Real-Time Data Distribution System of Disaster Reduction Information for India

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Abstract: ***The Indian sub-continent is faced with enormous number of disasters every year. The disaster management officers and researchers of each state are thus responsible for the task of floating mechanisms which allow disaster information for a broad area extending over many countries to be obtained for fast and easy tracking and analysis of the scale and size of the destruction. We therefore propose to put forward a methodology that can aid in spreading disaster reduction information to the Indian sub-continent and neighboring regions, using the Internet technology for efficient distribution and GIS technology that explains the geographical propagation of the disaster for easier analysis of the state of disaster. In order to abate the damage when disasters strike, there is a need to collect and distribute disaster information instantaneously. We thus need to sort out pre-existing and state-of-the-art technology for collecting disaster information immediately and verify the accuracy of this information. We then require conducting experiments to measure the duration for the period from actual collection of the data to its distribution. Based on these results, we will study effective data sources and data collection technology for distributing disaster information briskly to the neighboring countries. This paper will cover the results of the study on the actual-time collection and distribution of disaster information as well as the features of the mechanism developed.***

Keywords: Real-Time Data Distribution, Information Technology in Disaster Reduction, Data Collection

1. Introduction

The Indian sub continent is subjected to a series of natural disasters often hit by climatic and geological disasters like earthquakes, landslides, floods, tsunamis, volcanic eruptions and cyclones and therefore undergoes a considerable social and economical damage. Very frequent and often devastating rainfall levels in the country causes conditions such as flood and drought in different parts of the country. The country has experienced earthquakes causing severe damage to life and property. India has a long coastline of about 8000 km, which is prone to very severe cyclonic formations in the Arabian Sea and the Bay of Bengal.

Since the damage often extends to vast areas affecting huge populations, the exchange of disaster information through cooperation and coordination of multiple groups which is imperative for the efficient collection, organizing and distribution of the disaster information and for implementing various methodologies. The setting up of methods that allow such exchanges is thus a challenge. Though the techniques for developing individual systems by the officials of each state or a localized region are possible, to facilitate coordination in administering relief for the damages incurred and starting up the rescue activities, the widespread sharing of disaster information is essential, as it is to standardize the system functions and data formats. Relevant information on topography and transportation facilities (roads and railways) is a must for tracing the geographical location of information, which is also required to be integrated and stored for the working of system in each region. This means that substantial amount of time and money would be required for developing the required systems and a background. With an increase in the perception for the promotion of a culture of disaster prevention management, now a major emphasis is placed on research and development of information on disaster preparedness and prevention. It has brought significant positive change, although the number and frequency of disasters in the country has increased.

1.1 Recent examples from the Indian context

Recently we have witnessed two eminent examples of severe floods in the Indian sub continent itself- The Uttarakhand floods of 16 June, 2013 and the very recent Phailin floods that struck the eastern coast of the country on 12th of October, 2013. A clear distinction is observed in between both the floods in terms of management. While the former was an immensely large scale flood, the amount of measures taken by the administration to help the public in evacuation was not sufficient. No precautionary measures were observed by the state Government. On the other hand prior information at the Meteorological Department helped in saving the lives of over 5 lakh inhabitants of the coastal region. Thus, the forecast by the officers of the IMD, with the help of the state Government, helped in evacuating over 5, 50,000 people greatest in the history of 23 years.

1.2 Current functioning of emergency operation

An Emergency Operations Center or Control Room functions in the Ministry of Home Affairs, which works round the clock, to help the Central Relief Commissioner in his duties. The tasks of the Control Room include collection and distribution of information related to natural calamity and relief, keeping close contact with governments of the victim States, interaction with other Organizations or Departments in connection with relief, maintaining records of all relevant information related to action points and contacts in Central government and other agencies etc., the details of all the responsible officials at the Central and State levels being kept updated.

Table 1: Details of all the responsible officials at the Central and State levels

Disasters	*Agencies*
Cyclone	India Meteorological Department
Tsunami	Indian National Centre for Oceanic Information services
Floods	Central Water Commission
Landslides	Geological Survey of India
Avalanches	Snow and Avalanches Study Establishment
Heat &Cold waves	India Meteorological Department

