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Probabilistic Seismic Hazard Analysis Incorporating Monte Carlo Method in the Case of Adelaide Region

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Abstract - A topic of seismic hazard analysis (SHA) is briefly elaborated. A probabilistic seismic hazard analysis (PSHA) is commonly used to assess the ground motion level expected with different likelihood at a rock site during a future seismic event. The Incorporating Monte Carlo method into PSHA in an intraplate region (*i.e.* Adelaide region) is an interesting topic to explore. The result of the analysis using this method is able to characterize the likelihood of seismicity in a targeted region. Furthermore, the results clearly display the seismic ground motions in term of peak ground acceleration and peak ground velocity in Adelaide region. The de-aggregation of the analysis suggests two expected severe events for the Adelaide City. The first expected event is an earthquake M5.2 from a distance of 15 km and 25 km from the city. The second expected one corresponds to an earthquake M6.6 occurring 85 km away from the Adelaide City. However, the results of this analysis must be treated carefully due to dubious seismic data catalogue for a relatively large seismic event in Adelaide region.

Keywords: probabilistic, seismic hazard analysis, Monte Carlo simulation

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Introduction

Background

Currently, the seismic hazard analysis (SHA) is the most appropriate method to assess seismic vulnerability. SHA is capable of describing earthquakes that could contribute to the most severe damage in a region for any future seismic events (McCalpin, 2009). Commonly, there are two types of SHAs, which are deterministic seismic hazard analysis (DSHA) and probabilistic seismic hazard analysis (PSHA) (McCalpin, 2009). Both DSHA and PSHA have been criticized for different reasons. However, by considering the capabilities of both DSHA and PSHA models (cf: McCalpin, 2009), this study employs PSHA for the analysis. Barani *et al*. (2012) stated that PSHA is commonly used to assess the ground motion level expected with different likelihood at rock sites during a given period of time. The PSHA displays relative contributions to hazards from different values of random components of a problem, a specifical magnitude (m) and a source-to-site distance (r) by a process called de-aggregation. Recently, two open applications, OPENQUAKE (Bommer *et al*., 2013; Pagani *et al*., 2014; Silva *et al*., 2014) and OpenSHA (Field *et al*., 2005a; Maechling *et al*., 2005; Field *et al*., 2005b) have been introduced for this PSHA.

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Considering the advantages of Monte Carlo simulation in the prediction of future events (Muson, 2000), EqHaz (an open source probabilistic seismic hazard code based on the Monte Carlo method) was employed in the PSHA model in the present study. EqHaz was developed by Assatourians and Atkinson (2012) for the eastern part of North America (ENA). The ENA seismic study is often considered to be representative of intraplate conditions around the world (Lam *et al*., 2000). The EqHaz model was developed to perform PSHA by incorporating the Monte Carlo simulation method (Musson, 1998, 1999; 2000; Hong and Goda, 2006; and Musson, 2012). Assatourians and Atkinson (2012) stated several advantages of the EqHaz: the model is fast, flexible, and easy to be used for typical PSHA problems in moderate-seismicity regions; the programme accepts both common type source models and user-specific ones; the model is able to define both epistemic and aleatory uncertainty in key input parameters; and EqHaz has been validated against other commercialized applications *i.e.* EZFRISK and FRISK88.

Adelaide, South Australia, lies within the most seismically active region in the Australian Continent (Sandiford, 2003; Quigley *et. al*., 2006; 2007). Thus, an in-depth seismic hazard study of the Adelaide region is urgently required. PSHA to assess the likelihood of seismic event for Adelaide must be warranted. Furthermore, several probabilistic seismic risk studies have been carried out in the Adelaide region, *i.e.* McCue (1975), McEwin *et al.* (1976), Rossiter (1982), Stewart (1984), Gaull and Michael-Leiba (1986), Greenhalgh and McDougall (1990), and Malpas (1991). Three methods of risk determination, namely: Gumbel statistics, the Cornell-McGuire method, and the seismic moment method have been employed in these studies. PSHA using Monte Carlo simulation method has never been attempted in the studied area (*i.e.* Adelaide region). Thus, results of PSHA incorporating Monte Carlo simulation in Adelaide region is presented.

