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GIS APPLICATION IN DISASTER MANAGEMENT IN BANGLADESH

J B Alam & **K M N Habib,** BUET, Bangladesh

Introduction

Natural disasters, like cyclone and flood, frequently occur in Bangladesh. They cause huge economic losses and take many human lives. In most cases, these disasters occur suddenly. Therefore, timely response from a monitoring and assessment system is essential. By developing and implementing well-planned disaster mitigation strategy, economic losses and human casualties can be reduced greatly. Through utilizing the small amount of time available before such disasters hit, the sufferings of the people can be alleviated by a great margin. Realizing the benefits of such disaster management strategies and its cost effectiveness, such measures have become an integral part of national policies of many countries. Geographic Information System (GIS) and Remote Sensing (RS) is an integral tool of disaster management strategy (Kumar, 1999).

Geographic Information System (GIS) is a computer-based system that is used to store and manipulate geographic information. It can also be used as a tool for correlating geographic information for purpose of developing and implementing strategies to cope with disasters like flood and cyclone. Remote Sensing is the procedure of collecting various geographic and environmental information using space-borne and airborne sensors. Considering the potential of GIS and remote sensing much attention has been paid to their usage for monitoring, assessment and developing expert systems to cope with disasters. GIS and remote sensing can be very effective for forecasting natural disasters like flood and cyclone at a particular area by utilizing prior information and develop commensurate strategies.

This paper describes the development of a GIS and remote sensing based expert system for disaster management purpose.

Monitoring and Assessment System

The monitoring system consists of five subsystems which include the following.

- Space-borne remote sensing subsystem for receiving and processing NOAA, Landsat and GMS images.
- Airborne remote sensing subsystems for collecting data. This includes data transmission system and data processing system.
- Subsystem for processing and analysis of images and geographic information.
- Assessment subsystem for evaluating disasters including integrated database and model-base.
- Expert system for developing alternate strategies to cope with the disaster.

The major aim of the monitoring system is to monitor and assess the disaster. The system has the capability to provide image and other data concerning the disaster in real time.

Within the monitoring system, data from various space-borne and airborne sensors are used. It includes NOAA-AVHRR data which has a high temporal resolution (almost twice a day) and wide coverage. Landsat TM data has high spatial and spectral resolution which is used for the determination of land cover, land use and other prior and posterior information. Real time data acquisition and display of the data is vitally important for disaster decision making. For this purpose a real-time data transmission system has been developed. It utilizes information collected by meteorological organizations and SPARSO.

Geographic and Demographic Information System

For fast and accurate assessment of natural disaster and development of management strategy, two main types of databases have been developed. These databases include geographic and demographic information. Databases for nation-wide topography, environment, resources and socio-economic variables have been used as background for disaster assessment and disaster management planning purpose. The databases include:

- Database for resources and environment information.
- Database for demographic, social and economic information.
- Database topographic information.

The GIS software system for the purpose has been developed by combining ARC/INFO and self-developed software and models.

Procedure for Action of Emergency

The procedure for disaster monitoring and assessment consists of four stages;

- Collection and analysis of information from airborne and space-borne systems
- Extraction of information regarding the expected damages and their geographic distribution. This stage utilizes the damage forecasting models.
- Development of disaster management strategies by using expert systems.
- Development of post disaster reports with detailed damage assessment combining GIS and databases of the affected areas.

Various interfaces of the disaster management action plan are shown in Figure 1.

