Disaster in Bangladesh and management with advanced information system

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Abstract

Purpose – This paper aims to document a case study of a disaster in Bangladesh and the role of an information management system for disaster management planning.

Design/methodology/approach – The paper uses a methodology that considers perceptions or constructions – including the role of information systems – to be dependent on the social and cultural structures, which is helpful in reducing destruction in disaster-prone areas.

Findings – Advances in information technology in the form of the internet, geographic information systems (GIS), remote sensing, satellite communication, etc. are beneficial in many aspects of the planning and implementation of hazard reduction arrangements.

Research limitations/implications – Natural disasters strike countries, both developed and developing, cause enormous destruction and create human suffering, and have negative impacts on national economies. Bangladesh suffers regularly and frequently from disasters like floods, cyclone storms, tidal surges, river bank erosion and earthquakes.

Practical implications – Incorporating knowledge of information management system is becoming increasingly important in the derivation of management solutions for disasters.

Originality/value – Information systems including GIS, communication technology, other information retrieval and information management systems should be maintained during natural disasters to reduce the cost and time for contingency. In this paper, an attempt is made to highlight the role of information technology in the management of natural disasters in Bangladesh.

Keywords Natural disasters, Destruction of disaster, Information technology, Management system, Bangladesh

Paper type Case study

Introduction

Different disasters occur regularly and frequently due to the changing geo-climate of the world. General natural disasters include floods, earthquakes, cyclones, landslides, droughts, tidal surges, river bank erosion, etc. Natural disasters strike both developed

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and developing countries alike, with enormous devastation and human suffering. Bangladesh is disaster-prone country with a high population (about 1,100 persons per square kilometer) having area of 144,000 square kilometers and population of about 160 million people. Bangladesh is affected by common disasters such as floods, cyclonic storms, tidal surges, river bank erosion and earthquakes (United Nations, 2008; R8306 FTR Annex H, 2003). The main reasons for disasters in Bangladesh are considered to be the flat topography of its coastal areas, drainage congestion, low relief of floods, low river gradients, heavy monsoon rainfall, enormous discharge of sediments, funnel shapes and the relative shallowness of Bay of Bengal, etc. In addition, Bangladesh is a developing country that has numerous problems including over-population, poverty, a complex socio-economic structure, frequent disasters, a low-level industrial base, the lack of appropriate infrastructural and institutional facilities, and a dearth of trained manpower for disaster management. The development of a competent disaster management system with information technology, strong management commitment and cooperation for natural disaster contingency are important in reducing destruction in this disaster-prone area.

Disasters are conquered with an emphasis on the responsibility of the local community and the commitment of the organizational, political, professional and sociological sectors. The responsibility for disaster includes response to the disaster, recovery, mitigation, and preparedness to overcome the disaster (Yodmani, 2001). Representatives of various sectors of public and private levels should be involved in the design of system of disaster management with information technology. It is necessary to increase awareness amongst the public and individuals, society members as well as the general public, about the devastation caused by disasters, to share the responsibility of overcoming disasters and the management of disasters with information technology.

A robust communication system will provide real-time information to support the control centers and operating agencies related to disaster monitoring, mitigation and enforcement. Information retrieval and distribution is also crucial for in reducing destruction in disasters. A data and information management system supports the disaster management unit and the national committee for disaster management and relief in the country.

At present, the utilization of information technology is helpful in the planning and implementation of hazard reduction in natural disasters. Advances in information technology can be observed in the form of the internet, geographic information systems (GIS) (Fuhrmann *et al.*, 2008), remote sensing, satellite communications, radar communications, mobile communications and wireless networking systems, etc. (Chung and Oh, 2006). New and emerging technologies are also supportive to managing the information infrastructure in a disaster.

This paper gives a case study of a severe disaster in Bangladesh and suggests disaster management planning to reduce the destruction of disasters. Communication technologies and the advanced technology of an information management system are demonstrated in this paper to be maintained during a natural disaster to reduce the costs and time for contingency. The aim of this paper is to highlight the devastation caused by disasters and the role of information technology in the management of natural disasters in Bangladesh.