Basics of Probabilistic Seismic Hazard Analysis and Monte Carlo Method

Probabilistic Seismic Hazard Analysis

The probabilistic seismic hazard analysis (PSHA) involves quantification of ground-shaking induced by a seismic event in which uncertainties in magnitude (m), epicentral distance (r), and time of occurrence are being considered. A large amount of seismic catalogue is used for this PSHA from which all the crucial parameters are deduced. The probability of a ground motion parameter Y will exceed a particular value y* and can be written as:

$$P\left[Y > y^*\right] = \int_{-\infty}^{+\infty} P\left[Y > y^* \middle| (M,R) = \middle| (m,r)\right] f_{M,R}(m,r)\,dmdr \quad \dots (1)$$

Assuming that m and r parameters are independent, the probability of exceedance can be written as:

$$P\left[Y > y^*\right] = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} P\left[Y > y^* \middle| m,r\right] f_M(m) f_R(r)\,dmdr \quad \dots\dots\dots\dots (2)$$

In the Poisson model, the probability of exceedance y* in a time period T, can be written as:

$$P\left[Y_T > y^*\right] = 1 - e^{-\lambda_{y^*} T} \quad \dots\dots\dots\dots (3)$$

where M is expected seismic magnitude at the expected epicentral distance of R, and λ is the mean rate of a cumulative number of earthquakes with magnitude equal to or greater than M occurring per unit time of interval.

Monte Carlo Simulation

A Monte Carlo simulation or Monte Carlo experiment applies repeated sampling to determine the properties of some phenomena (Sawilowsky, 2003). The Monte Carlo simulation runs a large number of simulations by randomly selecting inputs of the simulation models according to their respective probability density functions. The more simulations run, the better the Monte Carlo simulation will approximate the actual reliability. This Monte Carlo simulation is incorporated in the present study as this simulation has several advantages *i.e.* simple, fast, flexible, and robust (see Musson, 1998 and Musson, 1999 for detail). In order to ascertain the simulation is appropriate, the results must be consistent with a number of conditions such as the pseudorandom generation much long, the input factors must pass randomness tests, the number of samples must be large, and the system model must be valid and relevant to the actual of the targeted model (Sawilowsky, 2003).

Results and Discussion

Input Parameters

In order to carry out the analysis, two main seismic parameters have to be defined. The parameters are seismic source zones and earthquake recurrence parameters. Seismic source areas are defined as a set of arbitrary quadrilateral areas/regions which are similar in terms of seismicity, geological setting, and tectonics. In the case of the Adelaide region, Malpas (1991) divided South Australia into sixteen zones including the background, as shown in Figure 1. The source zones were constructed to enclose three major seismic regions, which are Adelaide Geosyncline, Eyre Peninsula, and the southeast corner of the state (Malpas, 1991). Each seismic source zone is treated as a gross source which has its own recurrence parameters and depth estimates.

The difficulties of seismic zoning in Australian continent have been discussed by Leonard