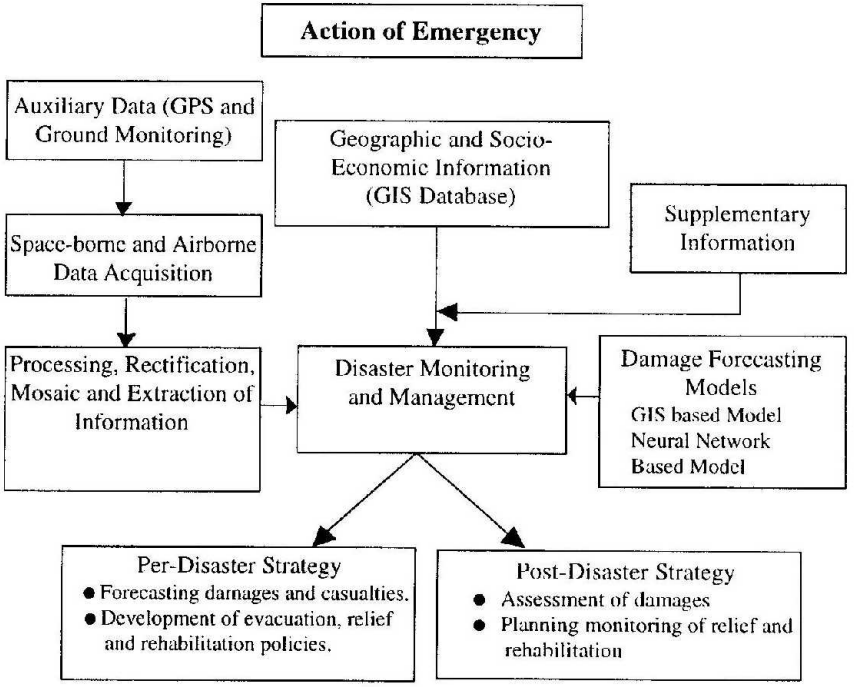

Figure 1 : Flow Chart of the Disaster Monitoring and Management System

Integrated Remote Sensing and GIS System

Integrated remote sensing and GIS software has been developed for the disaster management system (Alam et al, 1999). The system is capable of processing and extracting information from satellite images and storing the information in the databases. Figure 2 shows an interface of the software developed for this purpose.

The software has been designed to analyze images to extract information. The satellite images are not like normal photographs. The color of any object in a satellite image will not be as same as that of a normal photograph. For example, in a satellite image forest will not be as green as it is in a normal photograph. This variation is caused by noises due to air, temperature differential, suspended particles and sensor capabilities. To make the analysis practically meaningful, color property of various objects in this special image type needs to be identified and range of color is to be set for each object. This phase of the analysis is called calibration phase. Afterwards, the calibrated classification schemes are utilized to analyze the images and identify the objects.

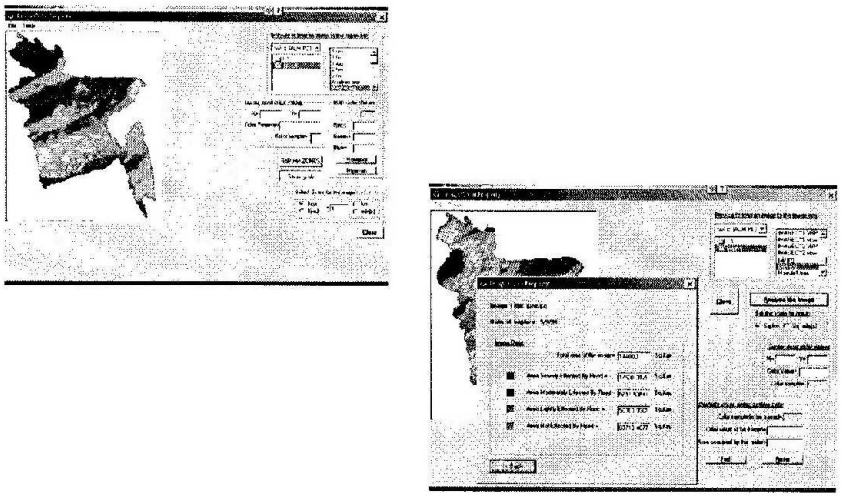

Figure 2: User Interface of GIS and Remote Sensing System

Neural Network Model for Forecasting Damages

A set of models has been developed for forecasting damages caused by cyclone. Neural network technique has been applied to develop the model (Alam, 1999). The inputs and outputs of the model are summarized in Table 1. The neural network models have been applied satisfactorily to predict damages caused by cyclone.

Table 1: Inputs and Outputs of the Cyclone-Damage Forecasting Models

Models	Input	Output
Human Causalities Model	• Population • Wind Speed, Height of Surge, Distance	• Human Casualties
Livestock Casualty Model	• Livestock • Wind Speed, Height of Surge, Distance	• Livestock Casualties
House Damage Model	• Number of Houses • Wind Speed, Height of Surge, Distance	• Fully Damaged Houses • Partially Damaged Houses
Road Damage Model	• Paved Roads • Unpaved Road • Wind Speed, Height of Surge, Distance	• Paved Road Damaged • Unpaved Roads

The models have been applied to forecast damages caused by cyclone utilizing information of socio-economic and demographic database and spatial information regarding the location of the area and path of cyclone from GIS based geographic and demographic database and satellite images.

Conclusion

Disaster management can be a very efficient and cost-effective way of reducing the casualties and damages caused by natural disasters. Highly sophisticated and effective Disaster Management Systems can be developed by utilizing Geographic Information System (GIS) and remote sensing technologies. Such a system is being developed by the Department of Civil Engineering, BUET which is described in the paper. The paper summarizes the design of the system, development of the subsystems and simple applications.

The system needs further improvements to evolve into a complete disaster management tool. Its integration with satellite data needs to be developed further. Also, the availability of accurate and continuous satellite data must be ensured to utilize the system for practical purpose. Consequently, the system must be implemented where the flow of such data can be ensured.

Damage forecasting model and interfaces for the damages caused by flood is yet to be developed. These subsystems will be developed very soon and integrated into the system.

References

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