UNIT 12 ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN HEALTH RESPONSE

Structure

12.0 LEARNING OUTCOME

After studying this Unit, you should be able to:

- describe the meaning and concepts of Information and Communication Technology (ICT);
- examine the various tools of ICT and their role in health response; and
- discuss the ICT initiatives taken in the field of health management of disasters.

12.1 INTRODUCTION

Disasters are generally geo-climatic events, and they strike the human beings with no or very little prior indications. Around the world, disasters strike both developed and developing nations, and leave a huge dent on the economy and infrastructure. Globally, natural disasters account for nearly 80 percent of all disaster-affected people. Situation in regions like South-Asia is no different. Suffering of the people due to natural disasters are common in the countries of this region.

Natural disasters cannot be prevented, but their adverse impacts can be minimised by taking certain mitigation measures. Among the various measures to mitigate the negative impact of disaster, planning and preparedness are the most crucial. With ICT, it has become possible to get prior information about the location and magnitude of a likely disaster. Today, ICT plays an important

role in disaster management and in catering to the varying health needs of the affected population with its tools and applications.

We will now discuss the meaning, significance, and role played by ICT in the health management of disasters.

12.2 INFORMATION AND COMMUNICATION TECHNOLOGY: MEANING AND CONCEPT

Information and Communication Technology (ICT) is a term that encompasses all forms of technology used to create, store, exchange, and use information in its various forms (business data, voice conversations, still images, motion pictures, multimedia presentation and other forms, including those not yet conceived). It is a convenient term for including both telephony and computer technology in the same word. Information and Communication Technology uses an array of modern electronic gadgets like satellites, radars, computers, sensors, cameras, etc. to collect, process, and disseminate the information. It is a reliable, cost-effective, and fast medium of handling information. There are number of components of Information Technology like Remote Sensing, Satellite Imagery, Internet, Geographical Information System, mobile and satellite telephones, etc., which either work individually, or in combination towards handling the available information.

In the following sections, we will discuss the various tools and applications of ICT in disaster health management.

12.3 TOOLS OF ICT: APPLICATIONS

We will now discuss the applications of four tools of ICT, namely:

- Geographical Information System (GIS)
- Remote Sensing
- Satellite Imagery
- Internet

12.3.1 Geographical Information System (GIS)

Burrough has defined GIS as ‘a set of tools for collecting, storing, retrieving, transforming, and displaying spatial data from real world for particular set of purposes’. The Department of Environment defines GIS as a system for capturing, storing, checking, integrating, manipulating, analysing, and displaying data, which are spatially referenced to the earth.

There are three main components of GIS, namely: computer system, software and spatial data, and data management and analysis procedures. Spatial data is also referred as to geographical data, and is characterised by information about position, connections with other features, and details of non-spatial characters. For example, spatial data about a particular area may include:

i) Latitude and longitude as a geographical reference.

ii) Connection details, such as, service roads, rail heads, etc., which allows the outsiders to access that area.

iii) Non-spatial (or attribute) data, such as, details of amount of snow or rainfall, wind speed, and direction.

GIS uses geographical position or location, as a common thread to integrate and analyse information from various sources. GIS can also be put to use to assess risk to life and property stemming from natural hazards, such as, earthquakes, cyclones, tsunami, and floods.

The potential uses of GIS in geographical planning of health for different situations are many. They are as follows:

i) **Studies of environmental hazards and disease clusters**

The geographical investigation of environmental health hazards encompasses a wide range of studies in which GIS play a useful role, including, studies of reported disease clusters, geographical surveillance, analysis of health statistics in relation to single or multiple sources of pollution, natural calamities, chemical accidents, etc. It is also useful for modelling distribution of exposures, as well as, the size and characteristics of population at risk. It has application in areas, such as, quantitative risk assessment of exposure to outdoor air pollution, estimation of health impact of flood hazards, health consequence of localised water pollution, infectious diseases and effects of global change, spread of vector borne diseases, heat-related and cold-related deaths, change in agricultural patterns and yields, effects of ultra violet radiation from ozone depletion, etc. GIS methods are also used in planning of response of emergency services to major chemical or radioactive element spillage, earthquakes or similar incidents.