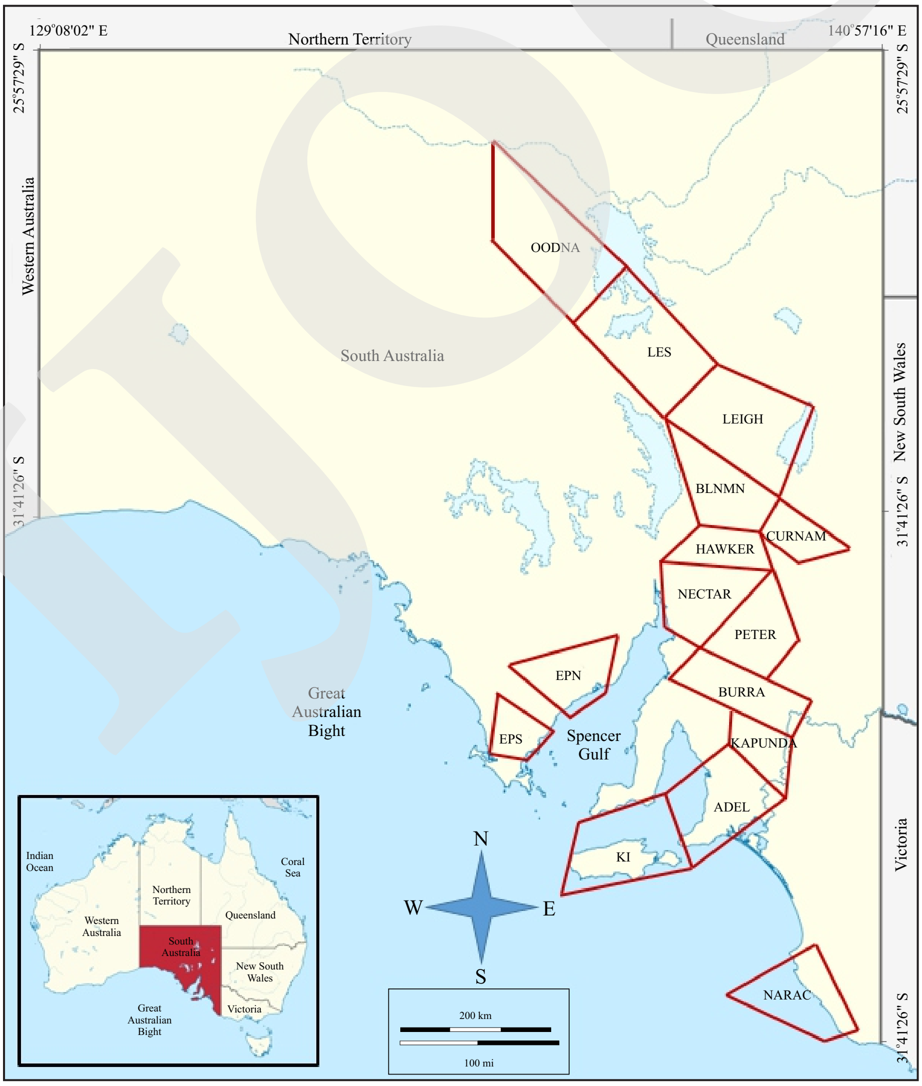

Figure 1. Earthquake source zones used in this study (adopted from Malpas, 1991).

et al. (2011). In the intraplate region, such as the Australian Continent, earthquakes are often triggered by small faults and localizing these small active faults is always facing a great challenge. Therefore, zones of faults are introduced. The use of zonation in this study to represent the seismicity in the area of interest is based on the source zone model described by Malpas (1991) which was defined in accordance with the criteria as follow: a) the seismic source zones were developed in a series of quadrilateral shapes to comply the computer code; b) the zoning was defined from the seismic events up to 1991; and c) geological and tectonic settings of the region were considered in the development of the zoning. A list of significant earthquakes in South Australia for the zoning is shown in Table 1. The list covers the pre-instrumental and post-instrumental seismic data in South Australia.

The recurrence parameters adopted for the PSHA in the present study are listed in Table 2. Gutenberg and Richter (1954) have formulated the earthquake recurrence. This classic earthquake recurrence is shown in the following relationship.

$$Log_{10}N = a - bm_L \quad (4)$$

where N is the cumulative number of seismic events of at least magnitude mL, occurring per unit time in the seismic source zone. The constants, a and b, are the recurrence parameters that apply to a specific time and space sequence for all zones of the present study as shown in Figure 2 (OODNA and LES seismic source zones), Figure 3 (Leigh and BLNMN), Figure 4 (CURNAM and HAWKER), Figure 5 (NECTAR and PETER), Figure 6 (BURRA and KAPUNDA), Figure 7 (ADEL and KI), Figure 8 (EPN and EPS), and Figure 9 (NARAC and BCKGND). Parameters BETA and N0 are related to the parameters a and b. The relationships are:

$$\beta = b \ln 10 \quad (5)$$

$$N_0 = 10^a \beta^{-1} \quad (6)$$

The depth of the seismic source and weight of each depth used in the present paper are based on the comprehensive study by Malpas (1991). The average of the median values of the Adelaide region focal depth is 8 (±2) km which clearly indicates shallow focal depths. This shallow depth of the epicentre in South Australia was also being suggested by Greenhalgh and Singh (1988) who found that over 77% of the seismic activities in South Australia were occurring at the depth of less than 20 km.

