EARTHQUAKE INTENSITY ESTIMASTION AND DAMAGE DETECTION USING REMOTE SENSING DATA FOR GLOBAL RESCUE OPERATIONS

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1. INTRODUCTION

A strong earthquake can cause tremendous destruction in an urban area such as structure collapse and conflagration. When the disaster is too serious, rescue and medical activity cannot be carried out by individual countries acting alone. Accordingly, cross-border cooperation on countermeasures against disasters is very important. Many relief teams were dispatched to large disaster sites from many countries in the world, for example after the 2004 Indian ocean tsunami and the 2005 Pakistan earthquake. It is necessary to resolve the following issues so that the above mentioned operations are carried out effectively.

1. The relief operation plan and its logistics must be drawn up based on disaster risk evaluation beforehand. Therefore, it is required that the risk evaluation simulation of earthquakes is workable for the entire world.
2. Actual damage information of a struck area is absolutely necessary for rapid countermeasures against the disaster. This information is very useful for decision-making to determine where rescue teams are dispatched.
3. It is necessary to build a communication system for information sharing between the headquarters and disaster site.

In this study, for supporting global rescue operations, I propose a new earthquake damage detection method, based on a combination of earthquake damage estimation using earthquake information (magnitude, location of source, detailed ground condition, and attenuation equation for distance) and change detection by means of remote sensing data. First, to find collapsed buildings and houses on the earth's surface, I adopt a difference image calculated from multi-temporal SAR images observed before and after the earthquake. Next, to estimate seismic intensity and probability of destruction caused by the earthquake, I applied an earthquake engineering model. Finally, damaged area is calculated using a logical AND of difference image and the destruction probability. In order to show that I can obtain a damage detection map which corresponds with the actual damage of houses, I applied the method to simulations of the 2008 Sichuan earthquake in China.

2. PROPOSED METHOD

A change detection using SAR has the problem that no damaged region is identified as a structure collapse region because of the changes of the earth's surface that do not relate to an earthquake. An improvement of damage estimation accuracy is needed in order to apply remote sensing data to detect damage caused by earthquake disasters. Therefore, I adopt a data process to create damage detection map based on a combination of both earthquake information provided by the seismometer network and the SAR images observed by satellite. Figure 1 shows the data process flow of the proposed method to create the map with high accuracy.

2.1 Estimation of Seismic intensity using an earthquake engineering model

Earthquake intensity (V_{max}) can be calculated by means of magnitude, an attenuation equation for distance and ground condition (amplification factor:R) [1]. The R is given for the typical landform types - hill, plateau, fan, reclaimed land, etc. In this paper, a landform classified using the SRTM DEM is adopted.

2.2 Change detection using remote sensing data

It is necessary to gather actual damage information from areas struck by earthquakes to allow for rapid countermeasures against disasters. Since the telecommunication system may be damaged by the shock of an earthquake, it is difficult to get actual damage information from a seriously damaged region. Therefore, Ito (2003 ,[2]) proposed remote sensing appropriate for detecting earthquake damage, by using multi-temporal remote sensing image data. In this paper, to find collapsed buildings and houses on the earth's surface, I calculate a difference image using multi-temporal SAR images observed before and after the earthquake.

3. SIMULATION RESULTS

The 2008 Sichuan earthquake was an earthquake in China that measured 7.9 on the moment magnitude scale. It occurred on May 12, 2008 14:28:01.42 CST in Sichuan province of China. Official figures state that 69,227 are confirmed dead, including 68,636 in Sichuan province, and 374,176 injured, with 18,222 listed as missing.
First, to estimate seismic intensity (V_{max}), I applied the earthquake engineering model and the landform map processed by the SRTM DEM. Next, to find change on the earth's surface, I calculated differences of the backscattering coefficients from multi-temporal SAR images observed before and after the earthquake. Finally, the damaged area is found from a logical AND of the differences and the seismic intensity (V_{max}>30*cm/sec*). Results of this simulation are shown in Figure 1. As can be seen, the detection map has less noise, which indicates that the proposed method has better detection ability than that of using only the change of SAR images. It is expected that the proposed method can provide early and highly accurate information to headquarters for countermeasures against earthquake disaster, and can enable quick and effective relief and rescue operations.

