Disaster Preparedness and Technology
UNIT 11 INFORMATION TECHNOLOGY: ROLE IN DISASTER PREPAREDNESS WITH SPECIAL REFERENCE TO GEOGRAPHICAL INFORMATION SYSTEM

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11. LEARNING OUTCOME
After going through this Unit, you should be able to:

- Discuss the role of science and technology in disaster preparedness
- Highlight the use of information technology in disaster preparedness; and
- Describe the important aspects of meteorological and hydrological disaster preparedness.

11.1 INTRODUCTION
Along with global developments in science and technology, which are taking place by leaps and bounds, massive disasters with far-reaching repercussions are also occurring. Science and technology has been used in the past leading to disastrous results during the world wars, cold war and for terrorist attacks. People who utilise science and technology for purposes, which are detrimental to the society, remain sometimes one step ahead of the people who use it for peaceful or development purposes. Despite this, we have to endeavour to convert the applicability of science and technology from disaster to development. Some people argue that large scale developments are also leading to slow environmental disasters. But we have to strive for balanced development.

'Science and technology is a productive force. Advances in science and technology create an important influence to increase human beings' consciousness to disaster prevention, resistance and preparedness. Thus, a fundamental way to significantly reduce disasters is
Disaster preparedness is a complex natural social-economic systems engineering. It requires support not only from many basic disciplines but also from advanced technologies. Disaster preparedness and management in this context, includes:

1) Information Collection
2) Analysis and Diagnosis
3) Disaster Prediction
4) Transmission of Warning
5) Disaster Monitoring
6) Rescue and Relief
7) Post-disaster Recovery; and
8) Reconstruction.

The discharge of these tasks depends to a large extent on the advances in science and technology and more importantly, on its proper use and application. Every government department also needs scientific and technological support to make disaster preparedness policies and build disaster real-time monitoring system to coordinate activities during disaster.

India can learn not only from USA and Japan, but also a great deal from the developing and the most populous country, China. It has been said that multi-disaster and multi-functional scientific teams on disasters have been constituted in China that cover the fields from basic research to applications of disaster reduction technologies. Advanced technologies, which we have been referring to, have been successfully applied in prediction and prevention of several major meteorological, earthquake and oceanic disasters. There are about one hundred thousand monitoring stations over various disaster-prone sites in China. They are networked in a nation-wide monitoring and prediction system. This multi-functional system embodies scientific research, data collection, analysis, processing, prediction and deduction. The meteorological monitoring and prediction system has 2600 stations, 900 seismographic stations and earthquake precursory observatories, 3500 hydraulic stations, and 1300 water level observatories.

China’s recently established tsunami-monitoring station in its southern most-city Sanya detected tiny waves of about four to five centimeters in height on 29 March 2005. It proved that the earthquake that struck Sumatra, had evoked a “very small” tsunami with “a very little impact”. China established an automatic early-warning tsunami system after the December 26, 2004 tragedy which started operation on February 8, 2005 and thus far has received more than 20 alerts from the Pacific Tsunami Warning Centre (The Hindu, 2005).
Science and technology in disaster preparedness lays emphasis on the integration of natural sciences and social sciences and the studies of temporal and spatial clustering of natural disasters and comprehensive disaster preparedness and reduction. Mitigating the negative impact due to disasters is the common desire and cause of entire mankind. The social and economic impact of disasters is regional and is not restricted by any political boundaries, and its reduction requires joint efforts. International cooperation is an important way to facilitate disaster reduction and preparedness. We have already discussed about this in Unit 10 of this Course.

11.3 INFORMATION TECHNOLOGY AND DISASTER PREPAREDNESS

The Yokohama Declaration in 1994, outlined the need of information, knowledge and technology to reduce the effects of disasters, and enhance regional and international cooperation in mitigating disasters. Information Technology (IT) is vital for disaster preparedness. Any person throughout the world, who has access to Internet, and inclination to learn about disaster preparedness in general or about the local area in particular, can learn a great deal just by a few mouse clicks. Some of the websites are very informative and educative and provide a lot of information on various disaster management domains. They serve as knowledge base. In fact, one can even without paying any fee, download complete course material on disaster management. For example, the Federal Emergency Management Authority’s website www.fema.org contains information about a number of independent Study Courses. United Nations Disaster Management Training Programme www.unodc.org contains 22 training modules and 27 country case studies. These are just two examples. Websites enable one to get quick and useful information.

