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Role of Remote Sensing and GIS in Natural Disaster Management

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Abstract – In the recent past, whether it is a natural hazard or by the intervention of human activities, disasters have become an issue of rising alarm. Natural disasters are intense events of our global system, which brings forth major changes in the environment over a short period of time. For the past four decades, disaster events such as floods, earthquakes, volcanic eruptions, storms, etc, have caused a great havoc to livelihoods and brought down the socio-economic status of a country apart from severe damage to the environment. These catastrophic events clearly swab out years of urban development by demolishing the infrastructure and killing thousands to millions of people. One such example which caused an immense loss to lives and properties is the 2011 Tsunami in Japan. This paper presents a general review on utilization of remote sensing and GIS for natural disaster management. Remote sensing can be potentially employed to address various aspects of disaster management cycle. Rather focusing only on emergency response, it is essential to consider all facets of disaster management. Remotely sensed data extend their support to disaster management organizations by providing relevant and accurate information in a temporally. Disaster Management can be very efficiently and cost effectively handled by using innovation in the technology. Highly sophisticated and effective Disaster Management systems can be develop accordingly which are basically GIS based. This can help us to reduce the casualties and damages caused by disasters.

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INTRODUCTION

In the recent past, disasters have become an issue of rising alarm. Natural disasters are intense events, which brings forth major changes in the environment over a short period of time. The consequences of which leads to injury or death of living organisms demolish up of expensive properties such as communication system, physical infrastructure and loss of natural wealth such as forests, agricultural land, environment, etc. They have a profound impact on the socio-economic system of a Nation. Depending on the nature of the disaster, the impacts may be swift or slow as in case of drought and earthquake respectively. According to the magnitude of occurrence and frequency, disaster may vary in their trigger, duration, scale and necessary actions. Natural disasters arise in many parts of the earth, and each type of disasters is confined to particular regions. It have been estimated that more than 96 percent of all deaths in developing countries were due to natural disasters. These places are particularly vulnerable to disasters prone area because of densely packed population and poor infrastructures.

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CLASSIFICATION OF DISASTERS:

Disasters can be classified in several ways. A possible subdivision is between:

- *Natural disasters* are events which are caused by natural phenomena. These bring damage to human societies such as earthquakes, sunami volcanic eruptions, hurricanes);
- *Human-made disasters* are events which are caused by human activities. These are industrial chemical accidents, atmospheric pollution, major armed conflicts, nuclear accidents, oil spills.

- *Human-induced disasters* are natural disasters that are accelerated by human influence.

Major disasters definitions are:

- Geophysical desaster are the events originating from solid earth.Meteorological events caused by short-lived/small to meso-scale atmospheric processes (in the spectrum from minutes to days).
- Hydrological desaster caused by deviations in the normal water cycle.
- Climatological desaster caused by long-lived/meso- to macro-scale processes in the spectrum from intraseasonal to multi-decadal climate variability.
- Biological Disaster caused by the exposure of living organisms to germs and toxic substances.

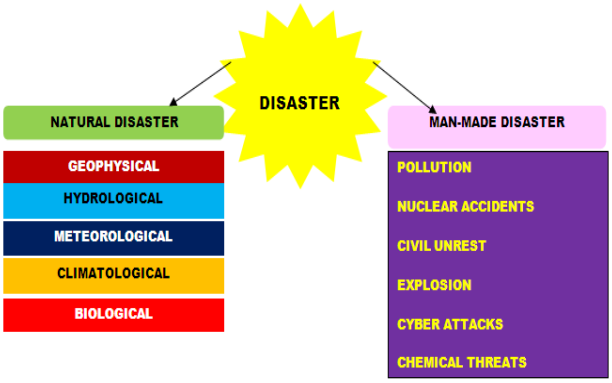

Figure1. Classification of Disasters

Table No.1 Classification of Major Natural Disaster

Geophysical	Hydrogical	Meteorological	Climatological	Biological
• Mass movement • Volcanic Activity • Earthquake i. Rockfall ii. Landslide iii. Avalanche iv. subsidence	Flood Landslide Wave action	Convective storm Extra-tropical Cyclone Fog Tropical Cyclone	Drought Glacial Lake Outburst Wildfire Extreme temperature i. Heat wave ii. Cold wave	Animal stampede Epidemic i. Viral infectious disease ii. Bacterial infectious disease iii. Parasitic infectious disease iv. Fungal infectious disease v. Prion infectious disease Insect Infestation

