Role of GIS (Geographical Information System) in disaster management:

Introduction:

Geographic Information System (GIS) is a computer based application of technology involving spatial and attributes information to act as a decision support tool. It keeps information in different layers and generates various combinations pertaining to the requirement of the decision making. In the recent times, GIS has emerged as an effective tool in management of disasters since, geo-spatial data and socio-economic information need to be amalgamated for the better decision making in handling a disaster or to plan for tackling a disaster in a better way. GIS could be utilized by the different line departments and agencies who are stakeholders in the disaster management process. Some basic hardware like computer system, printer, network systems, along with GIS software are required to set up the GIS in any organisation.

Objectives:

The prime objectives of developing the GIS database are to help disaster managers at State, District and Block level for:

i) Pre-disaster planning and preparedness

ii) Prediction and early warning

iii) Damage assessment and relief management

Application of GIS in disaster management

GIS has been effectively used in the following cases as a decision support tool.

1. Identification of location for construction of multipurpose cyclone shelters

2. Grid analysis for setting up the Automated Weather Stations (AWS)

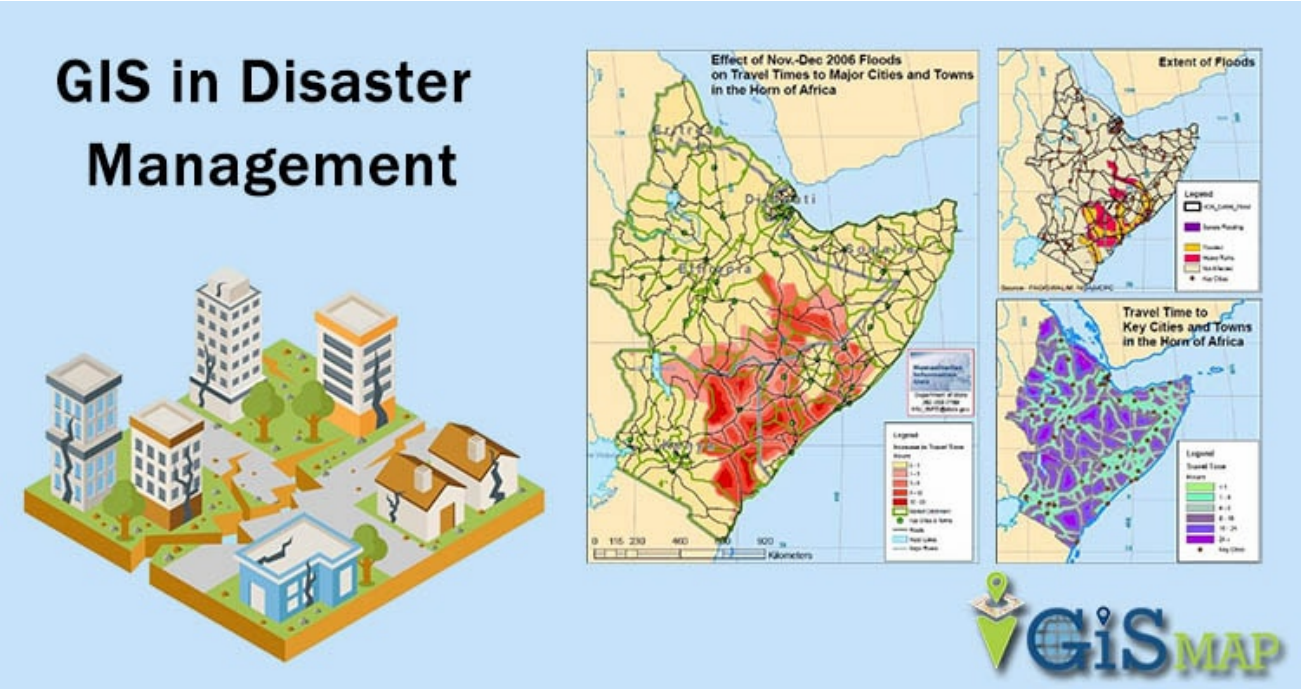
3. Preparation of the district and gram panchayat level vulnerability maps

4. Strengthening of embankment, repair of roads

5. Identification and demarcation of weak points in the embankments, area to be affected by flood for preparedness planning

6. Preparing the base map indicating location and operation of boats and deployment of rescue personnel

7. GIS was extensively used as a part of the Incident Command System and Decision Support System during the Air dropping operations in management of floods in 2007 and 2008



Today, current technology is advancing in various fields, especially in science and technology, while technological advances pose many challenges. We can use technology to artificially adapt and replicate things, but human beings and other living organisms are more important compared to development. Technological advances also increase the likelihood of disasters. A disaster can be a natural or man-made disaster or an accident, depending on several factors. The main factor is climatic conditions due to human activities such as air, water, and soil pollution. Geographic Information System (GIS) technology plays an important role in combating such disasters. Combining geographic information systems with remote sensing and photogrammetry technologies enables the seamless application of this technology at all stages of the disaster management cycle, from mitigation to recovery processes.