The Information Technology revolution has facilitated the setting up of Local Area Networks (LANs) within organisations, which link computers scattered across different departments and different locations. Wide Area Networks (WANs) link together computers across geographical locations covering a wider area. The government of Maharashtra has set up an Internet linking 40 nodes of Mantralaya at Mumbai, Yashwantrao Chavan Academy of Development Administration (YASHADA) at Pune, Six divisional commissioners, and 32 district collectors for audio-visual conferencing and data interchange (Menon, 2003).

IT can be effectively used in all stages of the disaster cycle. Sudha Maheswari (1995) has classified the communication for disaster management at four different levels.

1. Communication between experts involved in and doing research in disaster management: Research on disaster management is carried on all over the world. There are people researching the impact of disaster in various parts of the world and many of them have expertise in regions far away from them. Their expertise will definitely be of great help to those directly dealing with a disaster situation. At the time of disaster the need of the hour is the timely exchange of information and expertise. The World Wide Web (www) facilitates this by providing an excellent platform for exchange of information on the most current research being carried on across the world. United Nations Office for Coordination of Humanitarian Affairs (UNOCHA), for example, maintains a virtual on-site operations and coordination centre at the website: www.reliefweb.int/vosocc. This site could be accessed by anyone (upon request for
a password from system administrator) for entering into a dialogue with emergency
managers at the site of a disaster. Problems faced by disaster managers are usually
posted on this site, inviting the attention of public at large and especially those who
possess the required knowledge to address a particular problem and/or specific
details about the affected area.

2) Communication between organisations and agencies involved in disaster management:
Most organisations, which are involved in disaster management, have their own
websites. These sites provide information about the nature of work done by these
agencies and most sites have pointers to other agencies. World Wide Web is being
used by organisations for their publications, to interact with other similar organisations.

3) Communication tools in the disaster preparedness phase to educate the people who
are likely to be victims of disasters. Most sites on disasters maintained by organisations
have documents which deal with educating the public on how to cope with disasters
and what to do when disaster strikes.

4) Communication tools to promote disaster awareness amongst people who are not
victims of disasters. The World Wide Web is being used for promoting awareness
of disasters and their repercussions on the people. If people are better informed
about the disasters they are more likely to support funding for research, education,
preparedness and relief efforts.

The Internet transactions are instantaneous and paperless, which can be done from
anywhere in the world and are cost-effective. Stalberg (1994) visualises the intelligent city
that will dramatically transform emergency management or disaster management, as it is
known today. Computing and telecommunications technologies will combine their resources
to enhance all elements of decision-making by those involved in emergency management.
Mobile wireless networks will serve as the backbone for communications and offer access
to a variety of resources currently available only at a very high cost and in limited
situations. As a result of a greater interconnectedness of public, private, and non-profit
emergency management agencies, traditional organisation boundaries and separation of
departments will undergo a significant change as the intelligent community is created.
Resource allocation will become more efficient and the capacity to analyse more complex
issues in time of crisis will be available to decision-makers.

11.4 GEOGRAPHICAL INFORMATION SYSTEM

During any emergency situation, the role of a reliable decision support system is very
crucial for effective response and recovery. Geographical Information System (GIS)
facilitates this task by providing information about hazard zoning, incident mapping, natural
resources, critical infrastructure at risk etc. GIS-based information tools help disaster
managers to quickly assess the impact of a disaster, mobilise resources at right location
within the best response time. The problem with traditional manual maps is that they are
tedious and time consuming to prepare, difficult to update and inconvenient to maintain.
GIS is computer-based system to store, represent and analyse features present on the
earth's surface and events that take place on it.

Geographical Information System is an analysis that combines relational databases with
spatial interpretation and outputs often in form of maps. A more elaborate definition is that
of computer programmes for capturing, storing, checking, integrating, analysing and
displaying data about the earth that is spatially referenced. Geographical Information
System is increasingly being utilized for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures. It is a combination of several disciplines such as geography, computing, cartography, remote sensing etc., which help in the analysis of spatial data. GIS helps users to collect, store, link, analyze and update the data. It attempts to predict, quantify the expected losses arising out of disasters. In many countries, GIS tools are made of use in disaster management. For instance, in Bangladesh, GIS is utilized not only to provide warnings for areas prone to cyclones, but also mapping of flood-prone areas.

UNDP (2001) is of the view that "as the agency mandated by the United Nations system to coordinate the activities of various agencies working in Gujarat, UNDP helped to bridge the information gap between them and served as liaison between the Government, United Nations Organisations and Civil Society Organisations (CSOs). The database using the geographical information system (GIS) set up by UNDP has been put to effective use in mapping disease profiles, initiating surveillance and in rectifying duplication of allotments in the construction of schools and primary health centres."

