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Tools for Measuring a City's Resilience in a Fire Following Earthquake Scenario

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Abstract

The paper provides a framework to evaluate the response of buildings in a community subject to fire following earthquake. First, a model is developed to determine the probability of ignition in buildings of a community due to an earthquake. Second, fragility functions are developed for buildings subject to fire, to quantify the structural damage and the expected losses. The ignition model, combined with the fragility functions, can be implemented in a GIS based risk management platform to evaluate economical losses in a region from fire following an earthquake.

Keywords: Fire following earthquake; ignition, fragility; probabilistic; community; resiliency.

1 Introduction

Resilience of a community to extreme events is an issue of increasing concern in our interconnected and urbanized societies. Meanwhile, cascading multi-hazard events, such as fire following earthquake (FFE), can be the cause of major social and economical losses. This paper provides a post-earthquake ignition model and a sample fragility function; together they can be used to evaluate response of the buildings subject to FFE.

2 Ignition model

The ignition model is based on seven historical earthquake events, all of which occurred in California, U.S.A., between 1983 and 2014: 1983 Coalinga, 1984 Morgan Hill, 1986 North Palm Spring, 1987 Whittier Narrows, 1989 Loma Prieta, 1994 Northridge, and 2014 Napa. In order to compile the inventory data for the model, first information on the ignition incidents, including their location, for the seven historical earthquakes are collected. Then, geographic and demographic information based on census tracts for the regions that experienced the earthquake events are assembled in a database. Finally, USGS ShapeMap archives are used to collect the peak ground acceleration (PGA) values for historical earthquakes. The groups of data are assembled into one database using ArcGIS.

Compilation of the inventory of historical data is similar to the work completed by Hazus [1]; however, the proposed model takes a different approach than the existing FFE ignition model in Hazus and is based on probabilistic approaches [2]. The proposed model outputs probability of ignition at a census tract and at individual buildings.

A user can apply the proposed ignition model to estimate the number of post-earthquake ignitions for a region, as shown in the flowchart in Fig. 1, and described as the following: (1) compile an inventory of census tracts for the region of study, including population density (PD), total building square footage (SF), number of wood buildings (N_W), number of mobile homes (N_{MH}), and number

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