The completeness of the seismic data used in the present study has been investigated by Greenhalgh and McDougall (1990) using an approach by Stepp (1972). The approach defined the standard deviation of the mean earthquake rate, σ_λ is as follows:

$$\sigma_\lambda = (\lambda \ / T)^{1/2} \quad (7)$$

The mean rate of event occurrence, λ is defined by the total number of events, *N* over *T* years as shown in the following equation:

$$\lambda = N / T \quad (8)$$

Then, the result is plotted in a log-log plot and examined from the graph. The log-log plot of the standard deviation of the mean earthquake rate as a function of recording period of *T* should produce a bi-linear relationship as follows:

$$\log\sigma_\lambda = 1 / 2 \log \lambda - 1 / 2 \log T \quad (9)$$

When the mean rate of event occurrence, , is constant, which suggests a completeness, the slope of the trend line will be ½. The longest period of the slope of ½ is considered to be the period of observation completeness. However, when the slope of the observation trend is -2, incomplete period observation is displayed.

As aforementioned earlier that Greenhalgh and McDougall (1990) have carried this catalogue completeness test for South Australia. The results are presented in Figure 10. The estimated completeness period (years) for seismic magnitude below 4 is justified. The completeness catalogue

Table 1. South Australian Significant Historical Earthquakes (adopted from Malpas, 1992)

UT Date	Time	Latitude (°S)	Longitude (°E)	Depth (km)	Magnitude (ML)	Place name
1883-07-07	13:58	35.100	138.700	14.0	4.5	Mt. Barker
1887-04-16	13:10	33.500	139.000	14.0	4.4	Mt. Bryan
1887-04-16	22:10	34.300	135.800	14.0	5.4	Cummins
1889-02-12	06:45	34.000	139.000	0.0	4.6	Robertstown
1893-08-13	02:10	34.333	139.000	0.0	3.6	Kapunda
1896-08-22	02:56	33.750	138.917	0.0	4.3	Burra
1897-05-10	05:26	37.300	139.750	14.0	6.2	Beachport
1898-04-10	21:10	37.300	139.750	14.0	4.9	Beachport
1899-05-02	03:30	37.300	139.750	0.0	5.0	Robe
1902-05-07	05:10	32.750	138.500	0.0	4.8	Mid-north
1903-08-14	21:10	33.917	138.500	0.0	4.1	Clare
1905-08-21	18:35	34.200	138.800	14.0	4.6	Riverton
1908-04-09	16:25	33.917	138.617	0.0	4.7	Peterborough
1911-10-24	12:00	33.750	136.500	0.0	4.8	Cleve
1911-10-26	10:00	33.667	136.417	0.0	5.5	Eyre Peninsula
1914-05-28	13:21	34.900	138.700	0.0	3.9	Adelaide
1921-04-23	19:00	33.267	138.833	0.0	5.1	Jamestown
1937-10-28	09:34	26.100	136.500	0.0	5.5	Simpson Desert
1939-03-26	03:56	31.100	138.300	0.0	5.7	Parachilna
1939-05-01	19:07	31.400	138.000	0.0	3.9	Lake Torrens
1939-06-05	12:20	31.500	138.500	0.0	3.9	Hawker
1941-05-04	22:07	26.300	136.900	0.0	5.1	Simpson Desert
1942-02-14	22:50	29.500	136.000	0.0	4.3	Margaret Creek
1948-08-06	03:29	37.360	139.680	18.0	5.6	Beachport
1954-02-28	18:09	34.930	138.670	4.0	6.0	Adelaide
1959-05-21	11:28	31.400	139.000	0.0	4.4	Wilpena
1959-09-09	14:17	32.700	138.200	0.0	4.3	Melrose
1959-11-02	01:17	33.360	135.980	0.0	4.9	Mamblin
1960-08-18	15:04	33.800	136.150	0.0	4.3	Ungarra
1960-08-30	21:23	34.000	136.000	0.0	4.3	Ungarra
1960-08-31	02:14	33.350	136.400	0.0	4.4	Ungarra
1960-11-12	23:03	34.600	135.500	0.0	4.4	Coffin Bay
1960-06-10	15:58	34.500	135.000	0.0	4.2	Coffin Bay
1962-01-10	19:36	36.350	139.800	0.0	4.1	Chinamans Well
1962-03-03	22:04	33.000	136.000	0.0	4.2	Kimba
1962-05-16	21:41	35.510	137.660	0.0	4.6	Investigator Straight
1963-03-29	21:56	35.100	138.500	0.0	4.1	Parachilna
1965-01-17	02:48	27.968	135.655	0.0	4.1	Warrina
1965-01-25	20:22	31.928	138.495	0.0	4.6	Wilson
1965-03-02	15:18	30.525	138.222	10.0	4.8	Leigh Creek
1965-03-14	12:47	31.949	138.569	0.0	4.7	Wilson
1965-06-04	10:45	32.000	138.479	3.7	4.2	Cradock
1965-08-28	00:26	32.225	138.297	16.1	4.2	Willochra
1966-11-23	20:48	34.347	139.303	13.4	4.2	Truro
1969-01-29	15:03	31.797	139.115	20.3	4.1	Baratta
1971-07-26	07:50	31.375	138.756	18.6	4.9	Wilpena

