Chapter 34
Assessment of the Contribution of Crowd Sourced Data to Post-Earthquake Building Damage Detection

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ABSTRACT

This paper compares the results of building damage detection based on Crowd Sourced (CS) data, image processing of remotely sensed (RS) data and predictive modelling with institutional spatial data (Spatial Data Infrastructure - SDI). In particular, it focuses on the contribution of Crowd Sourcing to detecting post-earthquake building damages, while also considering the integration of Crowd Sourced with two other data sources (RS and modelling). To simulate CS data submission following the 2003 earthquake in Bam City (Iran) a survey was administered to the population which experienced the earthquake. The results obtained from this and two other sources are compared with the Actual Earthquake (AE) data by cross-tabulation analysis and McNemar's Chi Square Test. When assessed against AE data, the average accuracy levels of assessments based on the use of RS data and CS data integrated with each RS data and predictive modelling and with both, show a statistically significant increase relative to the predictive modelling. While this research does not provide for a full assessment of the value of CS data alone and in fact finds it slightly inferior to predictive modelling, it suggests that Crowd Sourcing could be a useful source of information, especially if combined with other sources.

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INTRODUCTION

Building destruction is the main cause of fatalities in earthquakes accounting for approximately 75% of deaths (Coburn & Spence, 2002). Earthquakes such as in Varzeghan and Ahar, Iran (2012), Van, Turkey (2012), Tohoku-Oki, Japan (2012), Christchurch, New Zealand (2011), Haiti (2010), and Bam, Iran (2003) had a major impact on the population, buildings and infrastructure in the affected areas. Therefore, rapid assessment of building damage is a crucial and urgent post-earthquake task that could increase the efficiency of the emergency response, and, consequently, lead to a decrease in the number of casualties.

Two methods which are currently utilized for assessing building damage are the vulnerability prediction method, based on the production of fragility curves (JICA, 2000; FEMA, 2003a; Coburn and Spence, 2002; Ueno et al., 2004), and the image processing method based on remotely sensed data. The vulnerability prediction method is based on spatial analysis and modelling procedures. Recent development in this area include HAZards United States (Hazus, Schneider et al., 2006; FEMA, 2003a), Risk Assessment tool for Diagnosis of Urban areas against Seismic disasters (RADIUS, Villacis and Cardona, 1999), SEISMOCARE (Anagnostopoulos et al., 2008), Global Earthquake Model (GEM, 2011), Central American Probabilistic Risk Assessment (CAPRA, 2011), SEimic Loss EstimatioN using a logic tree Approach (SELENA, Molina et al., 2010), Karmania Hazard Model (KHM, Hassanzadeh et al., 2013). These methods have been implemented in regions worldwide, including: Lisbon, California, Illinois, Istanbul, Stockholm, Bangkok, Teheran, and Kerman. Building damage detection using satellite imagery is based on visual inspection and image processing methods which measure the changes in several parameters between high resolution images captured before and after the earthquake (Saito et al., 2004; Yamazaki et al., 2005; and Miura et al., 2010).

Complementing these methods and data sources is an emerging trend in producing data based on so called Crowd Sourcing (CS). Crowd Sourced data is generated by communities and contributed via digital media from both inside and outside damaged areas by people who are neither trained nor supervised (Richter et al., 2011; Milo, 2011; Budhathoki et al., 2008). This data already has been applied in several projects including the U.S. Geological Survey's "Do you feel it?" web application for producing earthquake intensity maps by integrating Crowd Sourced with other institutional data (Wald et al., 1999), modelling of damages inflicted by flooding (Poser & Dransch, 2010), creating the "PeopleFinder and ShelterFinder systems" using a wiki after Hurricane Katrina (Murphy and Jennex, 2006), development of Haiti's post-earthquake Open Street Map database (OpenStreetMap, 2010), fighting wildfires in Santa-Barbara 2007-2009 (Goodchild & Glennon, 2010), gaining knowledge regarding burned houses as a result of the 2007 San Diego wildfires using a wiki (Jennex, 2010), and managing a snowstorm in Chicago (Agrios, 2011).

The potential of CS data to support disaster response has gained increasing attention following its successful contribution in creating a crisis map through the Ushahidi platform during the 2010 Haiti earthquake (Meier & Munro, 2010). The authors reported that people were able to send information using mobile phones. Furthermore, the usage of CS data has been examined through the design of the X24 projects which simulated an earthquake in the five Balkan countries, national disasters in coastal and desert regions of Southern California and Northern Baja California and a volcano in Mexico (Bressler et al., 2012b; Jannex, 2007). The purposes of implementing of the X24 projects were "to continue to build collaborative partnerships, while testing the use of social media, crowd sourcing and collaboration tools