Modelling of different scenarios, such as, pollution dispersion from an accident, provides an indication of expected casualties and later health impacts. This information can then be used to test, in theory, the capacity of emergency services and health systems to deal with the emergency. Useful lessons may be learnt from such case studies about emergency response procedures.

ii) **Disease mapping and geographical correlation studies**

One of the most useful functions of GIS in public health is mapping. Maps of health statistics can be invaluable in understanding local pattern of diseases and their geographical association. They have the advantage of conveying instant visual information accessible to non-experts, as well as, public health professionals. Yet another benefit of GIS is that it allows semi-automated data processing so that analysis can be carried out at high resolution and with wide geographical coverage.

iii) **Patterns of health service use and access**

In many ways, GIS is an ideal tool for planning organisational issues of health service. Firstly, referral patterns of the hospitals, and emergency clinic locations to deal with emergency situations are highly suited to GIS analysis. For example, in case of an occurrence of a cyclone in the coastal area, there are questions about the optimal size, structure, and location of treatment centres. Different hospitals may be provided with different specialist services. How services can be most effectively organised, which hospitals should develop specialist facilities, where clinics should be sited, etc., depend on many factors, some of which are clearly geographical. How people currently use health service facilities in different areas, and how restructuring them could improve their access are vital factors. GIS may be used to examine current patterns of use and carry out modelling of different ‘scenarios’, taking into account the population distribution, location of facilities, transport links, primary care services, and range of other factors.

Secondly, estimation of service areas of hospitals can be made. There are problems of accurate enumeration as the population served by a hospital is usually geographically dispersed, and not neatly constrained by administrative and census boundaries. Nonetheless, it is often desirable to characterise the population that a hospital serves, so that proper account can be taken of its needs. Overlay of map layers- address locations on census boundaries, and other geographical features- using GIS techniques can help to define hospital's service area.

Thirdly, that the primary, secondary, and tertiary health care services are accessible to all sections of the population including those who have to rely on public transport to reach a health centre, areas served by specific facilities and travel times are, therefore, important to service configuration and can be examined in the framework of location analysis of GIS. Social as well as physical factors can be brought into analysis using area-based markers of socio-economic deprivation, female-headed houses, houses with physically challenged children, houses with senior citizens, etc.

iv) **Search and rescue**

GIS can be used in carrying out search and rescue operations in a more effective manner by identifying areas that are disaster prone, zoning them according to risk magnitudes, inventorying population and assets at risk, and simulating damage scenarios.

v) **Records management**

Record keeping is a crucial task in disaster management. Claims, status of repairs, required repair work, personnel, and so forth, can be difficult to maintain and account for. GIS facilitates record keeping, and status of ongoing work. As work is completed and identified, GIS can visually display current project status. For example, damaged structures deemed unsafe for occupancy, or those requiring minimal work can be appropriately coded and displayed in GIS. As the status changes, information can be quickly updated and reports generated. Current status can be easily viewed and accessed through a centralised GIS, and Remote Sensing interface.

12.3.2 Remote Sensing (RS)

Remote Sensing is a technology for sampling electromagnetic radiation to acquire and interpret non-immediate geo-spatial data from which to extract information about features, objects, and classes on the Earth's land surface, oceans, and atmosphere. It gathers data and information about the physical "world" by detecting and measuring radiation, particles, and fields associated with objects located beyond the immediate vicinity of the sensor device(s).

Remote Sensing comprises of Arial Remote Sensing, which is the process of recording information, such as, photographs and images. The sensors may be fitted with the satellites or low flying objects, or may be installed on the ground (radars) to acquire the images of various kinds from the earth. Remotely sensed image data may be recorded in either photographic or digital (numeric) form. Data must be in digital form for computer processing. So any data, which was recorded photographically, such as, aerial photography, are converted to digital form before being used in image processing systems. Most satellite image data and airborne scanner imagery are initially recorded in digital form.