Table 1. South Australian Significant Historical Earthquakes (adopted from Malpas, 1992) continued...

UT Date	Time	Latitude (°S)	Longitude (°E)	Depth (km)	Magnitude (ML)	Place name
1972-04-18	22:20	31.578	138.619	11.9	5.4	Wilpena
1972-04-27	11:50	31.263	138.891	12.5	4.0	Blinman
1974-02-27	01:57	28.454	136.819	6.0	4.3	Douglas Creek
1975-01-03	02:18	31.243	138.716	6.4	4.0	Blinman
1975-11-22	19:32	37.977	140.207	17.9	4.2	Cape Banks
1976-08-14	03:47	37.669	139.441	31.3	4.0	Beachport
1978-03-26	22:37	32.389	138.923	16.4	4.0	Yalpara
1980-04-15	00:38	33.263	137.030	31.0	4.4	Kimba
1980-11-13	08:56	33.739	138.825	18.4	4.1	Clare
1983-12-29	17:42	30.794	138.405	20.4	4.3	Beltana
1986-03-30	08:54	26.285	133.019	19.5	6.2	Marryat Creek
1986-07-11	07:18	26.205	132.875	0.0	5.9	Marryat Creek
1986-12-16	04:29	36.118	136.577	7.5	4.4	Kangaroo Island
1990-02-08	08:23	27.891	137.342	9.0	4.5	Lake Eyre North
1990-12-01	22:35	26.582	131.325	21.6	4.1	Mt. Woodroffe

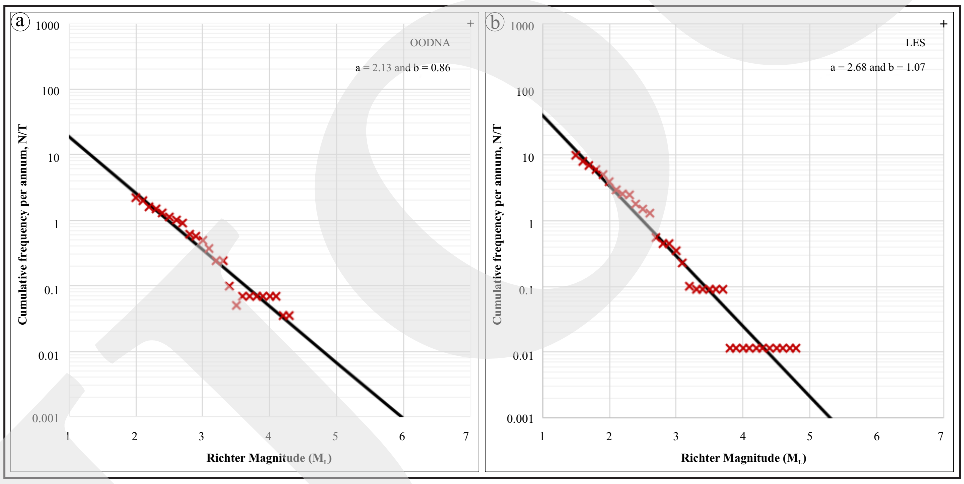

Figure 2. Recurrence parameters (a) for OODNA and (b) LES seismic source zones.