GIS can improve the quality and power of analysis of natural hazards assessments, guide development activities and assist planners in the selection of mitigation measures and in the implementation of emergency preparedness and response action. GIS establishes linkage between data and maps. In other words, it provides a representation of data in the form of maps. Maps are the graphic representation of the real objects with points, lines, and polygons. GIS contains many layers of information.

Eighty per cent of the cost of GIS lies in conversion of data into digital form. Satellite data alone cannot be used. It has to be used with verification at the ground level. GIS software uses geography and computer generated maps as an interface for integrating and accessing massive amounts of location-based information. This unique characteristic of a GIS makes it an effective tool in the field of disaster response and preparedness. It can be used for scientific investigations, resource management, disaster and development planning. For example, GIS might allow the emergency planners to easily calculate emergency response times in the event of a natural disaster, or it might be used for locating wetlands that need protection from pollution.

The GIS data base is an effective tool for emergency responders to get information about the location of public facilities, communication links and transportation network at national, state and district levels. The presence of a database enables drawing up multi-layered maps on district wise base. These maps along with satellite images available for a particular area facilitates district administration and state government carry out hazard zonation and vulnerability assessment.

GIS allows public safety personnel to effectively plan for emergency response, determine mitigation priorities, analyze historical events, and predict future events. GIS can also be used to provide critical information to emergency responders upon dispatch or while en route to an incident to assist in tactical planning. It also enables international agencies to integrate data for planning and implementation purposes. Analysis of geographic features with GIS allows the analysts to view new patterns, trends, and relationships that were not clearly evident without visualisation of the data especially in case of a disaster. GIS can also be used to get critical information about a humanitarian crisis to appropriate response agencies in a coordinated and efficient manner. Once in the field, the coordination can continue as new data can be added and disseminated through wireless applications and
Internet / Intranet connectivity. GIS applications are appropriate tools for endeavours such as geo-spatial data, infrastructure creation, geo-information capacity building, geo-chemical mapping of the country and mapping of priority sectors.

GIS is being put to use in varied ways by the government. The National Informatics Centre (NIC) developed the alert system for district collectors of Tamil Nadu. The software consists of four main modules namely (i) contingent plan modules, (ii) rescue and relief module, (iii) map analysis module and (iv) management module. The system helps in handling on-line information on daily cyclone situation data together with spatial (map basis) and non-spatial attributes (tabular/statistical data) to give a scenario of cyclone to enable the administration function more effectively during the cyclones. The system provided query and report generation facilities to the cyclone administrator. Any general or contingent plan information about the district is immediately available. On receipt of the cyclone warning messages from IMD, the relief and rescue modules generate evaluation plan based on the available contingent resources information. The management module generates various reports category-wise and officer-wise that are to be executed during the crisis situation (Vijayaditya and Rao, 1999).

The Ministry of Home Affairs in India has initiated the development of a GIS-based National Database for Emergency Management (NDEM) in collaboration with various government ministries and agencies such as Department of Space, Department of Science and Technology and Ministry of Communications and Information Technology. The Ministry with technical support from UNDP is also in the process of developing GIS-based tools for emergency management on pilot basis. The resources available, the critical infrastructure etc., are mapped for the national capital. In Bangladesh GIS tools are being applied in the country for flood prevention. The Disaster Management Bureau, working with a US NGO, used GIS to develop not only an early warning procedure for areas prone to cyclone-generated floods, but also mapping flood patterns to guide construction of more permanent facilities in areas least prone to flooding and less permanent structures recommended for areas identified as most at risk (Commonwealth of Learning Executive MBA/MPA, 2003). The Global Positioning system or a “GPS” is computer-based location system satellite. It enables measuring of precise locations of positions on earth, its applications include surveying, engineering, emergency management etc.

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Preparedness for geological disasters becomes difficult many a times due to problems in prediction whereas with regard to meteorological and hydrological disasters forecasting has become easier due to the important role played by the meteorological department, water commission, cyclone warning centres etc. According to the database of the Belgium Centre for Research on the Epidemiology of Disasters (CRED), weather–climate–and water–related hazards that occurred between 1993-2002, were responsible for 86 per cent of the 531,000 deaths, 99 per cent of the 2.5 billion reported affected peopleand 63 per cent of the US$ 654 billion damage caused by all natural disasters. These natural hazards are, therefore, the most frequent and extensively observed ones. Their spatial and temporal scales vary widely from short-lived, violent phenomena of limited extent such as tornadoes, flash floods and severe thunderstorms to large types like as tropical and extra tropical cyclones. At the largest scale, droughts could affect huge sub-continental areas from months to years. Among these hazards, droughts, floods and tropical cyclones are
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responsible for the most significant impact on human life and property. In particular, the potential of tropical cyclones for wreaking havoc caused by their violent winds, torrential rainfall and associated storm surges, floods, tornadoes and landslides is exacerbated by the vulnerability of the impacted area.