Case study background

A disaster is a serious disruption in a community or a society causing widespread material, economic, social or environmental losses that go beyond the ability of the affected society to cope using its own resources. A disaster causes sever hazard impacts, damage, casualties and disruption to the population. In definition, a disaster is the combination of hazard and vulnerability with insufficient capacity to reduce the potential chances of risk. Hazards create a dangerous situation that threatens or has the potential to cause injury to life or damage to property or the environment. Hazards – such as floods, earthquakes, cyclonic storms, tidal surges, river bank erosion and landslides – are frequently triggered events that coexist with a greater vulnerability due to the world's changing geo-climate. For example, floods cyclones or earthquakes would lead to disaster, causing great loss of life and property.

Bangladesh is a disaster-prone region that is affected by severe disasters frequently and regularly. Different types of natural disaster such as floods, droughts, earthquakes, cyclones, landslides, volcanoes, etc., strike in Bangladesh due to the vulnerability of the area. Strong cyclones cause serious hazards and devastation in Bangladesh.

Cyclone Sidr was the strongest cyclone to happen in Bangladesh, and arrived on November 15, 2007 (Charlie Forecast Team, 2007; Joint Typhoon Warning Center, 2007). Sidr formed in the central Bay of Bengal, and quickly strengthened to reach peak one-minute sustained winds of 250 km/h (155 mph), which would make it a Category 5 equivalent tropical cyclone on the Saffir-Simpson Scale (Ball, 2007). Save the Children (a NGO) estimated the number of deaths from Cyclone Sidr to be between 5,000 and 10,000, while the Red Crescent Society reported on November 18 that the number of deaths could be up to 10,000 (Inquirer.net, 2007; Rahman, 2007). International organizations pledged $US95m to repair the damage caused by Sidr (Reuters, 2008), which was estimated at $1.7bn (2007 dollar value).

Cyclone Aila was the second tropical cyclone to form within the Northern Indian Ocean during 2009. Severe Cyclone Aila formed on May 21, 2009, about 950 kilometres (590 miles) to the south of Kolkata, India (Joint Typhoon Warning Center 2009a, b). The disturbance developed slowly before a Tropical Cyclone Formation Alert was issued by the Joint Typhoon Warning Center early on May 23, 2009; the system was designated as a depression for Bangladesh (United Nations, 2008). As of May 27, 2009, 330 people had been killed by Aila and at least 8,208 more were missing, while about one million were made homeless. Health officials in Bangladesh confirmed that more than 7,000 people were infected by a deadly outbreak of diarrhea on May 29. In Bangladesh, about 20 million people were at risk of post-disaster disease due to Aila. The damage caused by Cyclone Aila was estimated to total $US40.7m.

Bangladesh suffers the natural disaster of flooding every year due to being situated on the Ganges Delta. In Bangladesh, 75 percent of the land is less than 10m above sea level, and 80 percent is flood plain (R8306 FTR Annex H, 2003). Many rivers flowing from the Himalayas into the Bay of Bengal. Bangladesh is marooned every year by heavy rainfall during the monsoon season from June to September. The rainfall in coastal areas or river areas is added to by the relief rainfall and the melting of ice in the Himalayas.

About 26,000 square kilometers of the country is flooded every year and about 5,000 die due to flooding. In 1998, 75 percent of the country was affected during severe

floods. Floods caused most devastation in Bangladesh in the years 1966, 1987 and 1988. A large portion of Bangladesh was also affected by flooding during 2007.

On the other hand, earthquake studies have taken an interest in Bangladesh, as earthquakes are one of the most destructive natural hazards. Current advances in research are constrained to predicting the timing and position of earthquakes properly. Earthquakes can destroy buildings and infrastructure within a short time, causing landslides (as shown in Figure 1), killing or injuring a lot of inhabitants in the affected area. Earthquakes not only destroy the entire habitation but also destabilize the government, economy and social structure of the country. Bangladesh is at risk of a severe earthquake because of the geographical situation that causes earthquake events. In addition, over-population and unplanned building increases the possibility of devastation in Bangladesh.

Methodology

The research and case study was conducted at Patuakhali Science and Technology University, Bangladesh. Information on disasters in Bangladesh is manifested in the case study on disasters. A planning and disaster management system through advanced information technology is highlighted in the Figure 2 for the reduction of devastation in disasters.

