LIQUEFACTION HAZARD RISK ANALYSIS USING FUZZY SETS THEORY

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Introduction

In general, the rate of natural hazard potential(liquefaction and slope failure potential), the knowledge and information of the selected evaluation criteria, and the weight among them may be assessed from some qualitative evaluation scheme and recorded by linquistic terms. When the qualitative evaluation scheme is adopted, results of the assessment are generally preferred in linguistic terms. For example, rating for the slope failure potential or liquefaction susceptibility, according to a particular criterion may be recorded by: very low, low, medium, high, and very high. Similary, the weight applied to each of the adopted criteria may be use one of the following terms on the natural language expression: extremely important, very important, important, moderately important, and relatively unimportant. On the other hand, the uncertainty may be arised using these linquistic expression system. For remove this problem, in this study, the expression of the hazard assessment in linguistic terms are represented with fuzzy set(Zadeh, 1965) before further processing.

Liquefaction Hazard risk analysis

The method for evaluation of hazard potential with fuzzy set in this study, is based on the given method by Juang *et al.*(1990). In this method, using the FWA operation, and according to chosen criteria for hazard evaluation system which, the rating is assessed and recorded as one of the five fuzzy subset such as: A,B,C,D, and E that are: A is very high, B is high, C is moderate, D is low and E is very low, the hazard potential in system will be evaluated. The FWA operation is defined as:

$$R = \frac{\sum_{i=1}^{n} (R_i * W_i)}{\sum_{1=1}^{n} W_i} \qquad (1)$$

Where:
R is combined rating of the hazard potential on the all criteria on a given branch of the decision tree; R_i is hazard potential rating of event according to the criterion i; W_i is weight or relative importance of the criterion i as compared with other criteria on the same branch of the decision tree; and n is number of criteria adopted in each branch of the decision tree.

Using described method, the final fuzzy subset which represents the overall assessment of group of alternatives as a hazard rate of the system is obtained. Then, a mapping model is used to ranking or converting the final fuzzy subsets into some utility. A simple model developed by the Juang, used for ranking of final fyzzy subsets. This utility model for a hazard potential assessment is defined as follows:

$$HPI = \frac{(A_L - A_R + C)}{2C} \tag{2}$$

where:
$0 \leq HPI \leq 1$, is the utility, A_L is area enclosed by the universe and to the left of the membership function of the final fuzzy set obtained, and A_R is the area enclosed by the universe and to the right of the membership function of the final fuzzy set obtained. Then on the described method, the hazard rate potential can be simulated and mapped.

Assessment of liquefaction potential in northwestern of Iran

The liquefied and nonliquefied area during 1990 Manjil-Iran earthquake in Gilan plain considered to evaluation of capability of the method to prediction of hazard potential. For each mesh, the liquefaction potential is assessed using the established criteria(S. M. Fatemi Aghda *et al.*, 1993)
All the weights and ratings are expressed in linguistic terms. The weight of criterion is assigned with one of the five terms: not important, moderately important, important, very important, and extremely important for accurance of liquefaction. In a similar manner, the rating will be one of the following terms: very low, low, moderate, high, and very high susceptible to liquefaction.
The obtained ratings of each criteria and considered weight of them in form of linguistic term are translated into fuzzy sets. Using the presented procedures earlier, FWA operations and ranking index model, the liquefaction potential of each mesh is calculated. The liquefaction potential conturs can be drawn based on the calculated LPI values, which the result will be a liquefaction potential map of the area.

References

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