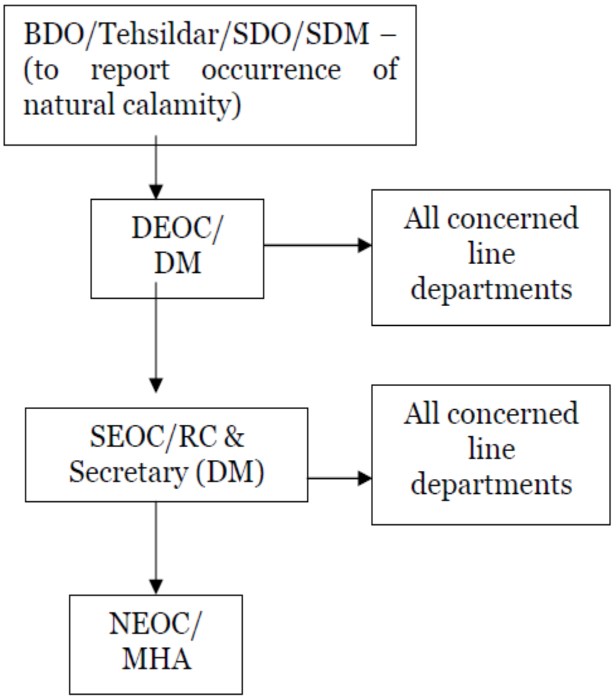
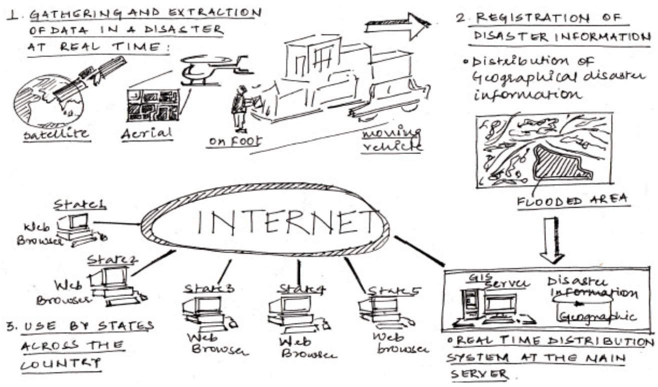


Figure 1: Information flow chart in Case II

In order to reduce the spread of damages when a disaster strikes, disaster management officials and researchers of the various states in the country should be able to gather disaster information on the scope of damage and disaster immediately. However, India currently is not using any such available technology to gather information on such large scale during times of disaster. The various agencies or Departments or Ministries controlling information related to the different disasters should make it accessible to all.

Hence, in order to have a better perspective on these issues, we have studied a technique-VENTEN (Vehicle through Electronic Network of disaster geographical information) that uses server-client interaction and can have great scope for disaster management in India. This is an already existing technique which is an actual-time distribution system of disaster control information for the Asian region using a type of Internet GIS technology.



The VENTEN system governs the disaster information at only a unique location (server) which is helpful in eliminating the need to standardize the system functions and data formats. In addition, because the geographical information of each region is administered at the server, there is no necessity to compile or store the information by any region. With the use of this system, the disaster management officials and researchers of each state only need to establish the settings for a running web browser. The application of the Internet for the distribution of data enables the officials and researchers to quickly acquire information on damage that has incurred in the disaster struck region.

To gather and transmit the disaster information in actual-time using this system, raw site data obtained from the disaster area is required just after the event. The sources of such data of disaster information that are fit for the Indian states and various regions therein are not clear. In order to facilitate the quick distribution of disaster information, it is also essential to compute the time taken for extracting disaster information from data sources. For this reason, investigation of data sources is imperative, that enable quick collection of information on the state of the earth's surface over a broad area, and the level of disaster information that can be extracted from these data sources. Moreover, experiments have been conducted using actual data on this system to check the time taken from obtaining data to acquire disaster information and its distribution. Actual-time distribution is aimed at distributing information within several days from the time a disaster strikes.

2. Study for Gathering and Distribution of Disaster Information in Actual-time

2.1. Utilization of Disaster Information gathered and distributed to the system in actual time

1) Photographs, aerial snaps, ground vehicles and population, disaster information on the range of floods and high tides, damage caused to homes, and the state of road blocks is obtained.
2) The obtained disaster information, along with the satellite photographs, aerial snaps and geographical images thus obtained, is listed in the database server.
3) Disaster control management officers and researchers (the clients) operate the system through the Internet, browse for the fed disaster data, and utilizing this information and geographical information, calculate the amount of casualty to attend and the minimum route for evacuation and

rescue.

2.2. Conclusions of Study on Actual-Time gathering and distribution

1) Existing Technologies for gathering various data Sources and extractable disaster information

Investigation of the platform for gathering data sources done that can be used for obtaining disaster information applicable to the region of Indian sub continent and the range of observation from already existing literature. The conclusions are given in Table 2. It shows that the platform suitable for the Indian region that can also aid in gathering data over a large span is the satellite.