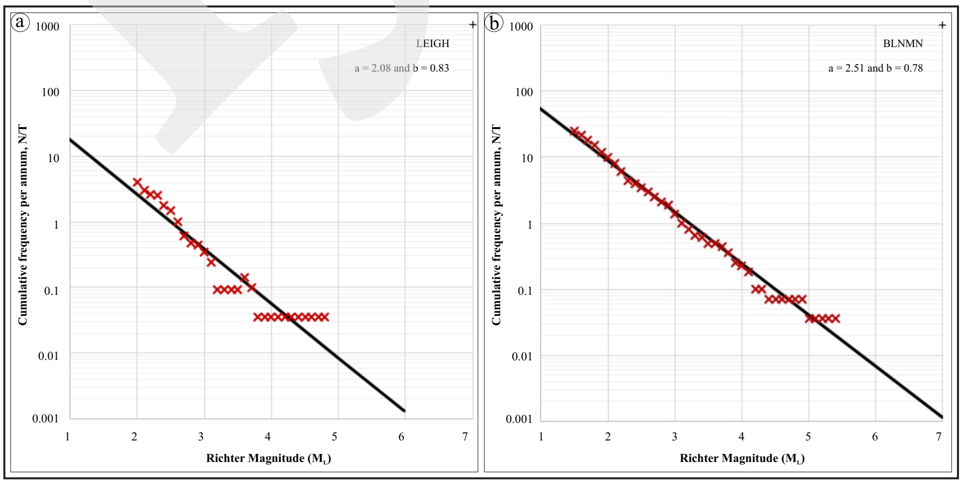

Figure 3. Recurrence parameters (a) for Leigh and (b) BLNMN seismic source zones.

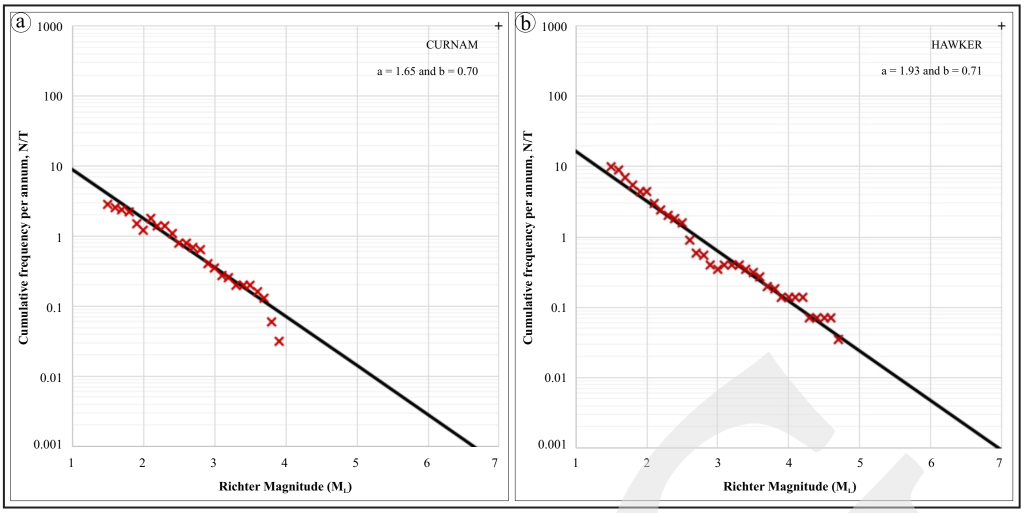

Figure 4. Recurrence parameters (a) for CURNAM and (b) HAWKER seismic source zones.

