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Disaster Management and the Role of Information & Technology

Barna Maulick

Abstract

Disasters are very bad accidents, causing great damage to properties and human lives along with the live stocks. Despite man's pride of having tamed the unpredictable forces of nature to his advantage, it is the same helpless man who proves a pigmy before the pounding power of nature. Disasters are caused mainly by the nature's powerful and destructive forces but some are also caused by man's callous attitude, misbehavior and unscientific exploration of natural resources. The common disasters are- earthquakes, volcanic eruptions, tsunamis, cyclones, drought etc. Disaster Management or Emergency Management is the discipline of dealing with and avoiding risks. It is a discipline that involves preparing for disaster before it occurs. Effective 'disaster management' relies on thorough integration of emergency plans at all levels of Governmental and Non-Governmental involvement. Information Management is not a product, but a strategy or approach. It is observed that advancement in Information Technology in form of Internet, GIS, Remote Sensing, and Satellite Communication etc. helps a great deal in planning and implementation of hazard reduction measures.

Keywords: Disaster; Management; Information Technology; Emergency; Human; Lives.

Introduction to Disasters

Disasters are very bad accidents, causing great damage to properties and human lives as well as the livestocks. India's geo-climatic conditions as well as its high degree of socio-economic vulnerability, makes it one of the most disaster prone country in the world. Despite man's pride of having tamed the unpredictable forces of nature to his advantage, it is the same hapless and helpless man who proves a pigmy before the pounding power of nature. Though natural calamities do not visit upon us as a routine matter, but when they strike, the rigors of aftermath are awesome and atrocious. Nothing bears such a taunting and teasing testimony to man's frailty before nature's malevolent fury than these disasters and expose the incompetence and apathy of those at the helm of affairs.

Causes and Types of Disasters

Mainly the nature's powerful and destructive forces cause the disasters. But some are also caused by man's callous attitude, misbehavior and unscientific exploration of natural resources and under estimating nature's fury.

The common disasters caused by natural forces are – earthquakes, volcanic eruptions, lava flows, mud flows, river floods, flash floods, avalanches, land slides, geological roof collapses, tsunamis, wind storms, snow storms, tornados, sea cyclones, forest fires, acid rains, epidemics and droughts etc.

The manmade disasters are building collapse, bridge collapse, dam collapse, tunnel collapse, mine roof collapse, other mining exploration hazards, industrial hazards like chemical spill outs, mixing of toxic waste flow to the natural water bodies and to the atmosphere, radioactive heat disintegration from power plants, sinking of sea vessels

Author's Affilation: *Research Scholar in Patna University, Visiting Faculty in Magadh Mahila College, PU, Research Associate in Centre for Economic Policy and Public Finance, a Research Wing of Finance Department, Government of Bihar , run by Asian Development Research Institute, Patna, Bihar.

Reprint's request: Ms Barna Maulick, C/o Mr. N.C. Ganguli, Road No. 13/B; Rajendra Nagar, Patna-800 016, Bihar. E-mail: barnaganguli@yahoo.in

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carrying petroleum and other chemicals, plane crashes, major road accidents, rail accidents, ferry capsize, building fires, factory fires, hazards related to space exploration, war situations and lately terrorist attacks etc.

Extent of Disaster Management

'Disaster Management' is full of real-life challenges. 'Disaster Management' or 'Emergency Management' is the discipline of dealing with and avoiding risks. It is a discipline that involves preparing for disaster before it occurs, disaster response, (e.g. emergency evacuation, quarantine, mass decontamination, medication etc.) as well as supporting and rebuilding society after natural or human made disasters. In general, any emergency management is the continuous process by which all individuals, groups and communities manage hazards in an effect to avoid or ameliorate the impact of disaster resulting from the hazards.

The Disaster Management Act, 2005 defines disaster as "a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of property, or damage to or degradation of environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area".

The United Nations defines disaster as "the occurrence of sudden or major misfortune which disrupts the basic fabric and normal functioning of the society or community".

'Emergency Management" is one of a number of terms which, since the end of the 'cold war', have largely replaced 'Civil Defense', whose original focus was on a more general intent to protect the civilian population in times of peace as well as in times of war. Another current term 'Civil Protection' is widely used within the European Union and refers to government approved system and resources whose task is to protect the civilian population, primarily in the event of natural and human made disasters. An academic trend is towards using the term 'Disaster Risk Reduction', is particularly for emergency management in a development management context. This focuses on mitigation and preparedness aspect of emergency cycle.