For the establishment of a proper disaster management system in Bangladesh, advanced and modern information technology has to be enhanced to overcome disasters. Modern information technology applications for a disaster management system include remote sensing systems, GIS technology, global positioning systems (GPSs), warning and forecasting systems, the internet, and communication technologies including wireless networking, etc.

Satellite and radar communication should be improved for the identification and mapping of land use patterns and potentially disaster-prone areas. More integration of remote sensing and GIS is needed for the planning of disaster management, as shown in the block diagram of Figure 2. An improved remote sensing and GIS data analysis centre should be developed in the coastal area, near the Bay of Bengal, with the cooperation of Patuakhali Science and Technology University. GIS technology can be

Figure 1.
Demonstration of hazards of landslides and earthquakes

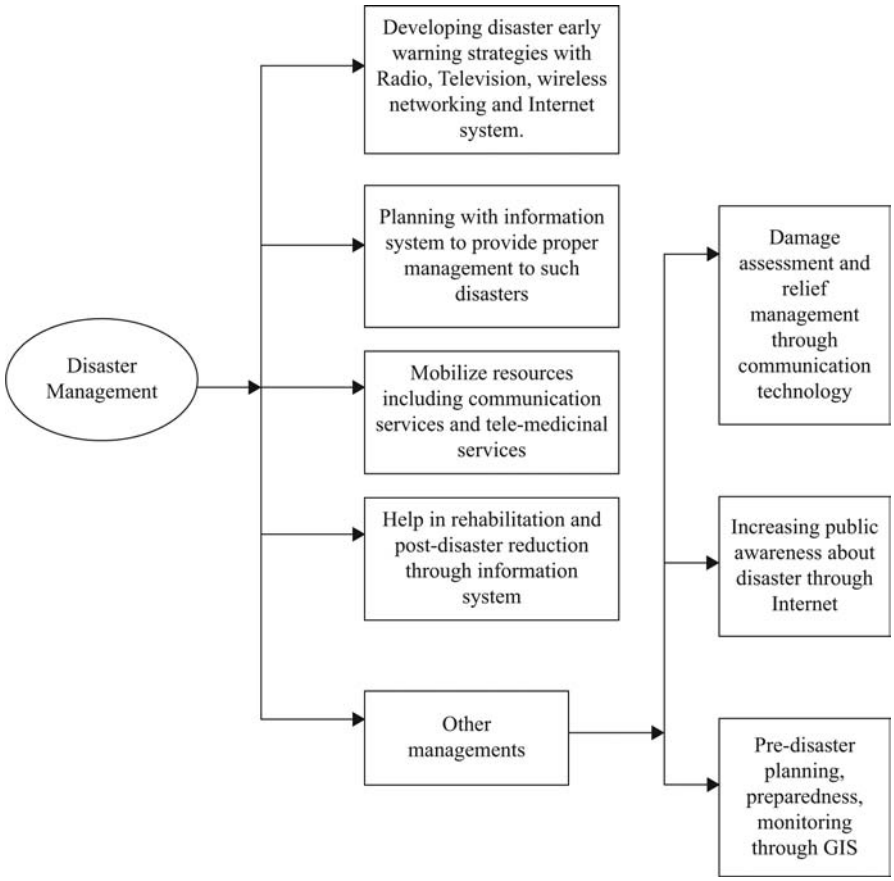

Figure 2. Block diagram of improved disaster management system

used for scientific investigations, resource management, asset management, disaster impact assessment development planning, cartography, and route planning (Fuhrmann *et al.*, 2008). Cyclone warning and flood forecasting have to be demonstrated in collaboration with data and information acquired using modern and advanced technology. Damage assessment, rehabilitation and reconstruction work after any disaster should be undertaken immediately by the public and private sectors. They can use information technology including GIS techniques (Sims *et al.*, 2008) and a database networking system in association with SPARRSO for development planning and infrastructure building activities in disaster prone areas.

The internet has to be used to disseminate messages regarding disaster information, awareness of disasters, responsibility for disasters, and the devastation caused by disasters to the whole world. Figure 2 shows that information media – including television, radio and electronic news – also have a key role in revealing news about disaster warnings and the damage caused by disasters as well as in helping to plan proper disaster management. Different websites should be developed with information regarding disasters in Bangladesh, messages containing disaster information, frequent

disaster warnings and a forecasting system. The warning and forecasting system should be a computer system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically referenced information.