» 2. Geographical Information System (GIS)

Geographic Information Systems are systems that process including, store, manipulate, analyze, integrate, and display data. Disaster prediction can be made using a lot of data, which is available in hundreds of thousands of information such as population and their age, gender details, utility service information, land details of the whole state, and so on.

» 3. Disasters

Natural disasters are dangerous events caused by natural processes on earth. An example of a natural disaster is a flood, earthquake, hurricane/cyclone, volcanic eruption, tsunami, and other geological processes. Man-made or anthropogenic disasters are caused by human activities. Anthropogenic disasters adversely affect humans, other organisms, and finally the ecosystems. Examples of man-made disasters include all types of pollution, nuclear disasters, chemical disasters, biological disasters, terrorism attacks, and other accidental disasters.

• 3.**1 Floods** – With the help of Remote Sensing & GIS techniques, floods can be predicted. National Disaster Management Authority (NDMA) & State Disaster Management Authority (SDMA) utilized remote sensing techniques in combination with GIS/Photogrammetric technology for Effective & Economic way management of disasters. GIS technology plays a key role in identifying flood-affected locations and providing shelter for affected people. In addition to that, the suitable places for constructing the retaining wall structures and an alternate route for draining the stormwater. This process also helps to create different levels of vulnerability maps which indicate the areas that are frequently affected by floods and base maps (Gram Panchayat, District) to show the location and setup of boats and the rescue team's plans.

The 3-Dimensional of Flood simulation results will give more strong information to understanding the disaster impacts quickly.

Flash Flood is one type of flood and it is a sudden flood that flushes water paths and is caused by many reasons like Heavy Rain, and melted water from snow/ice on a snowfield. Flash Flood before & after images were shown in Figures 1 & 2 using IGiS (Integrated GIS and Image Processing) software.

• **3.2 Earthquake**– It is one of the oldest enemies of humankind and now it is possible to map and analyze earthquakes in a detailed manner. GIS supports national, regional, and local emergency organizations in planning and managing preparatory programs. The GIS-based Urban Information Systems is used to analyze demographic data and infrastructure locations.Remote sensing and GIS Technology provides the exact position of the spatial data of historical sites. The vision of remote sensing and GIS technology is to visualize the critical vulnerabilities & damages and reduce the impact of the disaster. The GIS Technology results could be responded to quickly during the disaster.

Experience has shown that earthquake deaths can increase due to secondary disasters such as tsunamis and fires. Buffer analysis serves as a good remedy to reduce vulnerabilities to

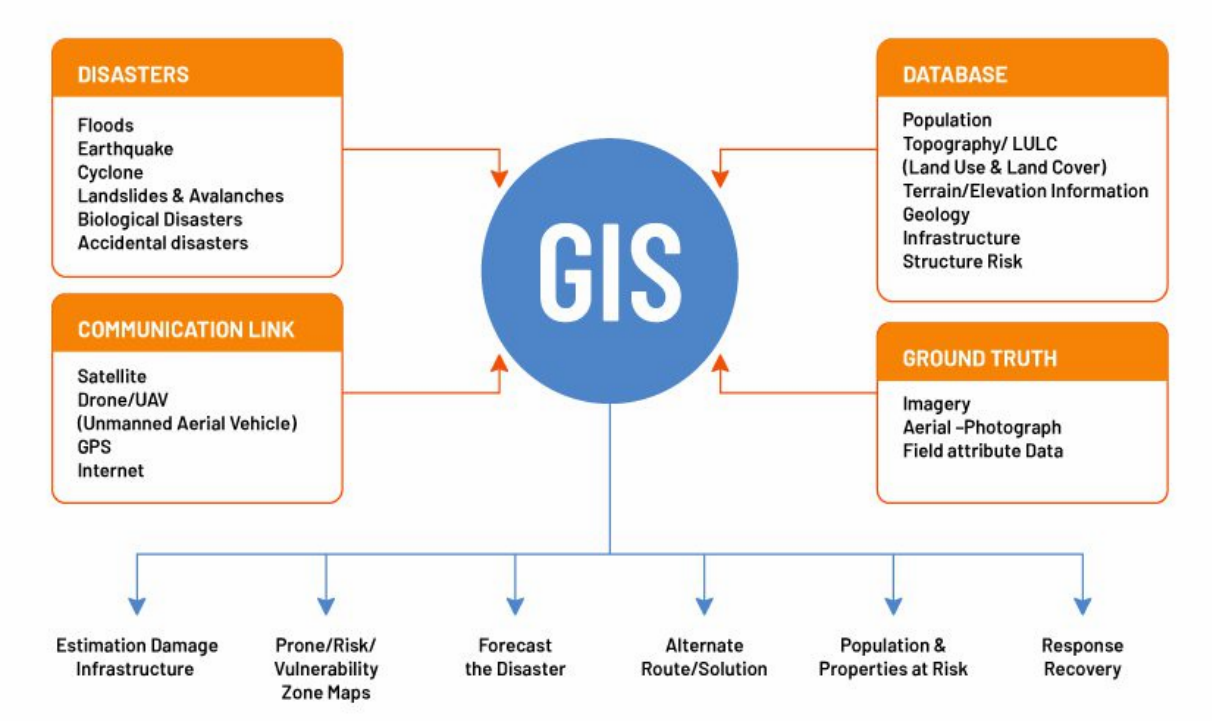
predict the damage that could be caused by a tsunami. The GIS-based Network analysis tool is used to identify the location and routes that provide the fastest response to emergency needs like a hospital, fire station, and so on The real-time location tracking platform or web/mobile GIS-based applications are enabled to interact with the maps which contain the details of the earthquake location & its intensity, health facility, nearby base camp information, and Damage assessment. The GIS-based application also acts as a collective platform for data gathering around the incident of infrastructure damage or fire and information dissemination to relief teams involved in providing aid to those affected by the disasters.