Phases and Professional Activities of Disaster Management

The nature of disaster depends upon local, economic and social conditions. Some disaster relief experts such as Fred Cuny have noticed that in a sense the only real disasters are economic. He has long noticed that the cycle of disaster management must include long-term work on infrastructure, public awareness, and even human justice issues. This is particularly important in developing nations.

The process of disaster or emergency management involves four phases – Mitigation, Preparedness, Response and Recovery.

Mitigation

Mitigation efforts attempt to prevent hazards from developing into disasters altogether, or to reduce the effects of disaster when they occur. The mitigation phase differs from the other phases because it focuses on long-term measures for reducing eliminating risk. The implementation of mitigation strategies can be considered as a part of the recovery process if applied after a disaster occurs. However, even if applied as part of recovery efforts, actions that reduce or eliminate risk over time are still considered as mitigation efforts.

Mitigation measures can be structural or non-structural. Structural measures use technological solutions like flood levees. Non-structural measures include legislation, land use planning, e.g. designation of non-essential land like parks to be used as flood relief zones and insurance. Mitigation is the most cost-efficient method for reducing the impact of hazards. However mitigation is not always

suitable and structural mitigation in particular may have adverse effects on our ecosystem.

A precursor activity to the mitigation is the identification of risks. Physical risk assessment refers to the process of identifying and evaluating hazards. In risk assessment various hazards within a certain areas are identified. Each hazard poses a risk to the population within the area assessed. The risk calculations give the proportions of population vulnerability to that hazard at disaster times. Catastrophe modeling tools are used to support the calculations. The higher the risk, the more urgent are the hazard specific vulnerabilities, which are to be targeted by mitigation and preparedness efforts. And if there is no vulnerability there will be no risk, e.g. an earthquake occurring in a desert where nobody lives.

Preparedness

In the preparedness phase, emergency managers develop plans of action for when the disaster strikes. Common preparedness measures include the –

- Communication plans with easily understandable terminologies and methods
- Development and practice of multi agency coordination and incident command
- Proper maintenance and training of emergency services, including mass human resources such as community response teams
- Development and exercise of emergency population warning methods combined with emergency shelters and evacuation plans
- Stock piling, inventory and maintenance of supplies and equipment
- An effective preparedness measure is an 'emergency operation center' (EOC) combined with a practiced region-wide doctrine, such as 'incident command system', for managing emergencies
- Another preparedness measure is to help organizations of trained volunteers among civilian populations. Professional emergency workers are immediately overwhelmed in mass emergencies, so trained, organizes, responsible volunteers can be extremely valuable. One notable system is the 'Community Emergency Response Team'. Another is the 'Red Cross'. If volunteers are organized, trained in the incident command system, and agree to mobilize, experience in the Red Cross and California Communities has shown that they can be utilized in responsible positions, including the staff in EOCs

Another aspect of preparedness is the 'casualty prediction', the study of how many deaths or injuries to expert for a given kind of event. This gives planner an idea of what resources need to be in place to respond to a particular kind of event.

Response

The response phase includes the mobilization of the necessary emergency services and the first responders in the disaster area. This is likely to include a first wave of core emergency services, such as fire fighters, police and ambulance crews. They may be supported by a number of secondary emergency services, such as specialist rescue teams.

First responders are normally immediately overwhelmed in a mass emergency, with official response times exceeding several days. In these situations, it makes sense to mobilize organized emergency volunteers, such as community emergency response teams and non-governmental organizations, such as local Red Cross branch or Doctors without Boundaries (MSF). These may provide immediate practical assistance, from first aid provision to professionally organized mass emergency shelters.

A well rehearsed emergency plan developed as part of the preparedness phase enables efficient coordination of rescue efforts. Emergency plan rehearsal is essential to achieve optimal output with limited resources. In the response phase, medical assets used in accordance with appropriate triage of affected victims.

Where required, search and rescue operations commence at an early stage. Depending upon the injuries sustained by the victim, outside temperature and victim's access to air and water, the vast majority of those affected by a disaster dies within 72 hours after impact.

Individuals often volunteer directly after a disaster. Unorganized, untrained volunteers can be both help and a hindrance to emergency management and other relief agencies. Pre-organized, pre-trained volunteers, who understand and support the official 'incident command system', provide valuable extra manpower.