Table No.2 Some Major Disaster in India From 1972 to 2014

S. No.	Name of Event	Year	State & Area	Fatalities
1.	Floods	October 2014	Jammu & Kashmir	
2.	Cyclone Hud Hud	September 2014	Odisha and Andhra Pradesh	
3.	Odisha Floods	October 2013	Odisha	21
4.	Andhra Floods	October 2013	Andhra Pradesh	54
5.	Cyclone Phailin	October 2013	Andhra Pradesh and Odisha	23
6.	Floods/Landslides	June 2013	Himachal Pradesh and Uttarakhand	4,094
7.	Cyclone Mahasen	May 2013	Tamil Nadu	07
8.	Cyclone Nilam	October 2012	Tamil Nadu	66
9.	Uttarakhand Floods	Aug – Sep 2012	Rudraprayag, Bageshwar and Uttarkashi	52
10.	Assam Floods	July – Aug 2012	Assam	---
11.	Cyclone Thane	December 2011	Puducherry ,Tamil Nadu,	47
12.	Sikkim Earthquake	September 2011	Sikkim, Bihar and West Bengal	60
13.	Odisha Floods	September 2011	19 Districts of Odisha	46
14.	Sikkim Earthquake	2011	North Eastern India with epicenter near Nepal Border and Sikkim	97 people died (75 in Sikkim)
15.	Cloudburst	2010	Leh, Ladakh	257 people died
16.	Drought	2009	252 Districts in 10 States	-----

17.	Krishna Floods	2009	Karnataka, Andhra Pradesh	309 people died
18.	Kosi Floods	2008	North Bihar	527 deaths, 19,333 livestock perished, 2,23,000 houses damaged, 3.3 million persons affected
19.	Cyclone Nisha	2008	Tamil Nadu	204 deaths
20.	Maharashtra Floods	July 2005	Maharashtra State	1094 deaths 167 injured 54 missing
21.	Kashmir	2005	Partially Kashmir, Mostly Pakistan,	1402 deaths in Kashmir (86,000 deaths in total)
22.	Tsunami	2004	Coastline of Tamil Nadu, Kerala, Andhra Pradesh, Pondicherry and Andaman and Nicobar Islands of India	10,749 deaths 5,630 persons missing 2.79 million people affected 11,827 hectares of crops damaged 300,000 fisher folk lost their livelihood
23.	Gujarat Earthquake	2001	Rapar, Bhuj, Bhachau, Anjar, Ahmedabad and Surat in Gujarat State	13,805 deaths 6.3 million people affected
24.	Orissa Super Cyclone	1999	Orissa	Over 10,000 deaths
25.	Cyclone	1996	Andhra Pradesh	1,000 people died, 5,80,000 housed destroyed, Rs. 20.26 billion estimated damage
26.	Latur Earthquake	1993	Latur, Marathwada region of Maharashtra	7,928 people died 30,000 injured
27.	Cyclone	1990	Andhra Pradesh	968 people died, 435,000 acres of land affected
28.	Drought	1987	15 States	300 million people affected
29.	Cyclone	1977	Andhra Pradesh	10,000 deaths hundreds of thousands homeless 40,000 cattle deaths
30.	Drought	1972	Large part of the country	201 million people affected

Source: National Disaster Management Authority Government of India.