4. REFERENCE

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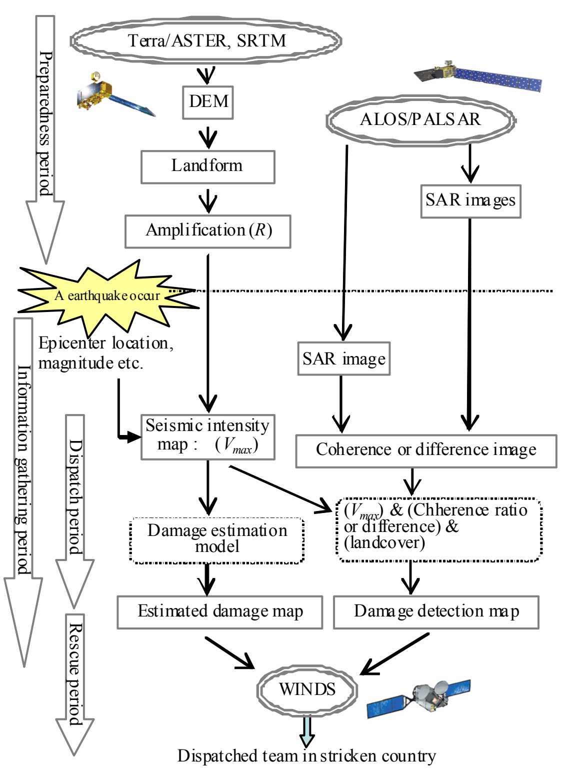

Figure 1. Data process flow

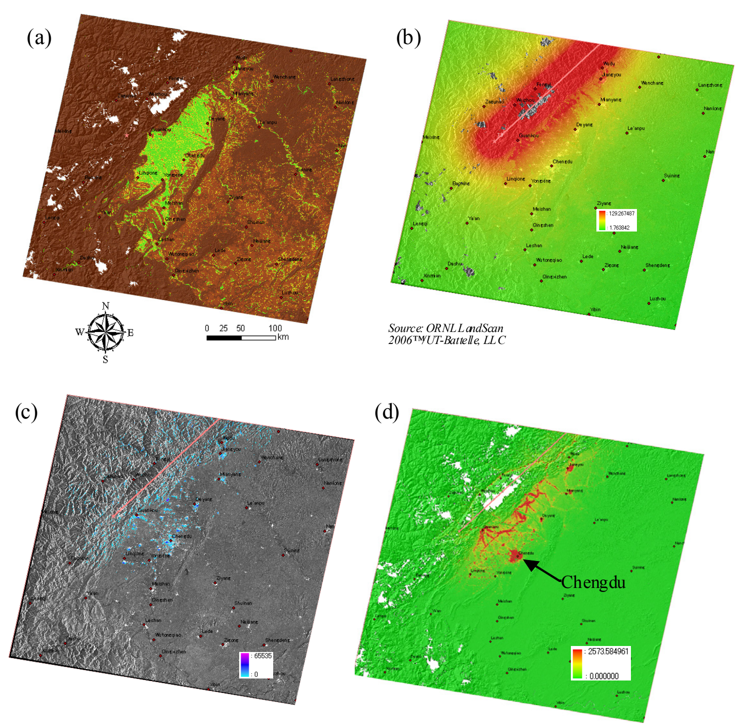

Figure 2. (a) Landform map processed by the SRTM DEM. (b) Seismic intensity map (V_{max}) estimated by the epicenter information and the landform. (c)The damage detection map superimposed on ALOS/PALSAR power image. (d)Number of deaths estimated by the seismic intensity (V_{max}) and LandScan™ 2006.