Recovery

The aim of the recovery phase is to restore the affected area to the previous state. It differs from the response phase in its focus. Recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed. Recovery efforts are primarily concerned with actions that involve re-building destroyed property, re-employment and the repair of other essential infrastructure. An important aspect of effective recovery efforts is taking advantage of a 'window of opportunity' for the implementation of mitigative measures that might otherwise be unpopular. Citizens of the affected area are more likely to accept more mitigating changes when a recent disaster is in fresh memory.

Natural Disasters and Responsibilities of Disaster Management in India

Natural disasters strike both developed and developing countries, causing enormous destruction and creating human sufferings and producing negative impacts on national economies. Due to diverse geo-climatic conditions prevalent in different parts of globe, different types of natural disaster occur according to the vulnerability of the area.

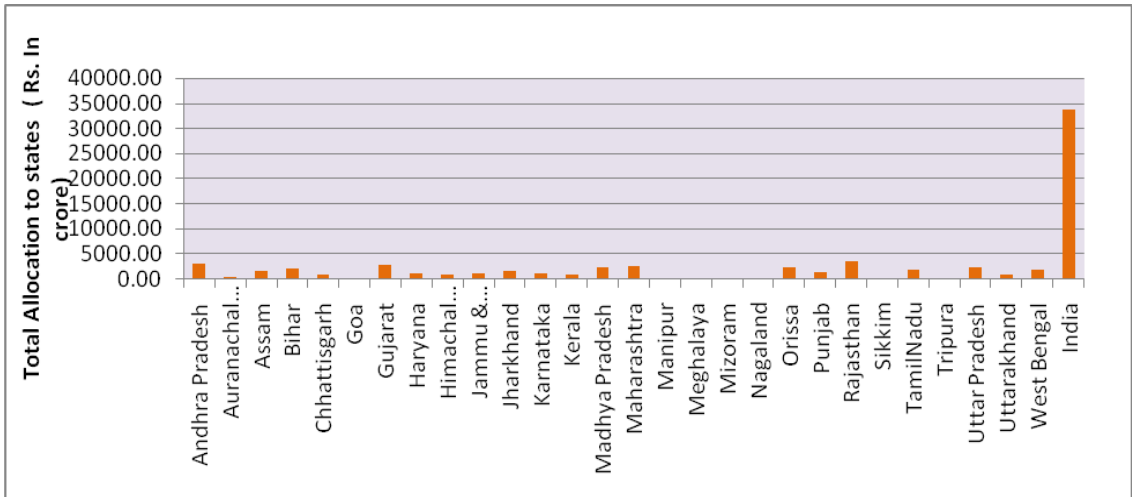
India is a large country with different geologic and geographic terrains. With tropical climate and unstable landforms, coupled with high population density, poverty, illiteracy and lack of adequate infrastructure, it is considered as the world's most disaster prone country with a number of natural hazards. India has witnessed many devastating natural calamities like river floods, flash floods, snow storms, sea cyclones, land slides, avalanches, earthquakes, volcanic eruptions, droughts and epidemics, causing widespread damage to

Table A: Yearwise damage caused due to floods, cyclonic storms, landslides etc. in India

Year	Live lost (human) (in No.)	Cattle Lost (in No.)	Houses damaged (in No.)	Cropped areas affected (in lakh hectares)
2001-02	834	21269	346878	18.72
2002-03	898	3729	462700	21.00
2003-04	1992	25393	682209	31.98
2004-05	1995	12389	1603300	32.53
2005-06	2698	110997	2120012	32.52
2006-07	2402	455619	1934680	70.87
2007-08	3764	119218	3527041	85.13
2008-09	3405	53833	1646905	35.56
2009-10	1677	128452	1359726	47.13
2010-11	2310	48778	1338619	46.25

Source: Ministry of Home Affairs (MHA)

State-wise Allocation of State Disaster Response Fund (2010-2015)



human life and property and environment. The table below gives an account of yearwise details of the loss due to some major natural disasters:

In India, the role of 'emergency management' falls to National Disaster Management of India, a governmental agency, subordinate to the Ministry of Home Affairs. In recent years there has been a shift of emphasis from response to recovery to strategic risk management and reduction and from government-centered approach to de-centralized community participation. 'Survey of India' an agency within the Ministry of Science and Technology, is also playing a major role in this field, through bringing the academic knowledge and research expertise of earth scientists to the emergency management process.