3.3 Cyclone – It is the most destructive force of nature, causing widespread loss. Remote Sensing technology is used to monitor & collect acute information for the entire earth globe concerning the topography and meteorological/climate data. The Temporal data of the same place has become strong and dominant in determining as well as forecasting the natural calamities for the environment & ecosystem protection and development. Similarly, Remote Sensing & GIS technology acting a major role in other disasters like Drought, Heatwaves & Cold waves, Climate Change, and Global Warming & its Effects.

The pollution disasters like air pollution, water pollution, and soil pollution are consequences of climate and Global warming effects. These types of disasters are based on the meteorological conditions of the locations/place.

GIS technology has been vital for emergency preparedness through planning & execution and has saved many lives in previously occurred cyclones. It has improved certain extended limits like environmental understanding, strategic decision making, monitoring of climate change impact, and ascertaining future risks. It is mathematics functional algorithms to analyze the geo-spatial data and display the output in a visual format.

The data is visualized and patterns & their relationships can be identified. Government agencies, as well as NGOs that support disaster management, can benefit from this technology because they know which regions are most affected.



Concluding of Role of GIS in Disaster Management

» GIS technology helps identify disasters before they occur, using forecasts or risk zone maps.

» Remote sensing and GIS technology for Disaster Management create an emergency database for people in need of all assistance in the event of a disaster.

» The emergency database contains information about nearby hospitals, emergency shelters, and more. Disaster risk or impact maps focus on taking corrective action against disasters.

» The GIS Technology is combined with Global Positioning System (GPS), which will help to receive/update the help from disaster rescue teams.

» GIS for Disaster Management uses remote sensing data to forecast climate conditions and climate anomalies at any given point by latitude-longitude coordinates.

» The alternate routes can be created by using Disaster Management technology i.e. GIS for rescuing from disasters.The details of the disaster like the occurred place, severity level, and how many areas are affected & disaster directions all will be mapped using GIS Technology.

» The GIS Maps will give also historical/past disaster events details, from this disaster management action will be taken more strongly.

» The Risk zone map of disasters may reduce the vulnerability of the disasters.

» In the event of a disaster or post-disaster emergency, GIS technology uses a combination of GPS & 5G to enhance assistance.

» Remote Sensing and GIS technology have strong essence to provide the solution to all types of disasters but only the method, and consideration of the factors are different.

So, disasters occur naturally or accidentally and cannot be stopped, but technology can be used to minimize the impact and damage.

Remote sensing: Remote Sensing is the science and art of acquiring information about material objects, area, or phenomenon, without coming into physical contact with the objects, or area, or phenomenon under investigation.

(or)

Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft). Special cameras collect remotely sensed images, which help researchers "sense" things about the Earth. Some examples are:

- Cameras on satellites and airplanes take images of large areas on the Earth's surface, allowing us to see much more than we can see when standing on the ground.
- Sonar systems on ships can be used to create images of the ocean floor without needing to travel to the bottom of the ocean.
- Cameras on satellites can be used to make images of temperature changes in the oceans.

