificant depression with a NS wavelength of more than 500 km, almost doubles stresses in the upper part of the Indian plate. These increased stresses (near Latur), and their transfer to the base of the Indian plate near the the crest of the bulge (near Jabalpur) are the underlying physical reason for earthquakes in India.

Remote sensing methods have importance in confirming the precise geometry of this stress system. India streams sluggishly northward through flexural troughs and bulges generating slow strain changes that over millenia, which when combined with stress changes caused by erosion, deposition, topography, reservoir-construction or nearby earthquakes, cause local rupture of the Indian craton. Stresses cannot be sensed remotely but their resulting strain and elevation changes influence the development of topography, river networks and coastal erosion.

The gravity field over India provides a crucial constraint of India's flexural geometry. A recent intriguing hypothesis is that India's northward progress is weakly retarded prior to sequences of earthquakes in the Himalaya causing increased stress in the Indian craton. If such stress changes prevail they may be reflected by increased buckling in India prior to Himalayan M>8 earthquakes, with a corresponding reduction in flexural amplitude in subsequent centuries. The resulting gravitational changes may be sufficiently large to be monitored by potential field satellites such as GRACE.

The large changes in strain in the near-field of earthquakes are an important target for InSAR methods given the aridity of large parts of the Indian continent. Such methods can reveal the details of fault kinematics and rupture especially in regions where pre-earthquake geodetic coverage is sparse. Their application to Himalayan earthquakes is limited to those areas where forest cover and steep slopes are absent.

Remote sensing has application in the characterisation of earthquake risk through the identification of regions prone to liquefaction: river valleys and in coastal areas. Seismic vulnerability from tsunamis are easily assessed by convolving digital elevations and bathymetry data with the distribution of coastal populations and economic infrastructures. Night luminosity data provide a proxy for vulnerable city systems. Insar and satellite-imagery provide methods to identify regions of most significant damage in the aftermath of large earthquakes, permitting appropriate post-seismic emergency strategies to be identified early in the recovery effort.

HARNESSING INFORMATION AND TECHNOLOGY FOR DISASTER MANAGEMENT

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Abstract

India, characterized by the unique geodynamics with active tectonic plates, typical monsoon behavior driven by less understood global interconnections, flood prone river basins coexisting with semi-arid and arid regions and a long coast line prone to severe cyclones is amongst the nations most vulnerable to natural disasters. Drought, floods, cyclones, earthquakes, landslides have not only causing substantial loss of human lives and property, but also reducing the pace of sustained economic development often leading to heavy drain of the resources meant for developmental programmes. It is imperative that recent technological advances be fully harnessed to aid the disaster managers towards reducing loss of life and property.

Disasters cut across many boundaries, including organizational, political, geographic, professional, topical and sociological. There is a need to integrate information across many disciplines, organizations, and geographical regions. A comprehensive disaster management system must allow access to many different kinds of information at multiple levels at many points of time. Disaster information involves more than just data and several interconnecting steps are typically required to generate the type of action–oriented products that are needed by the disaster management community. The exact steps taken depend on the disaster phase and how time critical the need is.

Technology support required for disaster management fall in the category of observations, data collection, networking, communication, warning dissemination, service delivery mechanisms, GIS databases, expert analysis systems, information resources etc. Emerging technologies such as remote sensing, Global Positioning Systems (GPS), Data Collection Platforms (DCPs), hand-held GPS, Geographical Information System (GIS), Geospatial models, Cyclone warning and Dissemination System (CWDS), etc. have potential to provide valuable support to decision making. In recent years, the focus of disaster management community is increasingly moving on to the more effective utilization of these technologies, enabling communities at risk to prepare for, and to mitigate the potential damages likely to be caused due to the natural disasters. However, there are several technological challenges constraining their effective utilization down the line at community level.

The disaster information infrastructure encompasses three subsystems: knowledge infrastructure, interconnectivity infrastructure and integration infrastructure. Knowledge infrastructure involves observation techniques for data collection and visualization, information analysis, event forecasting, knowledge modeling and information management. Interconnectivity subsystem relates to the mode of communication employed to retrieve and

distribute data and dissemination of information products. Integration infrastructure addresses the operational system, standards and protocols, procedures for evaluation of quality and reliability and training of key personal.