Remote sensors rely upon the detection of energy emitted from or reflected by the object. The source of the radiation being sensed may or may not be independent of the sensing device. Active remote sensing devices, such as radar,

direct radiation of a particular form towards an object and then detect the amount of that energy, which is radiated by the object. ERS images belong to the active remote sensing system. On the other hand, passive remote sensing relies on the radiation originating from some other source, principally the sun. Aerial photography and SPOT satellite imagery are examples of data collected by passive remote sensing systems. Images acquired from airborne sensors flying at a relatively low altitude cover rather small areas, with a good level of details. Images acquired from satellite borne sensors orbiting at hundreds of kilometres cover larger area, but usually provide a more coarse representation of the earth's surface.

Remote sensing data can be used in:

- Land-cover mapping
- Environmental assessment
- Traffic management (navigation information)
- Air pollution modelling
- Disaster management (pre, during, post).

Depending upon the need of the user, sources of remote sensing information are chosen among the pool of images taken by the platform/sensors. Since the launch of Landsat 1 in 1972, remotely sensed data have been used to map features on earth's surface. An increasing number of health studies have used remotely sensed data for monitoring, and surveillance or risk mapping of vector-borne diseases. Nearly all studies have used data from Landsat, French SPOT, and NASA's AVHRR. Remote Sensing in conjunction with GIS and photogrammetry can be used to identify hazards. Scientists using GIS to analyse satellite image, aerial photos, and field survey data, can identify seismic faults and flood prone areas.

Application in Disaster Management and Health Response: GIS and RS

Emergency disaster management requires response, incident mapping, establishing priorities, developing action plans, and implementing plans to protect lives, property, and environment. RS and GIS allow disaster managers to quickly access and visually display critical information by location. This information facilitates the development action plans that are printed or transmitted to disaster response personnel for the coordination and implementation of emergency efforts.

Real time monitoring of flood is useful for detecting the isolated marooned villages and people therein. This is very much helpful in initiating relief and health facilities to the victims. Simultaneously, the vulnerable population like aged, pregnant women, children, and physically challenged can be better served with accuracy. Tracking of an epidemic following a disaster can be done through remote sensing data, and required health facilities can be sent to the affected area. Also, health infrastructure damaged during a disaster can be highlighted, and necessary restorative action can be initiated.

For cyclone, India Metereological Department (IMD) provides cyclone warnings from the Area Cyclone Warning Centres (ACWCs). It has developed necessary infrastructure to originate and disseminate the warnings at appropriate levels. It has made operational, a satellite based communication system called Cyclone Warning Dissemination System, for direct dissemination of cyclone warnings to the cyclone prone coastal areas. IMD runs operationally a Limited-Area Analysis and Forecast System (LAFS), based on an Optimal Interpretation (OI) Analysis and Limited Area Premitive Equation (PE) Model, to provide numerical guidance.

Prior information acquired from the above mentioned facilities could be used to respond to the health requirements of the disaster affected people. Mobilisation of the health staff and other medical equipments, drinking water, food, etc., can be planned before hand with the information obtained through remote sensing. This will help in making health services responsive to the vulnerable group in the best of time. Equally, remote sensing data and images can play an important role in the process of damage calculation and planning for the rehabilitation and reconstruction of the health facilities.

Preparation of comprehensive landslide zonation map requires a large amount of data concerning many variables, and covering large scope areas to be collected, stored, sorted, and evaluated. The use of aerial photographs and adoption of remote sensing techniques help in collection of such data. Hazard zonation map can be helpful in planning the set up of the health facilities, like health centres and hospitals, to serve the most vulnerable in the mountain ranges.

In 1998, the National Aeronautics and Space Administration's (NASA) Centre for Health Applications of Aerospace Related Technologies (CHAART) evaluated current and planned satellite sensor systems as a first step in enabling scientists to determine data relevant for epidemiologic, entomologic, and ecologic aspects of their research, as well as developing remote sensing-based models of transmission risk. The model was first implemented to characterise the spatial pattern of key components of the Lyme disease transmission cycle in New York by using LANDSAT Thematic Mapper (TM) Image. This has very comprehensively analysed the Lyme disease transmission variables, such as, vector and reservoir habitats, as well as, human risk for disease.