Table 2: Platform for data Sources Collection

Platform	1- Hour observation range
People (on foot)	Several km2
Permanent sensor (seismometer, nilometer, hyetometer, etc.)	According to number of sensors and concentration
Permanent video camera	According to number of sensors and concentration
Bicycle	Over 10 km2
Motorcycle	Over 10 km2
Automobile (including cranes and vehicles for driving over wasteland)	Over 10 km2
Radio-controlled airplanes, helicopters	Over 10 km2
Balloons	Over 10 km2 to several hundred km2
Helicopters	Over 10 km2 to several hundred km2
Airplanes	Over 10 km2 to several hundred km2
Satellites	Over 10 km2 to several hundred km2 (When exposure timing matches)

As in Table 3, the resolution is less when using satellite images gathered by this platform for extracting detailed disaster information. For this reason, satellite images are often used for collecting disaster information on extensive damages such as floods in rivers, volcanic and pyroclastic flow, high tides, tsunamis, etc.

Table 3: Satellites for extracting disaster

Type of Sensor	Satellite	Sensor	Resolution	Observation Width	Observation frequency
Microwave Sensor	RADARSAT(Canada)	SAR	5-500m	5-500km	1 to 5 days
	JERS-1 (Japan)	SAR	18m	75km	44 days
	ERS-1'2 (Europe)	AMI-SAR	30m	100m	35 days
Optical Sensor	NOAA(U.S.)	AVHRR	1.1 km	3000 km	6 HOURS
	LANDSAT (U.S.)	TM	30m/120m THERMAL	180 KM	17 days
	SPOT(France)	HRV	10m/20m color	60km	26 days
	MOS(Japan)	MESSR	50m	100km	17 days

Table 4 lists the existing techniques for gathering data sources with greater resolution than satellite pictures vs. the advanced technology. Tables 2 and 4 shows that aerial photography techniques and on-vehicle video images (mobile mapping) technologies can extract detailed disaster information in actual time, but with the area of observation being smaller than that of satellite images. Disaster information that can be extracted from these collection technologies includes buildings damaged or tilted by earthquake disasters, rubble, the state of fires, and more.

Table 4: Technologies revealing the disaster state

Sensor	Platform	Resolution
Aerial Photograph Camera	Airplane	Several cm to over 10 cm
Camera	Automobile	Several meters
Video Camera	Helicopter Airplane Automobile	Several m to over 10m
Laser Profile	Airplane Helicopter	Over 10 cm
Human Vision	People	Several meters

2) Time taken for collecting, extracting and distributing information

① Satellite image information: On the basis of the data showing changes in the number of natural disasters by percentage and area of global disasters from 1963 to 1992, as released in "Disasters around the World-Global and Regional View," a survey was conducted on the Asian region. The results showed that river floods are the largest natural disaster causing economical damage to the entire Asian region.

Through experiments, the time for obtaining satellite images of actual river flooding, obtaining the data, and feeding the information in this system is calculated. The following describes details of the experiment performed using the satellite image and the results - Data utilized.

Images from Landsat satellite (TM sensor)*

- Disaster studied: Floods in Wuhan, China, August 14, 1998
- Method of extraction: Flood data is extracted by obtaining changes in photographs of territorial area before and after the damage by land-cover categorization.
- Inference of the experiment:
  •Time taken to receive images: About 1 month from time of disaster
  •Time taken for pre-processing and extraction: About 1 day
  • Data registration for distribution: 0.5 to 1 hour
  *- from an experiment conducted by ADRC

②Existing and latest technologies for gathering detailed information

Using both existing and latest technologies for gathering detailed information, time taken to obtain the actual photographs, extract and distribute the disaster information through experiments is calculated. The following illustration describes the experiments performed with various collection methods.

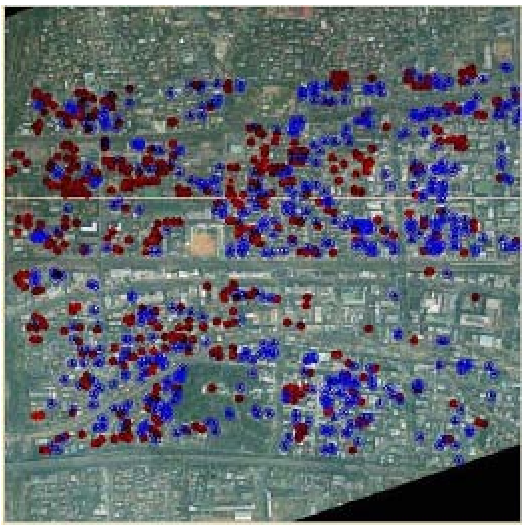


Figure 2: Great Hanshin-Awaji Earthquake--Overlapping of Collapsed buildings and aerial photography (January 17, 1995)

Aerial photograph information **

- Disaster studied: Approx. 1 km2 area at the west side of JR Nishinomiya Station during the Great Hanshin-Awaji Earthquake (exposed on January 18, 1995) (Figure2).
- Method of extraction: The damage is determined, twisting of homes, rubble, and fires by observing the color and shape of the neighboring areas.