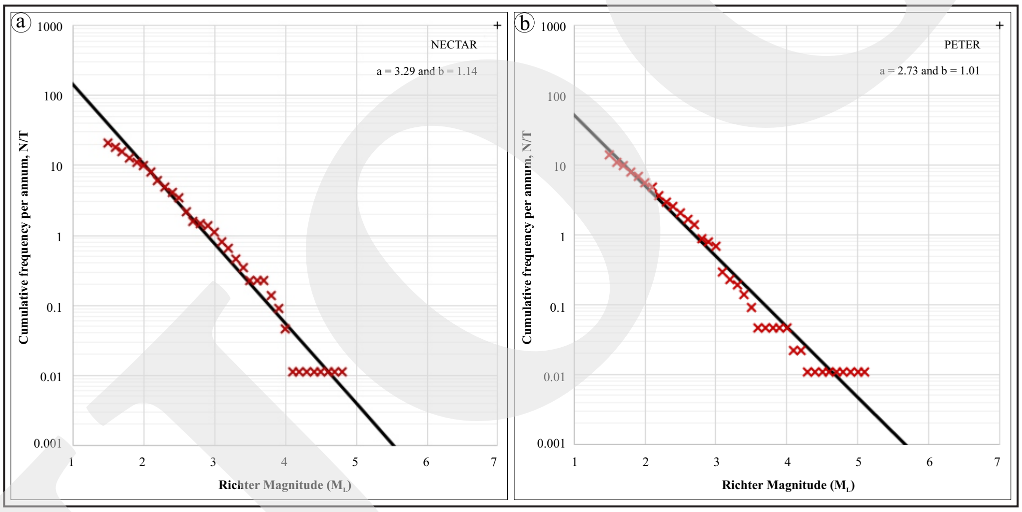

Figure 5. Recurrence parameters (a) for NECTAR and (b) PETER seismic source zones.

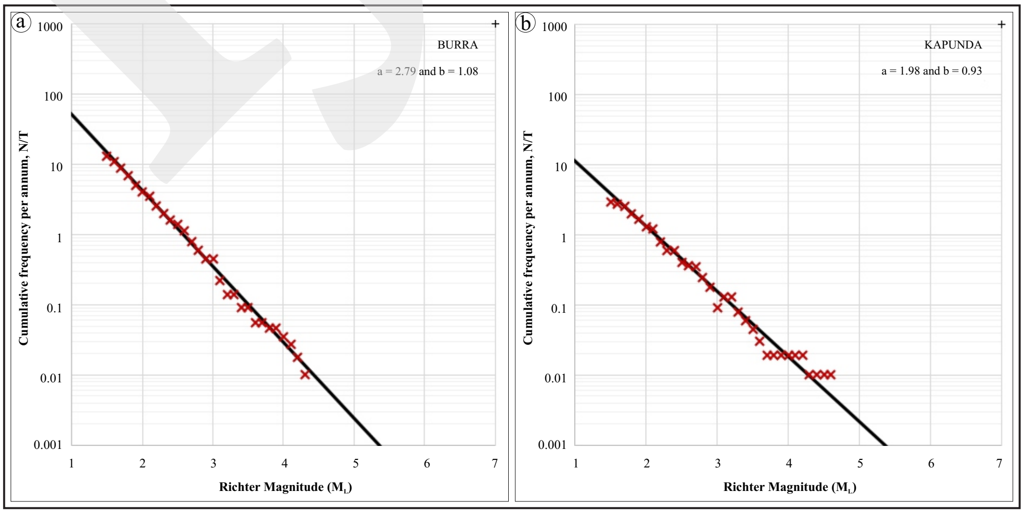

Figure 6. Recurrence parameters (a) for BURRA and (b) KAPUNDA seismic source zones.

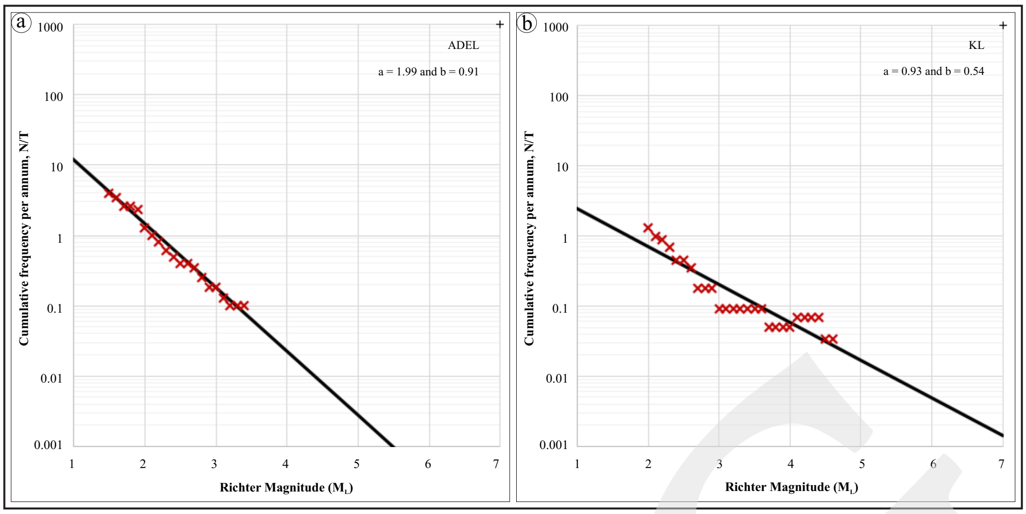

Figure 7. Recurrence parameters (a) for ADEL and (b) KI seismic source zones.