Recently the Government of India has formed the 'Emergency Management and Research Institute' (EMRI). This group represents a public/private partnership; funded primarily by a large India based Computer Company, and aimed at improving the general response to communities to emergencies, in addition to those incidents, which might be described as disasters. Some of the group's early effort involve in provision of emergency management training for first responders, (a first in India), the creation of a single emergency telephone number, and the establishment of standards for Emergency Management Service (EMS) staffs, equipments and training. It is hoped that this effort will provide a model for evaluation by all of India, however, at the moment it operates in only two states in India i.e. Andhra Pradesh and Gujarat.

The Thirteenth Finance Commission has made special provision for State Disaster Response Funds (SDRF) in its recommendations which has been accepted by the Government of India. The chart below represents total State-wise distribution of the SRDF funds between 2010-2015.

Role of Information Technology in Disaster Management

The rapid growth of world's population and its increased concentration often in hazardous environment has escalated both the frequency and severity of natural disasters.

With tropical climatic conditions, unstable landforms, coupled with deforestation, unplanned growth proliferation, non-engineered construction etc. makes the disaster prone areas more vulnerable. Tardy communication, poor or no-budgetary allocations for disaster prevention, developing countries suffer more chronically by natural disasters. Asia tops the list of casualties because of natural disaster.

With an increase in the perception towards spreading a culture of prevention in disaster management scenario, considerable emphasis is now being placed on research and development activities in the area of information technology.

Though it is not possible to completely avoid natural disasters and to fully recoup the damages caused by them, but the sufferings can be minimized by creating proper awareness of likely disasters and its impact by –

- Minimizing the potential risks by developing an early warning system and adopting a suitable strategy
- Disaster preparedness and implement development plans to provide resilience to such natural disasters
- To mobilize resources including communication and tele-medicinal services
- To help in rehabilitation and post-disaster construction

These Natural disasters are of the following origins:

- Geo-physical origin, such as earthquakes, volcanic eruptions, landslides, tsunamis etc.
- Climatic or Weather related origin, such as flood, drought, cyclone, snowstorms, forest fire, locust etc.

Information Management is not a product, but rather a strategy or approach for organizations to leverage information as a compelling asset, regardless of type or source. It can be defined as structured or semi-structured data into the established discipline of technological intelligence and the extraction and analysis of structured data to maximize the value of information while leveraging inputs made in content and other non-structured management technologies.

Disaster Management, on the other hand involves:

- Pre-disaster planning, preparedness, monitoring including relief management and capability building
- Predictions and early warnings
- Damage assessment and relief management

Disaster reduction is a systematic work, which involves with different regions, different professions and different scientific fields and has become an important measure for human, society and nature's sustainable development.

It is observed that advancement in Information Technology helps a great deal in planning and implementation of hazard reduction measures.

Below are the different forms of Information Technology which play major role in disaster management:

Internet

In the present era of electronic communication, the Internet provides an useful platform for disaster mitigation communications. Launching a well-defined web site is very cost effective means of making an inter-national as well as intra-national presence felt. It provides a new and potentially revolutionary option for the rapid, automatic and global dissemination of disaster information. A number of individuals and group, including several national meteorological services, are experimenting with the Internet for real–time dissemination of weather observation, forecasts, satellite and other data. In the most critical phase of natural disasters, electronic communication has provided the most effective and in some instances perhaps the only means of communication of outside world.

Geographic Information System (GIS)

GIS provides a tool for effective and efficient storage and manipulation of remotely sensed

data and other spatial and non-spatial data types for both scientific management and policy-oriented information. This can be used to facilitate measurement, mapping, monitoring and modeling variety of data types related to natural phenomenon. The specific GIS application in the field of Risk Assessments is – Hazard Zone Mapping to show earthquake, volcanic eruption, landslides, floods, tsunamis or forest-fire hazards. These maps could be created for cities, districts or even for the entire country. Tropical Cyclone Threat maps are used by meteorological departments to improve the quality of the tropical storm warning services and quickly communicate the risk to the people likely to get affected by the cyclone.

Remote Sensing

Remote Sensing makes observation of any object from a distance and without coming into actual contact. Remote sensing can gather data much faster than ground based observation and can cover a large area at one time to give a synoptic view. Remote sensing comprises Aerial Remote Sensing which is the process of recording information, such as photographs and images from sensors on aircraft and Satellite Remote Sensing which consists of several satellite remote sensing system, which can be used to integrate natural hazards assessments into development planning studies. These are – LandSat, SPOT Satellite, Satellite Radar System, and Advanced Very High Resolution Radio etc.