Yet another application of remotely sensed data has been to search for temporal pattern associated with cholera outbreaks in the Bay of Bengal region. Studies and observations suggest cholera epidemics caused by ***Vibrio cholerae*** O1 occuring regularly in Bangladesh and India, and sporadically in many parts of the world. The outbreaks of cholera that have occurred during the past decade originated mainly in coastal areas.

In the case of Bangladesh, the sediment load transported to the Bay of Bengal by the Ganges and Brahmaputra rivers had nutrients that supported plankton booms. Plankton is an important marine reservoir of ***Vibrio cholerae,*** which attaches primarily to zooplankton, which, in turn is associated with phytoplankton. Along with this, data on sea surface temperature (SST) and sea surface height (SSH) were also analysed after the colour infrared images were captured by different sensors. It has been observed that increase in SST and SSH has preceded cholera outbreaks in Bangladesh. A model driven by satellite remote sensing will be useful in tracking the spatial and temporal development of such plumes, as they impinge on coastal areas, related to outbreaks of cholera in the region. The model can be used to provide an early warning system for cholera in coastal areas and enable more effective deployment of resources to counteract, if not prevent, massive epidemics of cholera.

Wet soils indicate a suitable habitat for species of snails, mosquito larvae, ticks, and worms. Several types of sensors, such as, synthetic aperture radars (SARs), shortwave-infrared, and thermal-infrared sensors can detect soil moisture. SARs are particularly important for sensing ground conditions in areas of cloud cover, or vegetation canopy cover.

Some disease vectors are associated with specific urban features, such as, housing, which can only be detected by sensors with very high spatial resolution. Latest satellites with sophisticated sensors are expected to provide information

on the urban environment. It is estimated that in the next fifteen years, we will have new sensors that will provide valuable data in studies of disease vectors.

12.3.3 Satellite Imagery

In general, a satellite is a body or mass, which orbits a larger body or mass. When we speak of satellites as they relate to weather, we are usually referring to man-made machines, which orbit the earth. Satellites are useful for weather observation because they are at an ideal vantage point. All weather satellites orbit high above the atmosphere well above any clouds, storms, or other weather effects. This affords a clear view of the weather patterns below. The extreme altitude also allows us to view a large area of atmosphere. Also, depending on the nature of the orbit, it is sometimes possible for a satellite to view the entire earth in a matter of few hours. Most weather satellites carry a wide array of instruments to allow a great number of images and measurements to be made.

The satellites are placed frozen geo-centrically, which can offer repetitive coverage of particular locations at regular intervals with its beamed, as well as, timed photographs. In the present time, satellite imagery has become intrinsic to meteorological study, and has made weather predictions effective to manifold. All this has helped the health managers to plan in advance for the vulnerable population against any impending disasters.

12.3.4 Internet

Internet is a network that connects hundreds and thousands of local area networks creating a global medium in which millions of computers can connect to each other to share resources. It can store huge quantity of data in digitised form, and can access the data banks worldwide and retrieve those at any time, rapidly and automatically. This facilitates global dissemination of disaster information in a rapid and spontaneous manner.

The above features of Internet can be used to develop an effective disaster mitigation system. Information regarding the characteristic and losses of a past disaster can be stored safely for future references.

A well-defined web site containing disaster information can be launched to communicate to the out side world about any disaster. Internet can also be used to call for external help for an affected area from the intended agencies. This is instantaneous and paperless, and therefore, is most efficient and cost-effective.

Experiments are on by number of individual and groups, including several national meteorological services to provide real time weather observations, and forecasts through Internet for concerned professionals and people. Internet also facilitates two very effective system of health response in both normal and emergency times. These are telemedicine and medical transcription. These facilities are all the more important to masses who live in remote places and do not have easy access to health facilities.

i) **Telemedicine**

It is the investigation, monitoring, and management of patients, and also the education of patients and staff using systems that allow ready access to expert advice and patient information, no matter where the patient or relevant information is located. Through telemedicine super specialty health care centres or specialists are connected through Internet, and expert opinion is sought by sending the required data and relevant information about a health problem through Internet from any part of the world. The process is fast, cost effective, and time saving.

ii) **Medical Transcription**

This is yet another cost-effective measure in which medical professionals' conversations are recorded during the performance of operations and transcribed later for review. On one hand, this facilitates the professionals to review their own activities in pressure situations, on the other hand, it gives an easy access to professionals in far off places about the activities of their fellow professionals.