One of the essential elements of life on earth is fresh water. Sustainable development therefore demands sustainable management of the world's limited resources for fresh water. Although 70 per cent of the Earth's surface is covered by water, 97.5 per cent is saline and the remaining 2.5 per cent is stored in lakes, rivers, permanent ice sheets and ground water. Only about 0.26 per cent of this fresh water is accessible for human and ecosystem use. Today, more than 1 billion people do not have access to drinking water and 31 developing countries representing 2.8 billion people face chronic freshwater availability problems. They (floods) pollute water supply leading to the spread of diseases such as cholera and malaria. Among other things, they have implications for domestic, agriculture and industrial activities. Natural disaster risk management should, therefore, include water resources management as an essential component.

The World Meteorological Organisation (WMO) plays an important role in natural disaster reduction. In the area of risk identification, WMO gives utmost priority to monitoring, preparation of increasingly accurate forecasts, free and unrestricted exchange of data products and early warnings, with longer lead times.

Monitoring and Preparation of Forecasts

In order to contribute to effective monitoring and forecasts, WMO coordinates a global network for the acquisition and exchange of observational data under the Global Observing System of its World Weather Watch Programme. The system comprises some 10,000 stations on land, 1,000 upper-air stations, 7000 ships, some 3,000 aircraft providing over 150,000 observations daily and a constellation of 16 meteorological, environmental, operational and research satellites. WMO also coordinates a network of three World Meteorological Centres, 35 Regional Specialised Meteorological Centres and 187 National Meteorological Centres. These networks are essential in satisfying the requirements for monitoring and forecasting; to assure that the global telecommunication system will continue to be improved in order to allow for the exchange in a free and unrestricted manner of the needed data and early warnings; to improve the forecast capacity at regional and national levels, in particular through research and exchange of knowledge and technology; and to assure that policy makers are aware of the potential of early warnings issued by the National Meteorological and Hydrological Services and such warnings are appropriately integrated in national and regional disaster mitigation strategies and policies.

Early Warnings for Weather-related Disasters

The scientific understanding and technological capabilities underlying the system of weather and climate forecasting have made enormous progress over the past 25 years. The skill levels and utility of the resulting forecasts and warnings using numerous Weather Prediction and Ensemble Prediction Systems have steadily increased especially of the large scale weather systems and of the associated extreme weather phenomena. WMO's World Weather Watch system enables the availability of advanced and increasingly accurate forecasts and warnings to all countries. However, there is a continuing need to enhance the relevant infrastructure and capability to adapt the forecasts to local conditions effectively and to develop better preparedness plans in many countries.
An example of the benefits resulting from such an approach is from Bangladesh. A simple storm in 1970 devastated parts of the country and killed up to an estimated 300,000 people. This may have been the deadliest storm to strike a coastal region. A cyclone of similar intensity in 1997 hit the same coast and caused 180 deaths. This cyclone affected nearly two million people, caused severe damage to more than half a million houses, around 600 educational buildings, 29000 hectares of crops and 152 km of embankments. The property damage could not be stopped but human casualty due to this cyclone was effectively contained. Unlike the 1970 cyclone, casualties and devastation caused by the 1997 cyclone were remarkably low not only because it hit during low tide at day time but were mainly attributed to good preparedness in the form of timely storm warning, well tested procedures for disaster management, the availability of cyclone shelters and the evacuation of people in high risk areas.

The earthquake of 8.7 magnitude that struck Sumatra on 29 March 2005. raised fears of tsunami striking the coastal states. Andaman and Nicobar islands and the Lakshadweep in India. The networking and sharing of information with various research centres in Indonesia, Washington and the Pacific Tsunami Warning Centre led to a situation of preparedness with the central and state agencies putting in place functional and effective systems. The state governments of Andhra Pradesh and Tamil Nadu acted swiftly and all precautions were taken in time to save lives and property in the wake of an alert (The Hindu, 2005).

The National Institute of Oceanography in Goa has developed a real-time reporting and internet-accessible coastal sea-level monitoring system and it has been operative in the Mandovi estuary in Goa since 24 September, 2005. The gauge uses a cellular modem to put on the Internet real-time sea-level data, which can be accessed by authorised personnel. By using a cellular phone network, coastal sea-level changes are continuously updated on to a web-server. The sea-level gauge website can be made available to television channels to broadcast real-time visualisation of the coastal sea-level, particularly during oceanographic hazards such as storm surges or a tsunami. A network of such gauges along the coast and the islands that lie on either side of the mainland would provide data to disaster management agencies to disseminate warnings to coastal communities and beach tourism centres (Joseph and Prabhudesai, 2006).