Communication Satellites

Communication satellites have become vital for providing emergency communication and timely relief measures. Satellite communication capabilities, fixed and mobile are vital for effective communication, especially in data collection, distress alerting, position location and coordinating relief operations in the field. In addition search and rescue satellites provide capabilities such as position determination facilities onboard which are useful in different distress situations such as in land, in sea or in the air.

Space Technology

Space systems from their vantage position have unambiguously demonstrated their capability in providing vital information and services for disaster management. The vast capabilities of communication satellites are available for timely dissemination of early warning and real-time coordination of relief operations.

The Earth Observation Satellites provide comprehensive, synoptic and multi temporal coverage of large areas in real time and at frequent intervals and thus have become valuable for continuous monitoring of atmospheric as well as surface parameters related to natural disasters. Geo-stationery Satellites provide continuous and synoptic observations over large areas on weather including cyclone monitoring. Polar Orbiting Satellites provide much higher resolution imageries, even though at low temporal frequency, which is used for detailed monitoring, damage assessment and long term relief management.

The advent of Very Small Aperture Terminals (VSAT) and Ultra Small Aperture Terminals (USAT) and Phased-array Antennae have enhanced the capability further by offering low cost, viable technological solutions towards management and mitigation of disasters.

Types of disasters and role of it in their control

Drought

Drought is the single most weather – related natural disaster often aggravated by human action. Drought's beginning is subtle, its progress is insidious and its effects can be devastating. Drought may start any time, last indefinitely and attain many degrees of severity. Since it affects very large areas for months and years it has a serious impact on economy, destruction of ecological resources, foot shortages and starvation of millions of

people. Owing to abnormalities in the monsoon precipitation, in terms of spatial and temporal variation, prolonged break and early withdrawal of monsoon, drought is a frequent phenomenon over many parts of India. In India, 33% receives less than 750 mm rainfall and is chronically drought – prone, and 35% of the area with 750-1125 mm rainfall is also subject to drought once in four to five years. Out of 68% of the total sown area covering about 142 million hectares are vulnerable to drought conditions. India has faced three major droughts in this century – 1904-1905; 1965-66 and 1986-87.

Drought monitoring mechanisms exists in most of the countries using ground – based information on drought related parameters as rainfall, weather, crops and water availability etc. 'National Agricultural Drought Assessment and Monitoring system' (NADAMS) was sponsored by the Department of Agriculture and Co-operation and Department of Space (DOC) was taken up by the National Remote Sensing Agency in collaboration with the Indian Metrological Department (IMD), Central Water Commission (CWC) and concerned State Government agencies. It helps in assessment of agricultural drought conditions in terms of prevalence, relative severity level and persistence through the season. Satellite – derived Vegetation Index (VI) that is sensitive to vegetation has been used as a surrogate measure to continuously monitor the drought conditions. NADAMS is a short-term relief measure and long-term relief is provided by "Integrated Mission For Sustainable Development" (IMSD) in collaboration of other DOS centres and State Remote Sensing Application Centres.

Flood

India is the worst flood affected country after Bangladesh and accounts for one – fifth of the global death count due to flood. An estimated 8 million hectares of land are affected annually. The cropped area affected annually ranges from 3.5 million hectares during normal floods to 10 million hectares during worst flood.

Optical and microwave data from IRS, SPOT landsat ERS and Radarsat series of satellites have been used to map and monitor flood events. Information on inundation and damage due to floods is furnished to concerned departments so as to enable them organizing necessary relief measures and to make a reliable assessment of flood damage. WiFS data from IRS-IC and – 1D do a great work in flood monitoring.

Cyclone

The intense tropical storms are known in different part of the world by different names. In the Pacific ocean, its "Typhoons", in the Indian ocean its "Cyclones" and over North Atlantic, its "Hurricane". Among various natural calamities, tropical cyclones are known to claim a higher share of deaths and destruction world over. India has a vast coast line which is frequently affected by tropical cyclones causing heavy loss of human lives and property. Cyclones occur usually between April and May (called pre-monsoon cyclonic storms) and between October and December (called post – monsoon cyclonic storms). While cyclonic storms cannot be prevented, the loss of lives and damage to the properties can be mitigated if prompt action is taken.