Communication technology can be effectively used in mitigation, preparedness, response and recovery, and should be recognized as being integral to disaster management, as shown in Figure 2. Modern communication technologies includes the internet, mobile phones, fax, e-mail, radio and television, FM radio, etc. Computer networks should be established with optical fiber networking to form a robust and competent information sharing system. A computer network should connect headquarters, regional offices and district field officers to facilitate information sharing for disaster management.

A wireless networking system should be developed according to the block diagram shown in Figure 3 for monitoring disaster situations and management with proper information from the area affected. According to the wireless networking system proposed, the data supplied on the disaster situation, stored in the memory of a microcontroller, is modulated via the carrier signal for transmission through a Zigbee antenna. The microcontroller handles the data acquisition, signal processing, calibration, control and communication shown in Figure 3. The radio frequency (RF) terminal handles data transmission and reception during a disaster. This modulated signal is then transmitted to the computer through the antenna of a RF transceiver interfaced to the microcontroller. A ZigBee-based wireless network (Yick *et al.*, 2008) with the Mesh topology has to be configured to be able to react to external influences

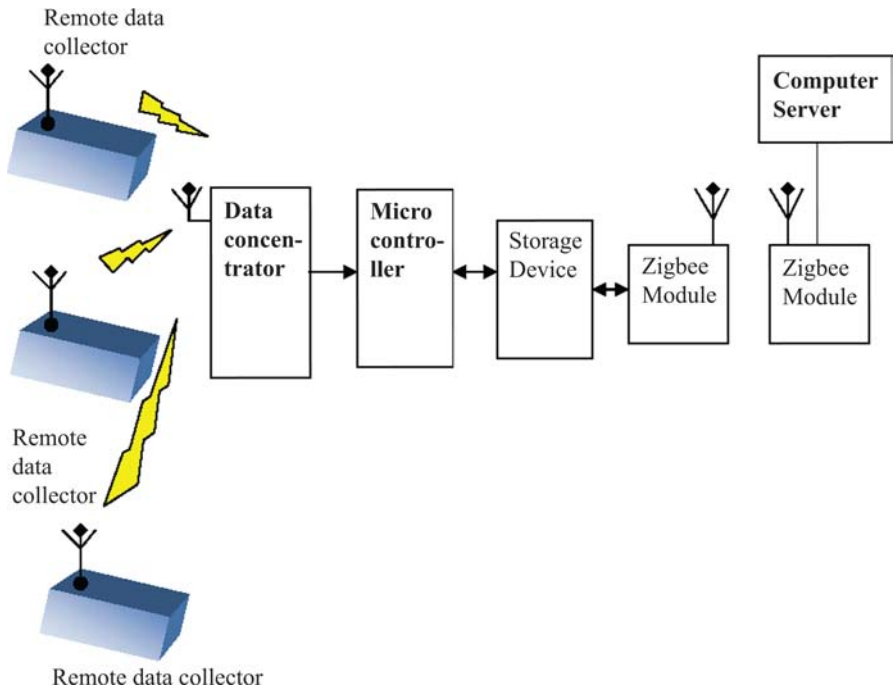

Figure 3.
Block diagram of wireless networking system in disaster area

and noise with robustness in order to transmit the information regarding the disaster situation and management of the disaster. Disaster data should be transmitted efficiently to a computer server through wireless networking; the data will be disseminated to the main server and computer website.

In addition, a critical incident management system can be used for search and rescue operations in the area of disaster hazard (see Figure 2). Local voluntary teams can be developed through proper training on disaster rescue operations and disaster management with information technology. Voluntary teams will work on awareness and the evacuation of people affected by or at risk of disasters. These teams also work on relief distribution and the management of shelter and relief for vulnerable people in disasters. A supply chain management system should be included to account all logistics needs and inventory requirements in a disaster situation. A financial management system has to be established to support the tracking of budgets. Moreover, applicant assistance centers can be used to centralize and consolidate disaster applicant information, enabling more efficient responses to inquiries from applicants.

