Tufts UNIVERSITY School of Engineering
Geographical Information Systems

Ground Motion Prediction in Southern California

Introduction

In recent decades, science has attempt to understand and study earthquakes, in order to predict and prevent damages. Several relatively recent studies have come to conclusions that can predict some of the aspects that characterize earthquakes. There are many parameters to be considered: the location of the event, duration and magnitude. In this particular case the study is performed about three seismic events occurred in Southern California (Northridge, Hector Mine and Whittier Narrows). Basically, we manage to establish a comparative-type analysis between the values observed in the monitoring stations and the predicted ones. As GIS, we used ArcMap. It is important to emphasize that, one of the most representative parameters with respect to earthquakes is its acceleration component. That is why this study is based on the comparison of this parameter, specifically the PGA (Peak Ground Acceleration).

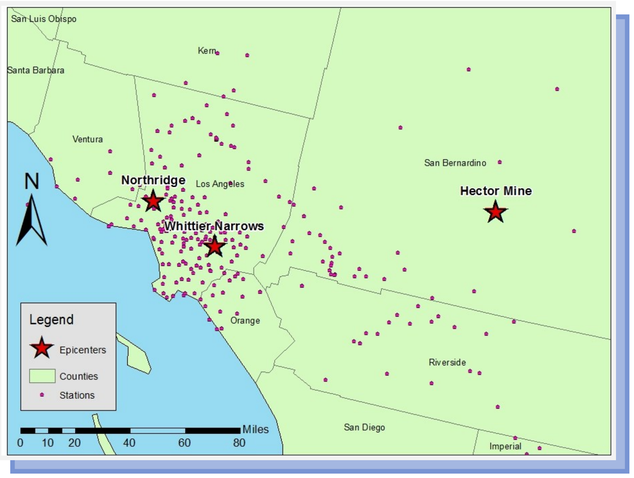

Figure 1 - Epicenters and Monitoring Stations

Data Sources

The Information related to the monitoring stations is stored in an Excel file. Where it is possible to find all the parameters describing the three earthquakes mentioned above. The data is applied to GMPs (Ground Motion Prediction Equations) obtained from the paper published in 1997 by Boore, Joyner and Fumal.

The equation used in this case is the following:

$$\ln(PGA) = b1 + b2 * (M-6) + b3 * (M-6)^2 + b5 * \ln\left(\sqrt{rjb^2 + h^2}\right) + bv * \ln\left(\frac{Vs}{VA}\right)$$

Where:

PGA - Peak Ground Acceleration [g]
Vs - Average shear wave velocity. [m/s]
M - Moment Magnitude
Rjb - Closest distance from site to rupture [Km]
b1, b2, b3, b5, bv, VA - Coefficients for period T = 0

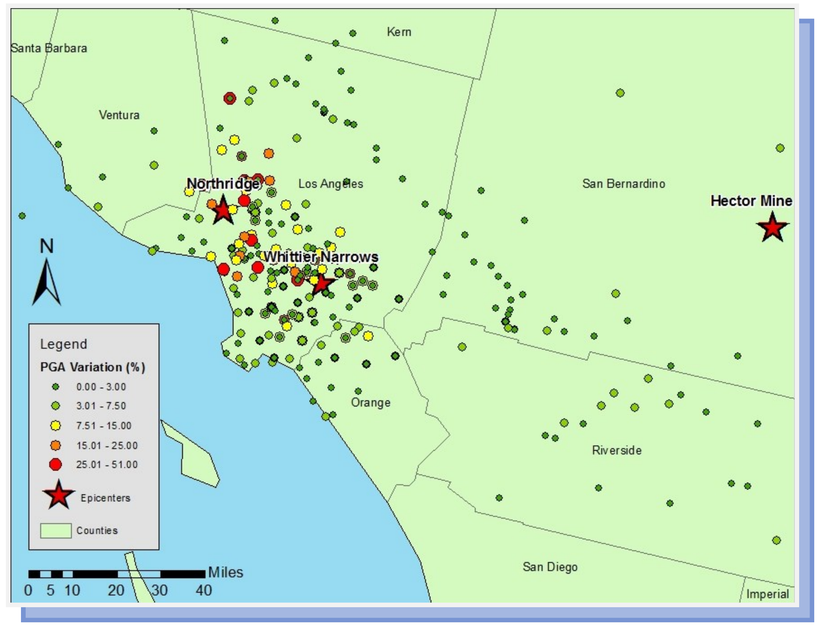

Figure 2 - PGA Variation (%)

Methodology:

Initially the data from the Excel file is used to locate the monitoring stations and the earthquakes epicenters (see figure 1) Then using the Boore et. al ground motion prediction equation to generate the new data related to the Predicted PGA, thus calculating the difference between the values observed at the monitoring stations and the predicted. Finally, display and make a comparative analysis of the results.