The above Table showing the major disaster occurrence in India. India is vulnerable, to a large number of disasters because more than 58.7 per cent of the landmass is prone to earthquakes of moderate to very high intensity; over 41 million hectares of its land is prone to floods and river erosion; close to 5,700 kms, out of the 7,516 kms long coastline is prone to tsunamis and cyclones; 68% of its cultivable area is vulnerable to droughts. Moreover, India is also

vulnerable to Chemical, Radiological, Biological and Nuclear (CBRN) emergencies and other human-made disaster. In India, disaster risks are further compounded by increasing vulnerabilities related to changing unplanned urbanization, development within high-risk zones, demographics and socio-economic conditions, environmental degradation, geological hazards, epidemics, pandemics and climate change. All of these contribute to a situation where disasters seriously threaten India's economy, its population and sustainable development.

DISASTER MANAGEMENT

The occurrence of calamities has been raised in the past years and this is primarily due to increased population pressure and other various factors contributed by natural or human interventions. There are different actions in the disaster management cycle such as mitigation, preparedness, recovery and response. Mitigation and preparedness are the pre-disaster phase concerned about the strategies to reduce the potential risks for living organisms, material or environment issues caused by the events. Emergency phase deals of relief and rescue operations. It includes checking up of Epidemic spread of diseases and assessments of loss. Basically it aims in ensuring the victims that their needs and provisions are met to alleviate and reduce suffering. One way of dealing with natural hazards is to ignore them. Due to many reasons, neither the population nor the authorities chooses to take the danger due to natural hazards seriously. The last major destructive event may have happened long time ago and is only remember as a story from the pas tand people may have moved in that area recently without having the knowledge on potential hazards. It may be that the risk due to natural hazards is taken for granted. Because of that, the many dangers and problems confronted with in people's day today lives. Sarcastic authorities may ignore hazards because the media exposure for their aid supply. After the disaster has happened has much more impact on voters than the quit investment of funds for disaster mitigation. To effectively reduce the impacts of natural disasters, a complete planning for disaster management is required.

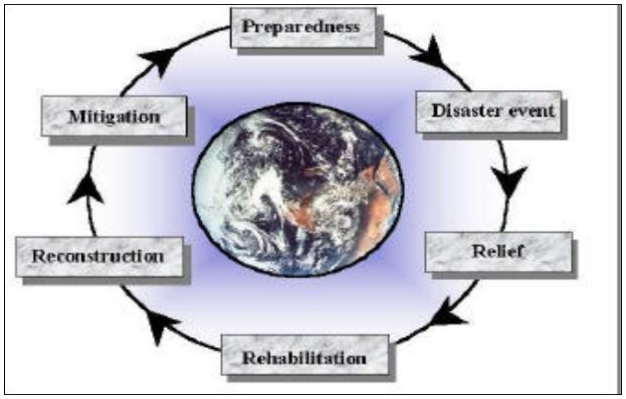

Figure 2: The Disaster Management cycle

ROLE OF GIS IN DISASTER MANAGEMENT

The role Geographical Information System (GIS) and remote sensing is very important in evolving a suitable strategy for disaster management. By using these technologies, the disaster management and occupational framework for their monitoring, assessment and mitigation, identifies gap areas and implements appropriate strategies for disaster management. With the tropical climate, coupled with high population density, illiteracy, poverty, and lack of adequate infrastructure, India is one of the most vulnerable in developing countries to suffer very often from various Natural Disasters, viz. cyclone, earthquake, flood, forest fire, drought, etc. Asia is on the top the list of casualties due to natural disasters. Space technologies play a central role in efficient mitigation of disasters. Communication satellite provides disaster warning and relief mobilization. Earth observation satellite provides essential database for pre disaster preparedness programmes and post-disaster preparedness programmes. This GIS is a perfect way for forest fire forecasting because Forest fire had a movement in both spatial and temporal. GIMS (Geographical Information and Modeling System) was installed for a management of Forest Fire, which could assign a part by telling the shape of forest fire in real time and help managers of forest fire to take best decision against these disasters. GIS and Remote Sensing can be a very useful tool to balance conventional methods. Disaster Management Mitigation of natural disaster can be successful only when complete knowledge is obtained about hazard events in an area. By the use of remote sensing data, such as aerial photos and satellite imageries, allows us to map the variabilities of topography properties. Many types of disaster, such as floods, earthquakes and droughts, etc. will have certain forerunner that satellite can detect per successfully. Remote sensing also allows monitoring the event as it occurs. From the vantage point of satellite, we can consider plan for and operationally monitor the event. At last, a complete strategy for disaster management is required to successfully reduce the impact of natural disaster. Disaster management cycle consists of two phases taking place before the event occurs, which are disaster prevention and disaster preparedness. Second phase after the event occurs, which are disaster relief, rehabilitation and reconstruction:

- First of all, remote sensing and GIS provides a data base from which the evidence left behind by disasters that have occurred before can be interpreted It combined with other information to arrive at hazard maps, indicating which areas are potentially dangerous. The zonation of hazard must be the basis for any disaster management project and should supply planners and decision-makers with adequate and understandable information. Remote sensing data, such as satellite images and aerial

photos allow us to map the variability's of terrain properties, such as vegetation, water, and geology, both in space and time. Satellite images give a synoptic overview and provide very useful environmental information, for a wide range of scales, from entire continents to details of a few metres. Secondly, many types of disasters, such as floods, drought, cyclones, volcanic eruptions, etc. will have precursors. The satellites can detect the early stages of these events as anomalies in a time series. Images are available at regular short time intervals, and can be used for the prediction of both rapid and slow disasters.

- Then, when a disaster occurs, the speed of information collection from air and space borne platforms. The possibility of information dissemination with a matching quickness makes it possible to monitor the occurrence of the disaster. Many disasters may affect large areas and no other tool than remote sensing would provide a matching spatial coverage. Remote sensing allows monitoring the event during the time of occurrence while the forces are in full swing that can help. The vantage position of satellites makes it ideal for us to think, plan for and operationally monitor the event. GIS is used as a tool for the planning of evacuation routes, for the design of centres for emergency operations, and for integration of satellite data with other relevant data in the design of disaster warning systems

- In the disaster relief phase, remote sensing and GIS is extremely useful in combination with Global Positioning Systems (GPS) in search and rescue operations in areas that have been distressed. The impact and departure of the disaster event leaves behind an area of immense devastation in the region. Remote sensing can help in damage assessment. It is also helpful in monitoring, providing a quantitative base for relief operations.

- In the disaster rehabilitation phase remote sensing and GIS is used to organize the damage information and the post -disaster census information. Remote sensing is used to map the new situation and update the databases used for the reconstruction of an area about disaster. It can help to prevent that such type of disaster occurs again. For example, the post disaster damage reports on buildings in an earthquake stricken city may be thousands. Each one will need to be evaluated separately in order to decide if the building has suffered irreparable damage or not by disaster. After that all reports should be combined to derive at a reconstruction zoning within a relatively small period of time.

CONCLUSION:

This paper presents a general review on utilization of GIS techniques for natural disaster management. Remote sensing can employed to address various aspects of disaster management cycle. It is not only focusing on emergency response but also it is essential to consider all facets of disaster management. In addition to that, one should tailor the technologies owing to remote sensing to fulfill the desired requirements of the disaster organization. It is necessary to examine and evaluate the so far accomplished work in relevant fields of various natural and manmade disasters. This can guide to identify the thrust areas and pave necessary way for future research. The increased availability of Remote Sensing data and GIS during recent decades has created opportunities for a more detailed and rapid analysis of natural hazards. Disaster Management can be very efficiently and cost effectively handled by using this innovation in the technology. Highly sophisticated and effective Disaster Management systems can be developing accordingly which are basically GIS based. This can help us to reduce the casualties and damages caused by disasters.

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