Here are some sites on Internet, which provide information on various aspects of disaster management:

http://www.undp.org.in/dmweb/NDPM-NE/map/Sambalpur.pdf

This site states the District Disaster Management Plan of Sambalpur district in Orissa, prepared by the district administration. It provides information about basic geo-climatic features, previous history of disasters like floods, heat wave etc. in the district, and the preparedness of administration to face the emergency situation. It documents information of the vital resources like drinking water source, earth moving equipment stores, reservoir details, health centres, ICDS personnel, transportation and communication network, vital road maps, fire stations, places of food stocks, etc., to get easy access to them in emergency situations. The plan also takes into account the probable places where disasters can strike (hazard mapping). More importantly, it provides the telephone numbers and the email addresses of important persons and NGOs working in the area, who may be contacted in case of an emergency.

http://wwwnotes.reliefweb.in

Relief Web is a project of the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). Its purpose is to strengthen the response capacity of humanitarian relief community through timely dissemination of reliable information on prevention, preparedness, and disaster response.

http://www.ndmindia.nic.in

This is a Government of India site launched by the Ministry of Home Affairs. The site consists of management plan of the government regarding disasters. It provides the details of current and past disasters. It also makes available the current weather status and cloud images taken by satellites, and the weather forecast by IMD.

12.3.5 Satellite Telephone Communication System

All disasters, whether natural or man-made, have the common characteristic of first disrupting the transportation and communication system. Satellite systems hold forth the promise of true 'anywhere, anytime' access to communication, even in the most rural and remote areas of the globe. A number of worldwide satellite telephone systems are already in operation. These systems provide communication coverage over very wide areas, including the ocean. In general, they fall into three broad classes: geosynchronous (GEO), "big" low earth orbit (LEO), and "little" LEOs. As the systems are run on wireless and can be operated with the help of solar energy, they, as expected, are playing a vital role in disaster situations. We have already experienced situations like, super cyclone Orissa, great flood, West Bengal, and massive earthquake, Gujarat, where all the other conventional communication systems failed miserably, satellite telephones played a vital role in keeping constant touch with the outside world. In fact, this was the only medium to communicate with the outer world till the conventional communication system, like, telephone, telegraph, etc., was restored.

12.4 CONCLUSION

Disaster preparedness, emergency relief, and recovery are the three main lines of action that provide for an effective public health management of disasters. ICT addresses these issues by facilitating access to, and dissemination of timely information and knowledge. It has operational utility, both, at the micro and macro level. At the micro level, ICT can be used in spreading awareness about disaster preparedness and mitigation in the community through Internet based community information centres. At the macro level, it can be utilised to facilitate health network connectivity within the nation, and also among countries.

ICT has made significant contribution to the field of disaster medicine. It has made tele-medicine and tele-consultation possible in remote areas that were not connected or accessible during disasters. It has established electronic connectivity between hospitals and disaster site, which has enabled immediate diagnosis and treatment of the disaster victims. It has further facilitated effective and quick communication and transportation and has rendered coordination effective with its ability to transfer and exchange information at a high speed. In all, it has ensured real time qualitative medical and health services in disasters.

12.5 KEY CONCEPT

Lyme disease was named in 1977 when arthritis was observed in a cluster of children in and around Lyme, Connecticut. Other clinical symptoms and environmental conditions suggested that this was an infectious disease probably transmitted by an arthropod. Further investigation revealed that Lyme disease is caused by the bacterium, *Borrelia burgdorferi.* Bacteria is transmitted to humans by the bite of infected deer ticks.

12.6 REFERENCES AND FURTHER READING

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12.7 ACTIVITY

Narrate an ICT Project in disaster management in India.