**- from an activity conducted by the developers of Venten

- Inference of experiment:
  - Time taken to obtain aerial photographs: Several hours - 1 day after exposure
  - Time taken for pre-processing and extraction (targeted areas this time): 10 or more hours
  - Data registration for distribution: 0.5 to 1 hour
  - On-vehicle video images -mobile mapping

According to the scarcity of information sources on the state of disasters after the technique was put to practical use, a model area is selected, and photographs with the on-vehicle video are clicked. From this data source, buildings are extracted that meet the prescribed simulated conditions as disaster information, and the time taken for distribution is obtained.

Figure 3: Image Exposed by On-Vehicle Video Camera (mosaic-processed)

Disaster studied: Inference of exposing 10 km of area of Maebashi City streets

Method of extraction: From the video images shown, photographs are generated for every linear-scanned region by automatic mosaic (Figure3), and from these images the positions of parking areas facing roads and the presence of parked cars as simulated information on the damaged state of buildings are read.

Results of Experiment

- Time taken to obtain on-vehicle video image information: Several hours to about one day from exposure
- Time taken for pre-processing and extraction (areas of target): Several hours
- Data registration for distribution: 0.5 to 1 hour

2.3 Conclusions of System Development

1) Data provided by system:

The data provided by this system is as follows.

①Information from the disaster: Information sources are gathered; disaster information is obtained and distributed after giving the inputs into the database server.
Specific information provided from the disaster: For those disasters and hazards whose range is within a bounded region, such as areas submerged by river floods and high tides, the range affected is provided as polygon information. Small damages such as the twisting of buildings and damage due to rubbles, earthquake and fires are provided as point information.

②Geographical information: For tracing the location of the disaster data and the conditions of the surroundings, information along the national boundaries of the disaster-struck region, water systems, transportation facilities, roads, railways, public facilities (hospitals, schools, colleges etc.), names of towns and cities, population dot graph/polygon graph/ line map (Table 4) are provided.

③Results of the study: The system user utilizes the buffering, search for shortest evacuation route and counting functions to obtain the following analysis and conclusions from disaster data and geographical information (Figure4).

- Search for shortest route for evacuation and rescue activities. Shortest route between two points is specified with the help of a road map or railway map.
- Number of affected individuals and damaged facilities is included in the stretch of disaster or stretch of disaster effects.

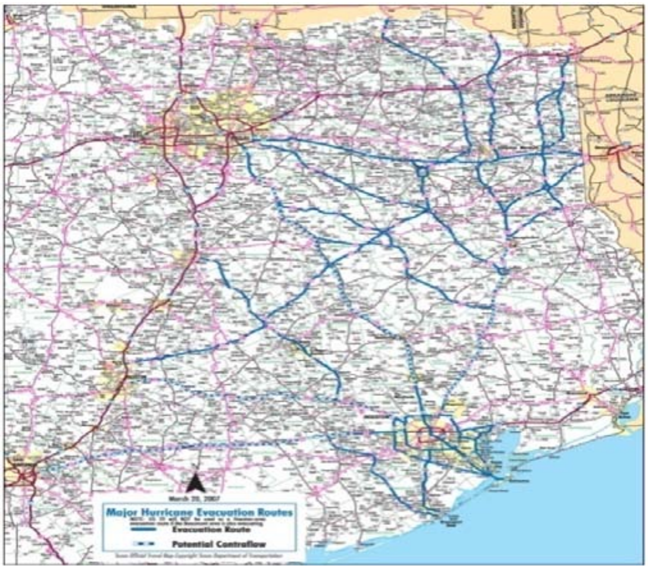


Figure 4: Search for Shortest Evacuation and Rescue Routes (Reference: Houston-hurricane travel guide)

Outcomes of totaling geographical data included in the scope of disaster information, such as submerged region and random region.

2) Attributes of the System: The following illustrates the various attributes of this system.