A Natural Disaster Information System (NDIS), a first of its kind, aimed at alerting people about any impending natural disaster was launched recently by the government. The project developed under private-public partnership by the Technology Development Council (TDC) and Bangalore-based Geneva Software Technologies is a landmark in managing disasters. The system will communicate to the people about any disaster in their local language in their locality in less than one minute (The Hindu, 2006).

Vulnerability Assessment and Hazard Analysis

The knowledge of vulnerability at the local, national and regional levels is an important factor in evaluating the adequacy of early warnings. A good tool to assess these different vulnerabilities is the linkage between weather, climate and disaster databases to the different types of meteorological or hydrological disasters (Jarraud, 2004).

The IMD's (India Meteorological Department's) responsibility, it has been felt in respect of cyclone forecasting and warning is for a region larger than the Indian territory. By international arrangement under the aegis of the World Meteorological Organisation (WMO), IMD New Delhi is designated as the Regional Specialised Meteorological
Centre for Tropical Cyclones (RSMC – Tropical Cyclone) and deals with all the cyclones that develop in the Bay of Bengal and the Arabian Sea. There are only three such designated centres in the northern hemisphere viz., Miami, New Delhi and Tokyo, each being responsible for a specified region. In short, the cyclone forecasting and warning system in India has a state-of-the-art proven and internationally recognised operational system.

In India, there are Area Cyclone Warning Centres (ACWCs) at Kolkata, Chennai and Mumbai and Cycle Warning Centres (CWCs) at Bhubaneswar, Visakhapatnam and Ahmedabad. These Centres have early warning systems. A satellite-based communication system known as cyclone warning dissemination system has been installed by IMD. The IMD monitors seismological changes through a network of 36 seismic monitoring stations.

11.6 CONCLUSION

Science and technology plays a very important role in disaster preparedness. The importance of science and technology is only going to increase, not diminish. The question is not, whether to use science and technology in disaster preparedness, or not but how best to use science and technology. Science and technology is developing at a very fast speed. Information technology is increasingly being used in daily life during normal course of living. In disaster situations, Internet and World Wide Web are instantaneous, real time, global communication source at very economical cost. World Wide Web facilitates quicker retrieval of information. There are search engines, which can help in locating information. This wind and water flow are the most important cause of natural disasters, excluding earthquake and volcano. The study of meteorology and hydrology helps in understanding impending natural disasters and provide warnings and for taking preparedness actions.

11.7 KEY CONCEPTS

Hydrology : The science of the properties, laws, etc., of water, especially of its movement on, under and above land.

Local Area Network (LAN) : A computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance via telephone lines and radio waves. A system of LANs connected in this way is called a Wide Area Network (WAN).

(www.webopedia.com)

Meteorology : It is the study of motions and phenomena of atmosphere especially for weather forecasting.

UNOCHA : The Office for the Coordination of Humanitarian Affairs (OCHA) is an organisation under the United Nations which originated in December 1991 with the General Assembly Resolution 46/182. The resolution was designed to strengthen the UN response to complex emergencies and natural disasters by creating the Department of Humanitarian Affairs (DHA). OCHA
World Wide Web: This usually refers to information available on the Internet that can be easily accessed with software usually called a "browser". Organisations publish their information on the web in a format known as HTML; this information is usually referred to as their "homepage" or "website".

11.8 REFERENCES AND FURTHER READING

Commonwealth of Learning, 2003, Commonwealth of Learning Executive MBA/MPA, Course Material on Disaster Management, Vancouver.


Jarraud, M. 2004, WMO’S Role in Disaster Mitigation and Response – Challenges and Opportunities, Paper presented at World Congress on Natural Disaster Mitigation, Institution of Engineers (India), New Delhi.


Sub-committee on Disaster Reduction, 2003, Interim Report on Reducing Disaster Vulnerability Through Science and Technology, USA.

The Hindu, 30 March, 2005.

The Hindu, 14 February, 2006.


Websites


www.fema.gov Federal Emergency Management Authority

www.undmtp.org United Nations Disaster Management Training Program


11.9 ACTIVITIES

1) Visit any nearby meteorological or hydrological station, laboratory or department and enquire about its activities.

2) Visit an international disaster preparedness website and write a report about its activities.