8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

AFTERSHOCKS PROBABILISTIC SEISMIC HAZARD ANALYSIS OF THE SARPOL-E ZAHAB EARTHQUAKE OF NOVEMBER 12, 2017

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Keywords: Aftershocks, Seismic hazard analysis, Omori law, Sarpol-e Zahab earthquake

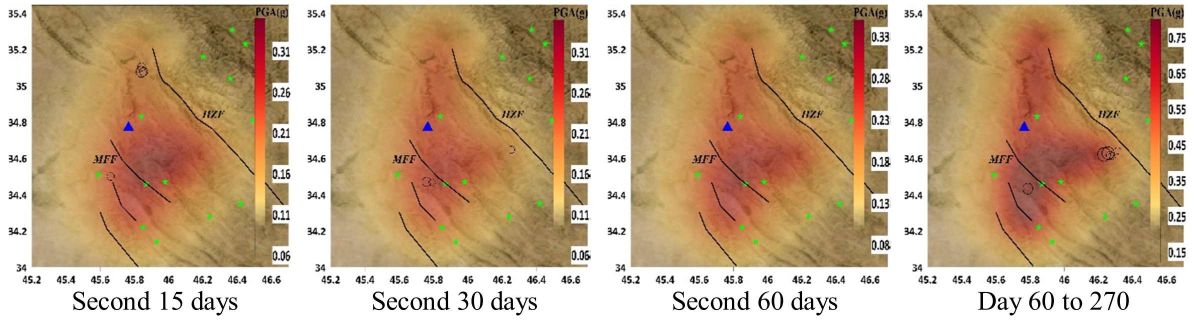
Aftershocks seismic hazard analysis plays an essential role in search, rescue, evaluation and repair of damaged structures and reoccupation after a severe mainshock. For this sake, several methods have been developed over the past years. During recent years, two practical methods have been proposed, one by Wiemer et al. (2002) and one by Yeo and Cornell (2005) known as APSHA (Aftershock Probabilistic Seismic Hazard Analysis). In this paper, we have derived the seismicity parameters (a and b), the modified Omori law parameters (a, p, k) and also their temporal changes for the Sarpol-e Zahab earthquake of November 12, 2017 which struck the western Kermanshah province and led to a great financial loss and fatalities. The affected region also experienced numerous aftershocks which some of them were strong and caused various problems. Implementing the obtained parameters in both aforementioned methods, aftershocks hazard maps were developed for 33% exceedance probability within three short time periods (second 15, 30 and 60 days after the mainshock) and one long time period (days 60 to 270) after the mainshock (Figure 1). This process has already been done around the world and also it has already been done for some regions of Iran by Ommi and Zafarani (2017). In order to improve the accuracy of the results, utilizing the available aftershocks' local data, a simple local attenuation relation appropriate for aftershocks was developed. Finally, the computed maps have been compared with the real recorded accelerations in the region (Table 1).

Table 1. Validation of the calculated aftershocks hazard for Sarpol-e Zahab earthquake, obtained by considering 33% exceedance probability within the time periods, (a): second 15 days, (b): second 30 days, (c): second 30 days and (d): days 60 to 270 after the mainshock against the recorded acceleration data.

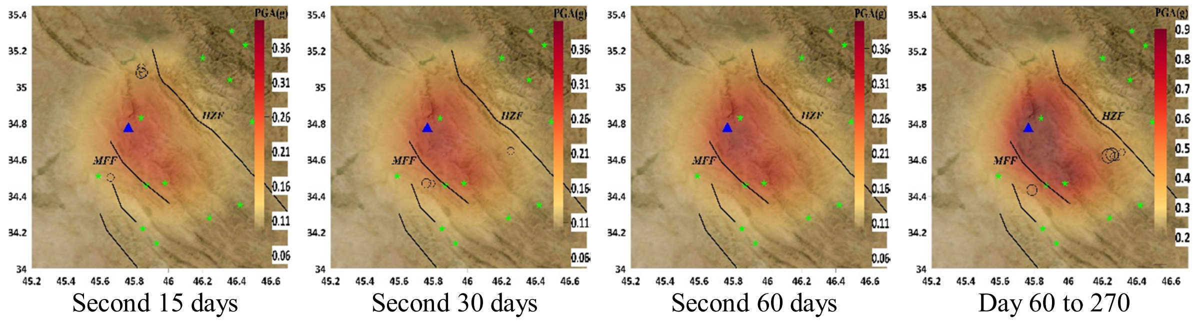
Wiemer et al. (2002) method					**Yeo and Cornell (2005) method**			
Sites with exceedance	n (g≥g*)	P_n (Poisson)	P_n (binomial)		Sites with exceedance	n (g≥g*)	P_n (Poisson)	P_n (binomial)
(a) Second 15 days after the mainshock								
-	-	-	0.02<0.05 OS		**Tazeh Abad**	1	26% OK	0.09>0.05 OK
(b) Second 30 days after the mainshock								
Tazeh Abad	1	26% OK	0.09>0.05 OK		**Tazeh Abad** **Sarv Abad**	1 1	26% OK 26% OK	0.2>0.05 OK
(c) Second 60 days after the mainshock								
-	-	-	0.02<0.05 OS		-	-	-	0.02<0.05 OS
(d) Days 60 to 270 after the mainshock								
Tazeh Abad	4	0.07% US	0.09>0.05 OK		**Tazeh Abad**	4	0.07% US	0.09>0.05 OK

It was observed that the seismicity parameters and the Omori law parameters varied over time. The spatial hazard prediction in Wiemer et al. (2002) method is based on the epicentre of the aftershocks, while in Yeo and Cornell (2005) method, it is distributed around the causative faults (Figure 1). Table 1 demonstrates that in our case, the method proposed by Yeo and Cornell (2005) matches the reality better. Moreover, within the long time period, a conspicuous underestimation in the Tazeh Abad station (close to the mainshock epicentre) is observed.

Figure 1 illustrates that the highest aftershocks hazard among the short time periods in Wiemer et al. (2002) method occurs within the second 15 days while in Yeo and Cornell (2005) it occurs in the second 60 days. However, in both methods, the considered long time period, possesses hazard values remarkably higher than the short time periods which can be due to the long length of the considered time period and neglecting the temporal variation of the seismicity parameters.



(a) Wiemer et al. (2002) method



(b) Yeo and Cornell (2005) method

Figure 1. Aftershocks seismic hazard maps for 33% exceedance probability within three short time periods (second 15, 30 and 60 days after the mainshock) and one long time period (days 60 to 210 after the mainshock) for the Sarpol-e Zahab earthquake, (a): Wiemer et al. (2002) method and, (b): Yeo and Cornell (2005) method. The blue triangle denotes the mainshock epicenter, the green stars represent the location of the accelerometer stations, the black lines represent the major faults (Hessami and Jamali, 2006) and the black circles indicate the epicenters of aftershocks with magnitude greater than 4.5.

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