

Prediction of the Areas Vulnerable to Earthquake in Mashhad City

Yones Gholami¹, Salman Hayati^{2*}, Mohammad Ghanbari, Asiye Esmaili

1. Assistant Professor of Geography, Department of Geography and Ecotourism, University of Kashan, Iran
2. Young Researchers and Elite Club, Lamerd Branch, Islamic Azad University, Lamerd, Iran
3. Young Researchers and Elite Club, Islamic Azad University, Mashhad Branch, Mashhad, Iran
4. Young Researchers and Elite Club, Bojnord Branch, Islamic Azad University, Bojnord, Iran

Received: 14 October 2014 Accepted: 06 May 2015

Expanded Abstract

Introduction

The map of earthquake-vulnerable areas around our country shows that more than two third of all the land is on high risk zones on which most of populated cities are located. These areas are more influenced by activities of faults and they have shallow quakes near the surface. This is to the extent that 90 percent of all the cities in the country are vulnerable to a 5.5 Richter's earthquake. Two existing powerful and active faults in two sides of Mashhad City, with short distance to the city, show a high risk zone. The city is located in a distance of 20 km to a fault 100 km long in east and southeast of the city and also in a distance just 2 km to a fault of 90 km long in south and southwest part of Mashhad. Up to 275 microseisms and earthquakes took place in Mashhad in 2006; 3 of them were more than 4.5 Richter and one with 6.6 Richter, as the most important in Mashhad. During the period 1891-2011, the City had population 60 times and 40 times the area. Given that, the city is a hub of religious tourism. More than 20 million pilgrims and tourists are allowed to enter the city each year. The population density in the area can convert an earthquake into a harmful humanitarian disaster.

Methodology

Fuzzy logic in GIS software was used for zonation of Mashhad vulnerability during possible earthquakes. In this software, small functions were used for fuzzification and fuzzy multiplication operator was used to overlap the data.

Results and Discussion

Overall results show that the west parts of the city have the highest risk of earthquake, while central and eastern parts are experiencing the lowest levels of relative earthquake risk. District 9 has the highest risk and following that the districts 12, 2, 11, and 10 have most risks, in order. District Samen has the lowest level of earthquake risk and districts 5, 3, and 4 are relatively low risk zones. Among three of the most populated districts of Mashhad, i.e. 2, 3, and 9, the districts 9 and 2 have high risk and district 3 is the only one with low risk of earthquake. But district number 9 which is the third one in the order of population in this city has also a high rank in the

* Corresponding Author: S.Hayati66@gmail.com Tel: +98 9305560163

view of earthquake risk. It is the most risky district in the city. Thus, it seems that special attention should be paid to the earthquake dangers in this region. It is obvious that the old buildings in Mashhad must be more considered, those with relatively high risks of earthquake damages based on findings. Some other results of this study are as follows:

- 51 percent of the city's area with 1.45 million residents is located in high risk region.
- After 1980s more than two third of the city has spread into high and very high risk region.
- 63 percent of old buildings and 55 percent of the areas with more than 120 people density are placed in high and very high risk regions.
- 81 percent of residential buildings and 86 percent of commercial/ administrative/ accommodations buildings are located in relatively high and very high risk regions.
- 76 percent of 4 floor and higher buildings are located in relatively high and very high risk regions.

Finally, it is suggested that if more extension of this city is required, more attention should be paid to the faults around the city and more growth towards the west, specially extending in district number 9, should be avoided. Therefore, to avoid spreading of the city into high risk regions, it is suggested to let it be extended towards the north east. It should be noted that all the results and suggestions given in this study are merely based on the researches related to earthquake risks on the basis of corresponding indices. It is obvious that a vast number of studies and researches from a variety of viewpoints are necessary to set programs to make development in a metropolis like Mashhad.

Conclusion

Imbalance and unprincipled growth of the city especially in the last decades, construction near the faults and places with geologic instability, lack of practical abilities to manage a disaster, existing vulnerable buildings and lots of more factors show that in case of a severe earthquake in Mashhad lots of irreparable damages and casualties would occur. Thus, according to the above agents and investigation about how vulnerable is this city to an earthquake, we can say that disaster management is consistent with behavioral and structural schools. Because we see unprincipled behaviors based on behavioral school like non-standard constructions, use of improper materials, establishment of slums, improper foundation, construction in the canals and watercourses, and etc., Based on structural thought, management problems and the absence of a united management in case of a disaster can also play a role in intensification of a disaster. Finally, to reduce Mashhad's vulnerability to possible earthquakes following suggestions are presented:

1. Providing a database from close or effective faults, which can make trouble;
2. Managing secondary risks like fire, gas leakage, flood and ...;
3. Reinforcing existing buildings as far as possible;
4. Preventing any construction without obeying seismic codes;
5. Cooperation and interaction among all related organizations;

Keywords: city vulnerability, earthquake, Fuzzy logic method, Geographical Information System (GIS), Mashhad City.

References

1. Abdullah, A., Hedayati Marzbali, M. & Maghsoodi Tilaki, M.J., 2013, Predicting the influence of CPTED on perceived neighbourhood cohesion: Considering differences across age, *Journal of Environmental Psychology*, 36, 54-64.

