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Probabilistic seismic hazard analysis by Monte Carlo simulation in Kermanshah region

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Extended Abstract

Summary

The area bounded in 46º-48º E and 34º-36º N is selected for probabilistic seismic hazard analysis of Kermanshah region utilizing the Monte Carlo method. Potential seismic sources model includes 7 clusters obtained from the combination of weighted K-means clustering and particle swarm optimization (PSO) method. The peak ground horizontal acceleration (PGA) and spectral acceleration (SA) for 5% damping ratio at 0.2 and 2 seconds corresponding to 10% and 63% probability of exceedances within 50 years are calculated for the region.

Introduction

Natural disasters are an integral part of human life; therefore, it is necessary to minimize the seismic vulnerability of structures. The study region is one of the most seismically active parts of the Zagros continental collision zone, which has experienced destructive earthquakes due to movements of Sahneh and Nahavand segments of the Zagros Main Recent Fault. Due to the fact that determination of the geometry of seismic sources and seismicity parameters in the conventional methods of seismic hazard and risk analysis is faced with inevitable uncertainties, the Monte Carlo method of probabilistic seismic hazard analysis is used to evaluate the levels of ground motion, in given time periods, using a synthetic earthquake catalog. Potential seismic sources are delineated using weighted K-means cluster analysis and PSO method. Predicted ground motion values are consistent with the ground motion levels in the more reliable recently published seismic hazard zoning maps for Iran.

Methodology and Approaches

The PSO method, which is a global random optimization technique, is considered as an appropriate tool for improving K-means clustering algorithm. The optimal number of clusters (7 clusters) is determined automatically by applying the PSO-weighted K-means algorithm to the spatial distribution of earthquakes. Two validity indexes, Davies–Bouldin's measure and Chou–Su–Lai's measure, were used to determine the optimal number of clusters in the optimization algorithms. A synthetic catalog is prepared by random sampling with replacement of the observed earthquakes, in which each member has a chance to be selected more than once. The Monte Carlo method of probabilistic seismic hazard analysis is used to determine the level of ground motion likely to be exceeded in given time-periods.

Results and Conclusions

With the Monte Carlo simulation and a model including 7 clusters obtained by combining weighted K-means clustering and the PSO method, the peak ground horizontal acceleration (PGA) and spectral accelerations (SA) for 5% damping ratio at 0.2 and 2 seconds corresponding to 10% and 63% probability of exceedances within 50 years (475-years and 50 years mean return periods, respectively) have been calculated for Kermanshah and adjacent regions. Resultant peak ground horizontal acceleration is equal to 0.35 g in Ezgeleh, Miyanrahan, Homeil. Nahavand, Marivan and Bijar areas. In the city of Kermanshah, PGA= 0.15 g and SA=0.5 g in the period of 0.2 seconds, and SA= 0.05 g in the period of 2 seconds. The applied method can provide more acceptable results than traditional PSHA in low seismicity areas.