Information on cyclone warnings is furnished on a real –time basis to the control room setup in the Ministry of Agriculture, Govt. of India. High-power Cyclone Detection Radars (CDRS) that are installed along the coastal belt of India have proved to be a very useful tool to the cyclone warning work. These radars can locate and track approaching Tropical Cyclones within a range of 400 Km. When cyclone is beyond the range of coastal radar, its intensity and movement is monitored with the help of INSAT, and NOAA series of satellites. The existing mode of dissemination of cyclone warnings to various Govt. officials

is through high priority telegrams, telephones, telex and fax.

Earthquake

Earthquakes are caused by the abrupt release of strain that has built up in the earth's crust. Major earthquakes occur within the interior of crustal tectonic plates such as those in China, Russia and the South–East United States.

GIS and Remote Sensing can be used for preparing seismic hazards maps in order to assess the exact nature of risks. Landsat – TM and SPOT images, and Radar interferograms have been used to detect the active faults. Active faults on the seafloor could also be detected by side-scan sonar system. Recently, space geodetic techniques and high-resolution Ariel and satellite data have been used for earthquake predictions. Space geodetic technique with Global Positioning System (GPS) provides an accuracy of a centimeter over 1000 Km., and thus helps in measuring the surface deformations and monitoring accelerated crystal deformations prior to earthquakes with required accuracy.

Volcanic Eruptions

Ground deformations, changes in the compositions of gaseous emitting from volcanic vents, changes in the temperatures of fumaroles, hot springs and crater lakes as well as earth tremours are the results of volcanic eruptions.

In the last three decades, aircraft and satellite based thermal infrared (TIR) data have been used extensively to detect and monitor many of the active volcanoes around the world. Repetitive coverage on regional scale and low cost of thermal infrared images from satellites make it an alternative tool for monitoring volcanoes. Studies show that upward migration of magma from the earth's crust just before eruption inflates the volcanic cone. Such premonitory signs can easily and quickly are detected with the aid of differential SAR interferometry.

Tsunamies

Tsunamies are giant waves, caused by earthquakes on the sea floors that could be 10 to 30 metres high, when they hit coastline, they cause devastating losses.

Tsunami inundation maps can be made with GIS and merged with census and boundary data to help map the potential inundation zone. Such mapping mock drills and empowering the community, in their response and in increasing the accuracy of the forecasts and early warnings are some of the steps taken for facing unexpected disasters.

Land Slides

Ariel photographs and large-scale satellites images have been used to locate the areas with the incidence of landslide. Higher spatial resolution and stereo imaging capability of IRS – IC and 1D enable further refining the location and monitoring of landslides.

Forest Fire

The Forest fire depends upon three parameters- fuel, weather and topography. For risk assessment variables such as land use, land cover, demography infrastructure and urban interface are considered. The IRS satellite data have been used for monitoring forest fires over Nagar hole Wild Life Sanctuary of South India.

Crop Pest and Diseases

One of the successful programmes where space technology has been used in risk assessment from crop pests/diseases is the Desert Locust Satellite Applications project of the UN/FAO for the International Desert Locust Commission. Temporal and spatial distributions of desert vegetation and rainfall derived from NOAA-AVHRR data have been used to identify the potential Locust breeding grounds. Improved desert locust forecasting system is being tried with the help of satellite data by the locust warning organizations by

narrowing down the potential breeding areas to undertake ariel spraying for arresting further growth of locust.

Conclusion

Apart from loss of human lives, natural disasters inflict severe damage to ecology and economy of a region. It may be observed that advancement in Information Technology in the form of Internet, GIS and Remote Sensing Satellite Communication etc. can help a great deal in planning and implementation of hazard reduction. Space technology has made significant contribution in all three phases i.e. preparedness, prevention and relief under disaster management. With a constellation of both INSAT and IRS series of satellites, India has developed an operational mechanism for disaster warning especially cyclone and drought and their monitoring and mitigation. Forecasting, monitoring and warning mechanisms are meant to reduce human suffering and misery and not to fatten the files with heaps of papers feeding them. Although funds have been allocated and departments formed but still serious introspection and action plan for future is required to help the people who suffer the pangs of pain and agony after the calamity has struck. There is still a need of strong social as well as political will to combat the disasters and calamities in our country.

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