2. Adl, G. & Fezoni, Sh., 1998, Check the status of the safety of a power distribution company with SAFETY AUDIT, The first seminar on workforce health and sustainable development, 14-16 November Tehran, 16-20.
3. Almasfar, N. & Ansari, M., 2010, Evaluation of environmental security in the regional parks as part of urban spaces from the perspective of women on the approach CPTED (Case Study: Saie Park), Urban Management Journal, 25, 21-34.
4. Atkins, S.T., Atkins, S.R.E. & Leq, N.D., 1990, Personal Security Aspects of Travel and Transport. Report to ESRC, England: published University of Southampton.
5. Crime Prevention Through Environmental Design, 2000, General Guidelines For Designing Safer Communities, City of Virginia Beach Municipal Center Virginia Beach, 34.
6. Demuth, C., 1989, Community Safety in Brighton, England : published Brighton Borough Council Police and Public Safety Unit.
7. Etemadifar, S.A., 2009, The role of lighting and lighting design in security of Tehran (with emphasis on correct principles lighting in urban landscapes), The second Conferences Safe community in Tehran, October, 1-22.
8. Fleming, R. & Burrows, J., 1986. The Case for Lighting as a Means of Preventing Crime, Home Office Research and Planning Unit London, Research Bulletin 22, 14-17.
9. Geison, S. & Wilson, P.R., 2011, Design out crime: crime prevention through environmental design, (Interpreters Mohsen Kalantare and Abuzar salami Bayrami), 1Edition, Zanjan: Azarkelk Press, 133.
10. Ha, T., Oh, G.S. & Park, H.H., 2014, Comparative analysis of Defensible Space in CPTED housing and non-CPTED housing, International Journal of Law, Crime and Justice, 2, 1-16.
11. Hanachi, S. & Moghani, P., 2008, Urban crimes prevention through environmental design, Proceedings of the First National Congress on Crime Prevention sent, preventive police Office of Applied Research, 1-12.
12. Home Office Crime Prevention Unit Branscomb, L.M., 2006, Sustainable cities: Safety and security, Technology in Society Journal, 28, 225-234.
13. Kang, S. J., 2013, Crime prevention in ethnic areas focusing on crime prevention through environmental design, Journal of Building Construction and Planning Research, 1(1), 15-23.
14. Karlen, M. & Benia, G., 2000, Lighting Design Basics (Translator: Mohammad Ahmadinejad), first Edition, Tehran: Kak publication, 216.
15. Keynia, M., 2000, Basics of Criminology, first volume, Fourth Edition, Tehran: Tehran University Press, 604.
16. Leong, K. & Sung, A., 2015, A review of spatio-temporal pattern analysis approaches on crime analysis, International e-Journal of Criminal Science, 1(9), 1-32.
17. Mahmodi Janaki, F. & Gorchibeige, M., 2008, The role of crime prevention and environmental design, Journal of Law, 2, 245-367.
18. Paterson, A., 2006, Crime Prevention through Environmental Design (CPTED) Guidelines for Local Government, National Crime Prevention Council Public Affairs Department, Police Headquarters, Level 4, 68.
19. Paterson, A., 2006, Crime Prevention through Environmental Design (CPTED), Guidelines for Local Government September 2006, www.npsp.sa.gov.au.
20. Pease, K., 1999, A Review of Street Lighting Evaluations: Crime Reduction Effects, Crime Prevention Studies Journal, 10, 47-76.

21. Porjafar, M., Mahmoodreza, H., Rafieian, M., & Aasari, M., 2008, Promoting environmental security and urban crime reduction approach with an emphasis on CPTED, International Journal of Engineering Science, 19(6), 73-82.
22. Prairie Sky Consulting, 2004, North Central Crime Prevention through Environmental Design (CPTED), Final Report, 85.
23. Ramsay, M., 1991, The Effect of Better Street Lighting on crime and Fear: A Review, Editor Gloria Laycock, London: Crime Prevention Unit Paper, NO29, 54.
24. Ramsay, M., 1989, Crime Prevention: Lighting the Way Ahead, Research Bulletin 27, Home Office Research and Planning Unit, London, 18-20.
25. Rostami Tabrizia, L. & Madanipourb, A., 2006, Crime and the city: Domestic burglary and the built environment in Tehran, Habitat International, 30, 932-944.
26. Sakipa, S.T., Joharia, N. & Mohd Sall, M.N., 2012, the Relationship between Crime Prevention through Environmental Design and Fear of Crime, Procedia - Social and Behavioral Sciences, 68, 628-636.
27. Sakipa, S.T. & Abdullah, A., 2012, Measuring Crime Prevention through Environmental Design in a Gated Residential Area: A Pilot Survey, Procedia - Social and Behavioral Sciences, 42, 340 – 349.
28. Strou, R., 2007, Parks recreation department play group safety, Internal Audit Department, 7 March, www.ta m pagov.net.
29. Tavanaei Marvia, L. & Behzadfar, M., 2015, Local Sustainability with Emphasis on CPTED Approach The case of Ab-kooch Neighborhood in Mash-had, Journal Procedia - Social and Behavioral Sciences, 201,409-417
30. Valath, I.J., 2009, Safety systems, (Translator: Homayon Lahyjanya), Fourth Edition, Tehran: publisher of Iran University of Science and Technology, 268.