Operational use of technology, in terms of information gathering and their real time dissemination leading to effective risk reduction at the national and local level, requires appropriate infrastructure, techniques and institutional systems to be in place. An ideal system needs to have subsystems on vulnerability/risk assessment, early warning and monitoring, emergency communication and short & long term mitigation strategies. There are several critical constraints in operational utilization of emerging technologies. Such constraints could be inadequate coverage/repetitivity of space data, effect of clouds on optical data, non-availability of close contour data, inadequate terrain models, assimilation of data in models etc. Currently information available at the national and State levels is limited in scale and content. Even where risk analysis takes into account vulnerability, this is normally restricted to the physical aspects. In most countries it is extremely rare to find risk analysis to take account of the social, economic, institutional and cultural aspects of vulnerability.

A concerted effort is needed to develop operational systems integrating recent technology to achieve a disaster information infrastructure appropriately networking the knowledge centers and generating appropriate information services. The paper highlights the critical role of technology in disaster reduction and management and identifies few key areas for strengthening/improvement technology inputs to the operational system.

Cooperative Satellite-based Flood Detection, Mapping, and Monitoring in Near Real Time

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Based on global records from 1985-present, portions of eastern and northern India experience unusually high per capita fatalities from inland flooding. Economic damage is severe and frequent. As in the U.S., this natural hazard is dispersed along thousands of km of river and tributary reaches and it crosses political boundaries. Mitigation at specific locations can make matters worse downstream; objective data are needed to resolve disputes. Up to now, hydrologists have employed in situ instrumentation in order to measure floods. It has not been possible to easily map floodplain inundation, or to track such through time. However, with the new array of orbital remote sensors, this situation has changed.

Wide-area, frequent repeat sensors such as MODIS and AWIFS now provide U.S. and Indian government agencies the potential to map flooding where and as it occurs. Currently, both nations mainly utilize satellite data to map large flood extents after the fact. What is needed is a transition to hydrographic monitoring via satellite, so that the satellite systems also detect such events. The "always-on" land sensors can be employed as are the weather satellites: their data output can be transformed to near-real time hydrographic measurements if appropriate processing methodologies are developed. As an example, we use an array of 700 gauging reaches (each 20 km in river length) for space-based hydrographic monitoring. Frequent optical and radar overpasses measure reach hydrologic status by use of numerical thresholds and as validated by higher spatial resolution sensors. There is broad potential for further development of this and related approaches.

India-US Cooperation on Improved Hydrometeorological Forecasting and Early Warning: The Anticipated Role of Space-based Systems

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The Disaster Management Support Project of USAID/India and the Government of India (GoI) includes a Climate Forecasting Systems (CFS) component that seeks to improve hydrometeorological forecasting and early warning in India. Following a joint technical workshop involving USAID, NOAA, USGS, and scientific counterparts from Indian agencies, the Ministry of Home Affairs (MHA) of GoI recently gave its approval to proceed with activities in five areas: tropical cyclone forecast and warning, local severe storms (including flash floods), extreme temperatures, flood forecasting, and forecast communications. A sixth activity, addressing drought, has been proposed by USAID and is under consideration by the Ministry of Agriculture. Scientific organizations in India consulted thus far include: the Indian Meteorology Department (IMD), National Center for Medium Range Weather Forecasting (NCMRWF), India Institute of Technology (IIT), Central Water Commission (CWC) of the Ministry of Water Resources, the International Crops Research Institute for the Semi- Arid Tropics (ICRISAT), Acharyn N.G. Ranga Agricultural University (ANGRAU), and the Central Research Institute for Dryland Agriculture (CRIDA). The Relief Commissioners of West Bengal and Assam have provided valuable input as well.

An overview of anticipated use of space-based systems will be provided. Satellite rainfall estimates are expected to find application in flood, storm, and drought activities. Both NOAA and NCMRWF have experience blending station data with imagery from geostationary and polar orbiting satellites. Gridded precipitation estimates from NASA, using imagery from the Tropical Rainfall Measuring Mission (TRMM), will also be important, and project experiences will be relevant to the future Global Precipitation Measuring (GPM) mission. Geostationary satellites provide invaluable imagery for tracking tropical cyclones, and the models used to forecast their tracks benefit from sea surface temperatures and wind fields derived from satellite data. Flooding studies involve inundation mapping, where imagery from systems like Landsat, IRS, MODIS, and the Shuttle Radar Topography Mission (SRTM) are needed. Remotely located Data Collection Platforms (DCPs) transmit real time stream gage data to flood forecast centers via satellite. Communication of hydrometeorological forecasts of all kinds is a cross-cutting theme of the project. The NOAA RANET system will be evaluated as a means of disseminating warning messages at the community level.