Geospatial Technology for Disaster Management

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Geospatial Technology in Disaster Management

• Both natural and man-made disasters pose great threats for the development and socio-economic well being of the people.

• It retards development and is particularly hit hard on the poor section of the society.

• The frequency and magnitude of these disasters and related emergencies are constantly becoming unpredictable with grave consequences.

• There are three basic phases of disaster management: Pre-disaster, during disaster and after disaster.

• Surveying, mapping and GIS techniques are now used to facilitate disaster management through the production of model for visualisation.

• Its helps to visualise how to mitigate an upcoming event, where the disaster has effected, effectively deploy rescue team and where to undertake post disaster reconstruction and rehabilitation.
Role of Geospatial Data

- Geospatial Data plays a very big role in disaster management because the features impacted by disasters are geographically located and have geographic addresses.

- GIS and remote sensing are dependable tools that have been used in the evaluation of geo-environmental disasters by providing a kind of synoptic coverage of a very broad area in a cost-effective manner.

- This overcomes the shortcomings of conventional ground stations for recording information during an extreme event.

For example:

- Geospatial data will provide information about the areas that are susceptible to flood and locations that people and live stock can be evacuated to in case of a disaster.

- Moreover, remote sensing tools provide the researcher with multi-date satellite imageries, which in turn aids the researcher in monitoring and recording the change progress of the past flood events.
• In recent years, advancements in GIS and remote sensing have been integrated into the evaluation of geo-environmental disasters, greatly facilitating the advancement of flood susceptibility mapping, flood risk assessment, and erosion prevention.

• It is evident that flood related problems could be solved through planning, studies and also through detailed mapping of flood plains.

• GIS systems are built to cover a wide range of applications.
• They are designed to integrate a vast variety of environmental data, allowing them to work together in a readily accessible way.
Role of GIS and RS in disaster management

• The application of remote sensing and GIS has become a well developed and successful tool in disaster management.

• The requirements for hazard mitigation and monitoring are high on the list of priorities in the development of most new Earth Observation Satellite Programmes.

• Using models, GIS enables the mixing of many types of data. It enables the mixing of various types of geographic data with non-spatial data, attribute data, and the use of this information as relevant information at various stages of disaster management.

• During the disaster mitigation stage, GIS is used in managing the huge levels of data required for vulnerability and hazard assessment.

• In the disaster preparedness stage, it is a tool for planning evacuation routes, designing centres for emergency operations, and for the integration of satellite data with other relevant data in the design of disaster warning systems.

• In the disaster relief phase, GIS, in combination with GPS, is extremely useful in search and rescue operations in areas that have been devastated.

• In the disaster rehabilitation stage, GIS is used to organise the damage information and post-disaster census information and in the evaluation of sites for reconstruction.
Disaster Management

Methodology

Disaster management

Before the Event
- Mitigation
- Preparedness

After the Event
- Relief
- Rehabilitation
- Mitigation
1. Mitigation: Emergency is the discipline of dealing with and avoiding risks. It is a discipline that involves, steps taken to contain or reduce the effects of an anticipated or already occurred disastrous event. It includes:

- Hazard assessment – Type, Frequency, Magnitude, Map of area likely to be affected.
- Vulnerability assessment – Assessing degree of loss of population, buildings infrastructure, economic activities.
- Risk Assessment – Quantifying numbers of lives likely to be lost, cost of damage to property, Preparation of maps, indicating risk areas
- Restrictive zoning – Acquisitions of hazardous areas, removal of unsafe structures, insurance and real-estate information
- Building codes – Example: Earthquake resistance design code
- Public Information
2. Preparedness: It is how we change behaviour to limit the impact of disaster events on people.

- It includes:
  - Preparation of disaster plan – Coordination of emergency services.
  - Anticipating damage to critical facilities - Damage to main roads, hospitals etc.
  - Damage inspection, repair and recovery procedures
  - Communications and control center
  - Disaster training exercises – Rehearsal, Availability of trained personnel
  - Prepare evacuation plans
  - Informing / training population
  - Forecast, warning, prediction of disaster
3. Response: An effective plan for public health and other personnel during a disaster would outline activities designed to minimize the effects of the catastrophe. These efforts can be summarized as closely situation analysis and response.

4. Disaster Recovery: The aim of the recovery phase is to restore the affected area to its previous state. Recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed. It includes:

- Rapid damage assessment
- Implementation of disaster response plan
- Establish communication and infrastructure
- Search and rescue operation
- Speed of information – Real time information, Aerial photogrammetry
- Damage assessment – Quantification of damage
Requirements for effective management

• Large amount of data
• Real time data
• Tool to analyse and interpret the acquired data
Data Management

- Data management is the development, execution, and supervision of plans, policies, programs, and practices that control, protect, deliver, and enhance the value of data and information assets.

