Remote Sensing and GIS Approach for Tsunami Damage Assessment –A Case Study

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Abstract: Tsunami cause widespread damage to the properties as well as human lives in the coastal regions. Sri Lanka is a vulnerable country for tsunami since Java-Sumatra is a very active subduction zone, where there were several very large earthquakes, during the last three years. Current study investigated the potential of remote sensing and GIS in damage detection after a hazardous event. The case study was carried out at Galle, Sri Lanka and the primarily focus was on identification and assessment of damage due to tsunami in 2004. The gravity of damage could not be identified only with the satellite data always, therefore GIS data and field observations had to be employed in such situations. A field survey was carried out to identify the damaged areas and to investigate the existing situation at present. There is an extensive need for a proper evacuation plan for the country. An evacuation plan was also developed for the Gall city using the road map. Schools and religious places such as temples and mosques near to coastal line were used as gathering places. Using the Contour map of the area, high elevation points were identified as evacuation places. The shortest path to evacuation places from the gathering places were calculated using Arc View Network Analyst Extension. Local authorities can use the proposed evacuation plan and maps to minimise the damage in a possible future tsunami event.

Keywords: Buffer Zone, Evacuation Plan, Galle-Sri Lanka, High Resolution Data

1. Introduction

Identification and assessment of damage after a natural or man made hazard is essential in various views. It basically helps to assess the magnitude of the damage as well as for rehabilitation and reconstruction activities.

In the view point of Sri Lanka, December 26 2004 tsunami was the worst hazard, which Sri Lankans had to face recently. According To United Nations reports, over 30,000 were dead, 4,000 more were missing, one million were displaced and US$ 1.5 billion worth property was lost due to the tsunami. Remote sensing and Geographical information systems (GIS) with high resolution data is a useful tool as an immediate means to identify and assess the damage due to a hazard.

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(Wijetunge, 2006). But only the remotely sensed data cannot give high accuracy identifications since field verifications have to be done along with that.

If a possible hazardous situation has been identified, a proper evacuation plan also should be designed to evacuate people. This is very much helpful to evacuate people as soon as possible and reduce the damage to the minimum. Also, prior training for a developed evacuation plan is also essential.

This paper presents the potential use of remote sensing and GIS for identifying damage after a hazardous situation and gives an evacuation plan for future tsunami situations in the study area.

2. Study Area

The Study area (Figure 1) is the Galle Municipal council, which consists of 43 GN divisions. It is one of the hardest hit cities from the 2004 tsunami in Sri Lanka. This is the largest urban area in southern Sri Lanka.

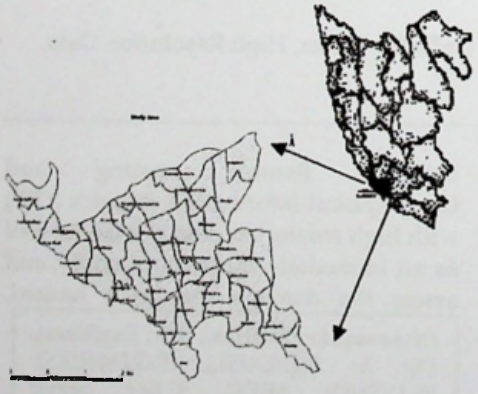

Figure 1. Study Area, Galle Municipal council

3. Methodology

Satellite images were geometrically corrected using the topographical map of the area into local transverse Mercator coordinate and the area of interest was subset using the boundary of Galle municipal council area. Quickbird panchromatic and multispectral (MSS) images were combined using resolution merge to increase the resolution of the MSS image. All the satellite images were enhanced to get better visualisation. Linear stretching and edge enhancement techniques were used for the enhancement. Image classification techniques such as supervised and unsupervised classification were used to classify the images and to prepare land use land cover map of the area. Changes between the satellite images were detected for the original image and band rationed image using change detection algorithm. Damage detection and identification for buildings was also done with visual observation (Figure 2) of the satellite data (Mehdiyev et al, 2005) and the current status was verified using field investigations. Evacuation plan was developed using the road map of the area.

Figure 2. Visual interpretation of satellite data

4. Results and Discussion

4.1 Damage detection

The damage detection was done with comparison of satellite images using change detection algorithm (Figure 3). Detection of damage is not 100% accurate due to distortion such as noise in the satellite data.

4.2 Generation of new buffer zone

The buffer zone imposed by the government is 100m from the coastal

line. But comparing with the inundation data we suggest that there should be alterations to this buffer zone. A new buffer zone (Figure 6) limit was developed using the existing buffer and inundation data.