①Scope: This system can cover the geographical data of a vast region of about 22 countries in Asia, and provide data on disasters occurring in this area.
②Actual information: The fed disaster information can be available for distribution immediately via the Internet.
③Suitability: The user can check the disaster information immediately if in an environment that can have access to the Internet.
④Operational ability: By specifying the name of the desired region or taking it from the index map, an enlarged map centering on that region will be displayed. This means that the user need not magnify or move items on the screen to display the information of a certain region. Disaster data can also be searched for by city name, type of disaster, and date the disaster occurred, thus speeding a check of registered disaster information.

Table 4: Geographical Information

Information	Data formats in system	Source of data	Accuracy
City	Point	Digital Chart of the world (Defence Mapping Agency)	1/1000000 (Original) 1/2000000 (Processed for this system)
Administrative Boundaries	Area (Polygon)		
Water Systems	Line		
Roads	Line		
Railways	Line		
Airports	Point		
	Line		
Land Cover	Area (Polygon)		
Cultural Facilities	Point		
Population	Point	World City Population Database (UNESCO, 1987, GRID)	City or State with population over 100000 people
Altitude/ Shade	Raster	GTOPO30 (U.S. Geological Survey)	Latitude and Longitude 30 seconds (Original) 10km, 50km (Processed for this system)

⑤Analysis function: The system displays disaster data as well as geographical information and it also carries out the function which uses this information to efficiently perform the task of advanced analysis on the Internet, such as buffering and evacuation route searches. The following illustrates the analysis functions of this system.

- Function for determining the stretch of disaster effects by buffering.
- Buffers (of the required dimensions) that consist of mostly the desired image of the disaster data or geographical information that are shown on the map. Utilizing this function to club the stretch of disaster effects with the geographical information available, the overall geographical information for that region can be displayed graphically.
- Function for clubbing disaster information with the desired geographical information: This function outputs the disaster data and the required geographical information together through a unique medium. It accounts for the tracing of the geographical status of the surrounding region--which is very crucial for disaster management in total.
- Function for adding Damage: This function totals geographical data (for example the number of victims and number of damaged facilities) included in the stretch of disaster information, like flood affected regions, for the desired locations. This function may be used to compute the total damage incurred.
- Function for shortest evacuation routes and search for rescue route: By mentioning the beginning and terminal points of roads or railroads on the map, the smallest route and distance can be computed. It's workable to search evacuation routes outside buffer areas organized according to the area of the disaster data with the desired size.

3. Analysis of Gathering and Distribution of Disaster Information in Actual-time

As a result of the study on the actual-time gathering and distribution of disaster information (Table2), it was found that satellite photographs are not necessarily able to provide data on conditions immediately after a disaster has struck because the satellite only has the chance to shoot the same area only once in more than ten days. It is however a relatively easy data source in Asian countries. It was also clarified that the gathering and distribution of detailed technical information by existing and latest techniques has high actual-time performance and the potential to serve as an effective means of gathering data immediately after a disaster has struck. These results show that it is advantageous to make use of satellite photographs for accumulating disaster records, tracing past disasters and capturing the surrounding conditions, because of its availability in the Asian region. However, aerial snaps can be used while gathering data sources in actual time. In the coming days, the latest technologies such as on-vehicle video techniques with high actual-time performance than satellite photographs easily operable from airplanes should become available.

4. Analysis of Actual-time Distribution System of Indian Disaster Reduction Information

By studying this system, we have suggested a mechanism for providing useful information to disaster management officers and researchers in India for tracing and analyzing disaster data. The geographical information presently available is in the small scale of 1 out of 1 million, and can be applied to large-scale disasters over several 10 km2. For disaster measures requiring analysis from an even smaller scale, there is a need to compile large-scale map data in the range of 1 out of several thousand to 1 out of several tens of thousands, with the cooperation of states in India.

5. Conclusion

To enable sharing of disaster information between different regions of a country in the event of a disaster and collect and distribute the disaster information at actual-time. We have studied a server-client type actual-time information distribution system developed by Asian Disaster Reduction Center. The system controls other systems, disaster data and geographical information at the server and distributes it through the internet immediately. This system has demonstrates the mechanism for disaster management officials and researchers in Asia to obtain disaster information in actual-time. We have studied the data sources that can be used for extraction of disaster data, and calculating the time required for obtaining disaster information through experiments using actual data so that this technology can be efficiently put in use by the Government sector and the various agencies to manage any disaster in the country. To gather and distribute disaster data in actual time using this system, it is necessary to grip over the technologies for collecting data sources that can extract information from disasters just after the event and clarify the disaster information that can be extracted and the time taken from collection to extraction. The system has been into existence successfully at the homepage of ADRC since April 2000 and what we just need to do is spread awareness among our people, officers and researchers regarding the technology.

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