- In the context of emergency operations, data management is gathering, managing, processing, and distributing information to users and across systems when and where needed.

- It is the capability to store, manage, update, and provide access to all of the unit's data through well-designed computer system architecture to meet the emergency management mission.
• GIS provides a platform for the management of geographic data and disparate documents (plans, photographs, etc.) necessary to meet the emergency management mission.

• GIS provides a capability to access information based on the geographic location to which it pertains, allowing users to get various types of information from the map display. This could include emergency response plans, mitigations plans, and contact lists.
GIS database

GIS Database includes the following data:

1. Use of different satellite imageries (Remote Sensing data) ex. Landsat, SPOT, IKONOS for GIS data creation.
2. Preparation of base map of different themes using satellite imageries.
3. Thematic maps such as a hydro geomorphologic map, slope map, terrain map, and DEM generation in GIS. It is used for disaster planning.
4. Macro and micro-level maps used for identifying vulnerability and threat condition.
5. Identification of safe locations and zones for rehabilitation.
Road and location maps used for finding alternate routes, shelters, and locations.
Planning of evacuation and operation.
Management of Rehabilitation and post-disaster reconstruction.
Suitable locations identifying scientifically for construction of houses and shelters.
No construction areas identified and rehabilitation of existing people can be done.
Hospitals and medical facilities identification for injured people.
LANDSLIDE DISASTER MANAGEMENT AND PLANNING - A GIS BASED APPROACH –Case study

• Landslide hazard zonation helps in identifying strategical points and geographically critical areas prone to landslides.

• Use of high-resolution satellite data play an important role in landslide disaster mitigation and management.

• In this study, a methodology has been developed to identify landslide prone areas using high-resolution images with 3D GIS.

• ROI comprises complex hilly terrain with steep slopes, thus making way for frequent landslides as a natural phenomenon. This has a great potential to destroy terrain, properties, and lives.

• The landslide in most of the study area occurs, due to changes in landuse/landcover and indiscriminate deforestation in the forest area.
• The data used for the study was obtained from aerial photograph on 1: 8000 scale.

• By the virtue of Photogrammetry, orthophoto map was generated from the aerial photograph.

• The advantage of the high-resolution data is that it helps in deriving 2m contour, which is ideal to get the elevation and slope values of the terrain.

• Digital Elevation Models are derived to refer to any digital representation of a topographic surface.

• The ideal structure for DEMs depends on the intended use of the data and how it might relate to the structure of a model.

• The products derived from DEMs are contour maps (2m interval), slope maps, aspect maps, shaded relief maps and three dimensional perspective views.

• A 3D GIS Software is very useful in such applications. The orthophoto map, topographic map, landuse/landcover map, drainage, slope map, soil map, transportation network and relative relief map have been utilized to generate various thematic data layers in GIS environment.
In order to get the landslide prone areas weightages are to be assigned depending on the threat posed by each category of the GIS Layers.

The zonation map divides the study area into five zones of landslide vulnerability viz., very high, high, moderate, moderate to low and low.

Arc view - 3D analyst has been used for generating 3Dview and getting slope and aspect information. It can be used for land use planning so that landslide can be avoided.

High-resolution data are useful in implementing landslide hazard planning and mitigation measures.

Satellite remote sensing data provide high-resolution images (Cartosat and IKONOS).

The methodology adopted in the study can be used effectively and becomes economical, if such high-resolution data is made available.
LANDSLIDE ZONAL MAP - KOTHAGIRI

LANDSLIDE HAZARD ZONATION MAP ON PERSPECTIVE VIEW

LEGEND
- VERYHIGH
- HIGH
- MODERATE
- LOW
- ROAD

Figure 7

Figure 8: Landslide
Similarly GIS and RS can be used for other disaster management applications too:

1. Earthquake
   - GIS can be useful for monitoring historical sites of the earthquake also for Response & data management for recovery.
   - It’s also useful for Impact assessment.

2. Flood
   - Flood mapping from Macro level to Micro level.
   - Flood Zone mapping.
   - Detecting Potential Site of Flood in reference with rainfall
   - Elevation Mapping
   - Preparing Response map in response to managing after flood situations
Conclusion

• Disaster risk reduction and management involves the participation of multiple sectors such as healthcare, finance, emergency etc. and the use of geospatial data is critical to efficient disaster management at all stages of disaster management; before, during, and after.

• Improved coordination and cooperation among disaster management stakeholders is required, since it will create a platform and a team to implement effective disaster management policies and actions

• It would also allow interoperability and effective data sharing among disaster management stakeholders.
Thank You