Some specific uses of remotely sensed images of the Earth include:

- Large forest fires can be mapped from space, allowing rangers to see a much larger area than from the ground.
- Tracking clouds to help predict the weather or watching erupting volcanoes, and help watching for dust storms.
- Tracking the growth of a city and changes in farmland or forests over several years or decades.
- Discovery and mapping of the rugged topography of the ocean floor (e.g., huge mountain ranges, deep canyons, and the “magnetic striping” on the ocean floor).

Types

1. In respect to the type of Energy Resources:

Passive Remote Sensing: Makes use of sensors that detect the reflected or emitted electromagnetic radiation from natural sources.

Active remote Sensing: Makes use of sensors that detect reflected responses from objects that are irradiated from artificially-generated energy sources, such as radar.

2. In respect to Wavelength Regions:

Remote Sensing is classified into three types in respect to the wavelength regions

1. Visible and Reflective Infrared Remote Sensing.

2. Thermal Infrared Remote Sensing.

3. Microwave Remote Sensing.

Advantages of Remote Sensing

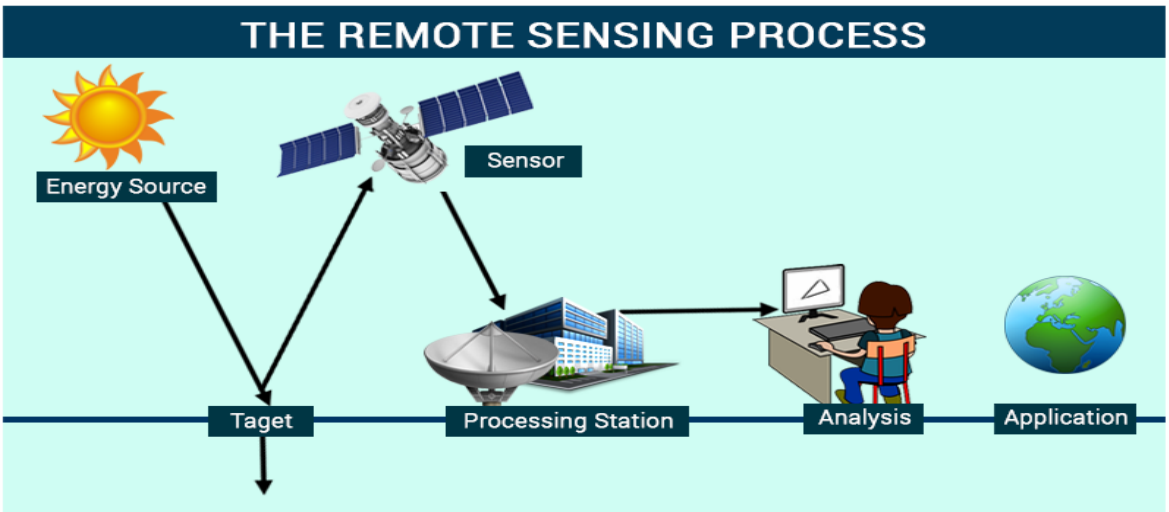
1. A large or wide area can be covered by a single image/Photo. Different Satellites with different sensor systems may cover different extent of areas.

2. We can get the data of any area repeatedly at regular intervals of time, enabling monitoring of changes.

3. Coverage of inaccessible or difficult terrain like mountains, thick forests etc are imaged.

4. Since data is obtained in digital form & in different channels, computer processing and analysis becomes possible.

5. Economic in cost and time.



Role of remote sensing in Disaster management:

Disaster	Response	Preparedness	Mitigation	Recovery
cyclone	Impact Assessment, identifying routes to escape,	Early warning signs, long range climate modelling	Vulnerability Analysis and Risk Modelling	Damage assessment; spatial planning.

	Crisis Mapping, Regular monitoring of cyclones and Storm surge predictions.			
Drought	Assessing the extent of damage, monitoring vegetation	Weather forecasting; vegetation monitoring; crop water requirement mapping; early warning.	Risk modeling; vulnerability analysis; land and water management planning	Informing drought mitigation.
Earthquake	Identifying escape routes, planning routes for search and rescue	Measuring strain accumulation.	Hazard mapping and assessment of building stock	Damage assessment; identifying sites for rehabilitation.
fire	Coordinating fire fighting efforts	Fire detection; predicting spread/direction of fire; early warning	Identifying and mapping fire-prone areas, monitoring fuel load, risk modelling	Damage assessment
Flood	Flood mapping; evacuation planning; damage assessment	Flood detection; early warning; rainfall mapping	Identifying and mapping flood prone areas, delineating floodplains, land-use mapping	Damage assessment. Spatial planning