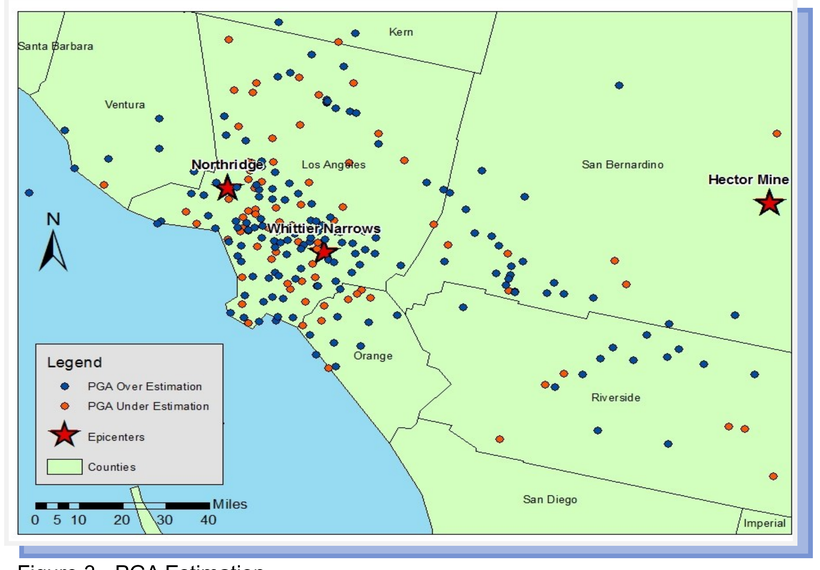

Figure 3 - PGA Estimation

Results:

As we can see in Figure 2, variations between the observed and predicted PGA are generally small, in fact, most of the monitoring stations perceive a difference less than 25%. It is important to mention that, in this map is displayed only the absolute percentage difference. On the other hand, in figure 3 we can find a map displaying which are the stations that are registering a positive difference and which are showing negative difference. In other words it is presented where the equation is underestimating or overestimating the PGA (see figure 3). In conclusion of this map we can say that there is a similar pattern between underestimating and overestimating.

In order to determine the reasons why there is so much difference (over 25%) in 11 monitoring stations, it is displayed in figure 4 a soil type distribution of the region, thus determine if this parameter is influencing in results. Nevertheless, when in a ground motion prediction equation the Vs30 values in inputted the soil variability is already taken into account.

As a conclusion we can see that the highest variation of PGA is registered only for stations located close to the epicenter and only for the Northridge earthquake.

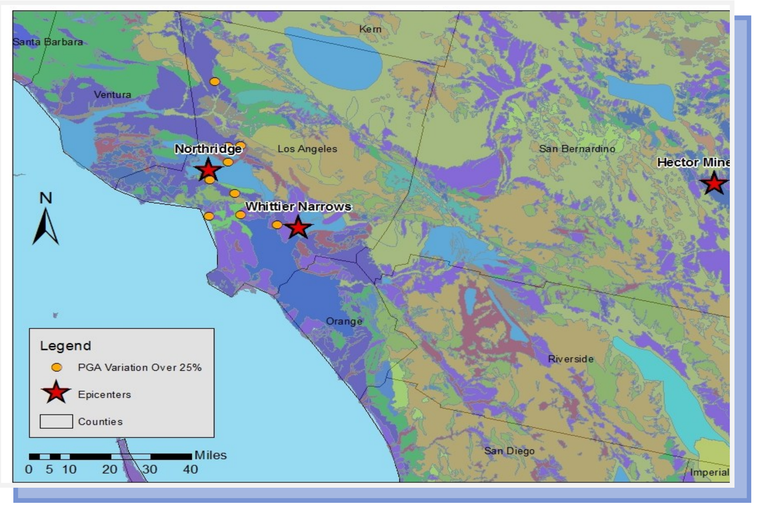

Figure 4 - PGA Variation over 25% and Soil Type distribution

Recommendations

Importantly, the ground motion prediction equations can give variable results and statistical analysis helps to determine how reliable they can be, for this reason is very important to take into account the data that will be used as input. The studied area (Southern California) is characterized for being vulnerable to earthquakes, so It is recommended to make more emphasis in the developing equations that are more localized specifically for the zone.

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