Discussion

This paper reveals a case study on disaster events in Bangladesh, a country at risk of destruction and hazards through disasters. The paper also manifests the disaster management system with the information management system and role of advanced technology.

Incorporating information technology into the usual disaster management system (Yodmani, 2001) is capable of reducing destruction and hazards in a disaster. In this work, different types of technologies are highlighted to be used for disaster prevention and management. GIS is considered a modern technology to aid in carrying out search and rescue operations in a more effective manner by identifying areas that are disaster-prone and zoning them according to risk magnitudes (Fuhrmann *et al.*, 2008). GIS provides a support for the effective and efficient storage and manipulation of remotely sensed data and other spatial and non-spatial data types for both scientific management and policy-oriented information. GIS manifests geo-graphical and environmental information for a concentrated area based on satellite and remote sensing data. These maps can be created for cities, districts or even for the entire country and for tropical cyclones.

This facilitates the measurement, mapping, monitoring and modeling of a variety of data types related to environmental and geo-climate phenomena. One application of GIS is hazard mapping to show earthquakes, landslides, flood or fire hazards in the field of risk assessment. GIS is a tool to estimate natural and geo-environmental information in remote sensing data. Remote sensing is the process of recording information such as photographs and images from sensors on aircrafts, while satellite remote sensing consists of several satellite remote sensing systems that can be used to integrate natural hazard assessments into development planning studies. Remote sensing observes any object from a distance without coming into actual contact. Remote sensing is significant due to the fact that data is gathered much faster than in ground-based observation, as well as a large area being covered at one time to give a synoptic view. Examples of modern remote sensing systems are Landsat satellite, SPOT satellite, satellite radar systems, and advanced very high resolution radio.

In advanced disaster management systems, information forecasting, monitoring and issuing early warnings play the most significant role in reducing the destruction caused by disasters. Cyclone detection radar (CDR) is a convenient system for monitoring the creation of cyclones, and their position and movement. These radars are capable of locating and tracking approaching tropical cyclones within a range of 400 km. In Bangladesh, most cyclones are created in the Bay of Bengal. Information on the creation of a cyclone can be acquired with the installation of CDR radar along the coastal belt of Bangladesh.

Communication technologies including mobile communications, radio, television and FM radio are important in disseminating warnings of cyclones frequently and in giving forecast information. Early information is very helpful in evacuating coastal people including fishermen, boatmen and passengers of launches and steamers into safe areas. Early information also reduces the number of domestic animals killed in disaster-affected regions.

Flood forecasting and monitoring are crucial for appropriate planning and management by administrative organizations in flood hazard mitigation. Flood information has to be conveyed through the network of forecasting stations on riverbanks, in marooned areas and to people affected by floods in the country. Mobile communications are helpful in providing relief with proper management systems and rescuing vulnerable people during floods. In addition, Zigbee wireless networking with the mesh topology is a robust networking system for transmitting information about the disaster situation in a disaster-affected area. The Zigbee wireless networking system shows better performance in overcoming the natural interruption of data transmission during a disaster.

In the arena of information technology and communications engineering, the internet provides a useful platform for disaster mitigation communications. A website including disaster events and the hazards of disasters is a very cost-effective means of spreading information intra-nationally and internationally. It is very supportive of the rapid, automatic, and global dissemination of disaster information to people worldwide. In the management of natural disasters, the role of electronic and communication engineering provide the most effective performance in overcoming the hazards of a disaster.

Conclusion

This paper gives a case study of disasters and hazards for disaster in Bangladesh. The proper management of disaster is proposed for the implementation of hazard reduction in disasters. Advances in information technology, manifested in the form of the internet, GIS, remote sensing, radar and satellite communications, mobile communications, etc., are incorporated in planning and disaster management. In terms of natural hazard assessment, the development activities in this paper are a guide to assist planners in the selection of mitigation measures and in the implementation of emergency preparedness and response action. It is necessary to create awareness amongst the public as well as amongst decision makers for disaster management through information technology. Awareness and training in information technology, relief distribution and evacuation for the people affected is required to develop human resources, particularly in developing countries such as Bangladesh

that suffer chronically from natural disasters. Disaster preparedness, awareness, and proper management are effective ways of mitigating the impact of disasters.

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