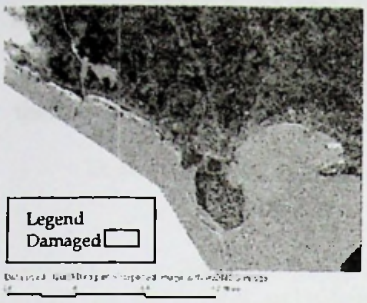

Figure 3. Damage detection using change detection algorithm- Galle

There for visual observation of satellite data was also used to identify the building damage (Figures 4 & 5).

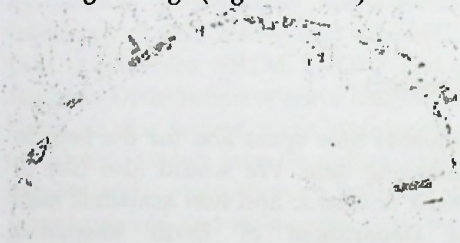

Figure 4. Building damage identified using visual observation of satellite data

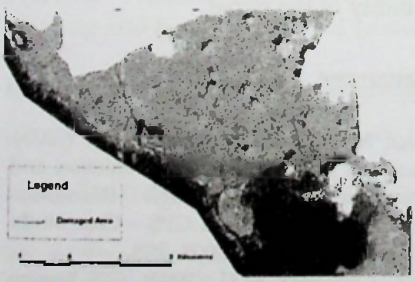

Figure 5. Building damage of Galle MC

4.3 Evacuation plan for the Galle MC

The inundated area was identified with previous data, and the proposed evacuation plan is based on that data. Present area is mostly a flat land area except a limited numbers of high elevation locations. Using the 3D model (Figure 7) higher elevation locations were selected as evacuation places. People are advised to gather to the gathering places or else use their own vehicles to evacuate to safe places. Shortest path available (Figure 9) was identified using the arc view3.2 network analyst extension. (Turk and Gumusay, 2004)

Table 1. Total damage in the Study area

Criteria	Number
Number of Deaths	774
Number of People missing	143
Houses Fully Damaged within 100m	763
Houses with partly damages within 100m	495
Houses fully damaged out side 100m	155
Houses with partly damages outside 100m	652
Number of families affected	6364
Number of persons affected	31867

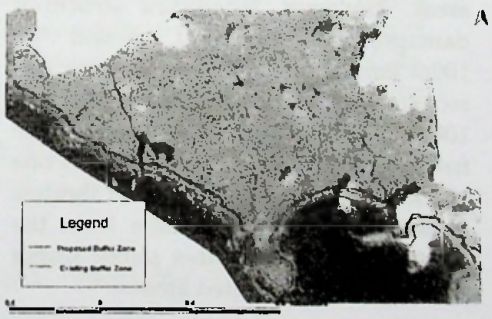

Figure 6. New buffer zone limit of the area

4. Conclusion

Remote Sensing and GIS is one of most appropriate tools for rapid damage assessment for tsunami affected area for rehabilitation purposes and generation of evacuation plan.

Figure 7. 3D model of the study area

- Develop an evacuation plan for the whole country.

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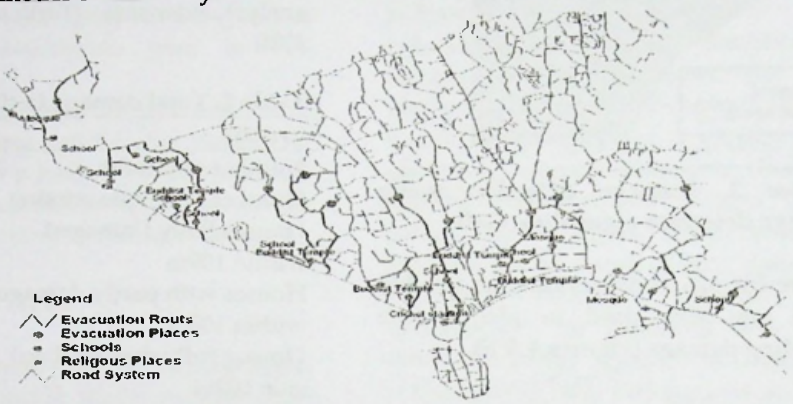

Figure 8. Evacuation plan for Galle municipall council

Structural damage occurred due to tsunami is very high within the 100m areas. However, significant structural damages have occurred beyond the 100m limit in some areas. Therefore it is recommended to extend the existing 100m buffer zone up to 200m distance from the shore. Network analysis is one of the reliable tools for generate shortest possible path for evacuation from the existing schools and other public places located in the inundated areas.

Recommendations

Following recommendations are proposed for future studies.

- Use of Satellite data having Infra Red band so the damage on vegetation could also be detected.
- Use RS and GIS for detecting damages and assessment for other hazards prevalent in the country such as landslides and floods.

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