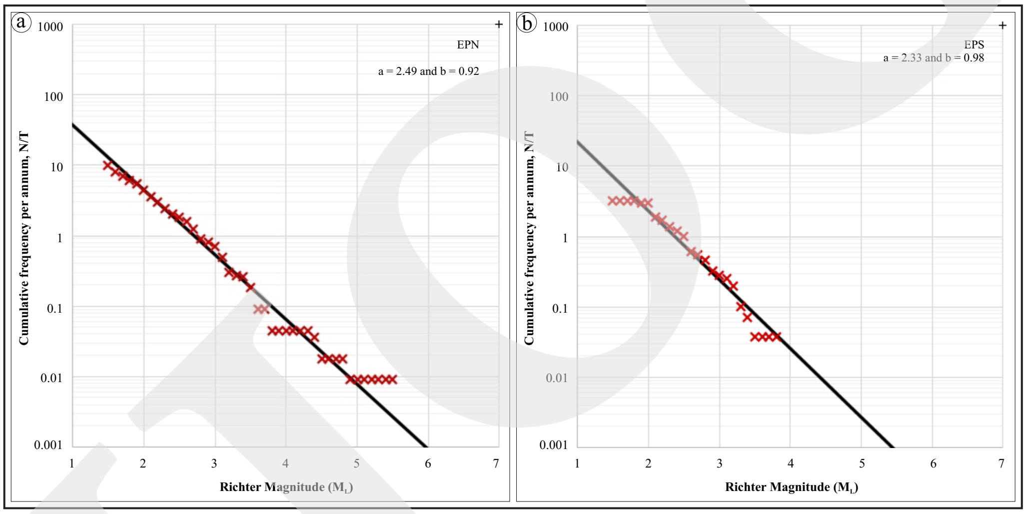

Figure 8. Recurrence parameters (a) for EPN and (b) EPS seismic source zones.

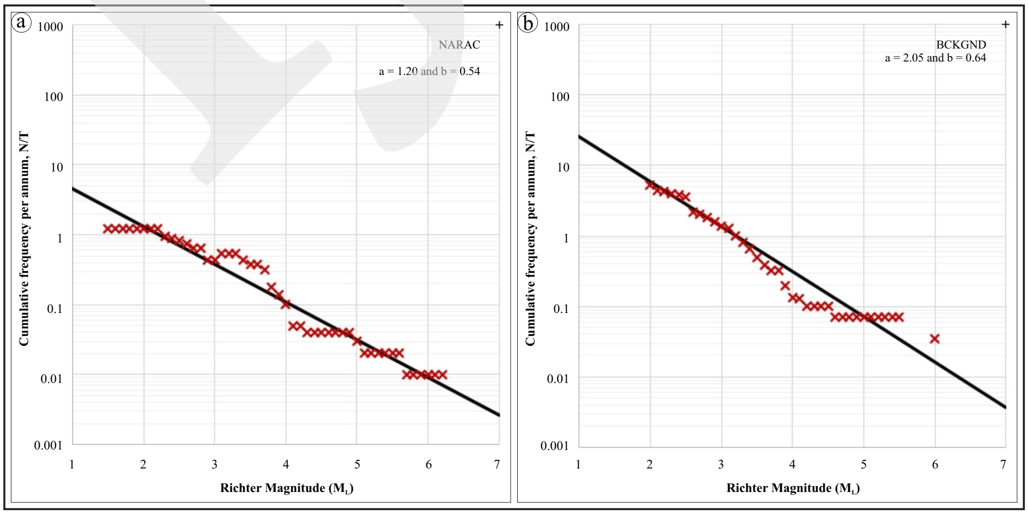

Figure 9. Recurrence parameters (a) for NARAC and (b) BCKGND seismic source zones.

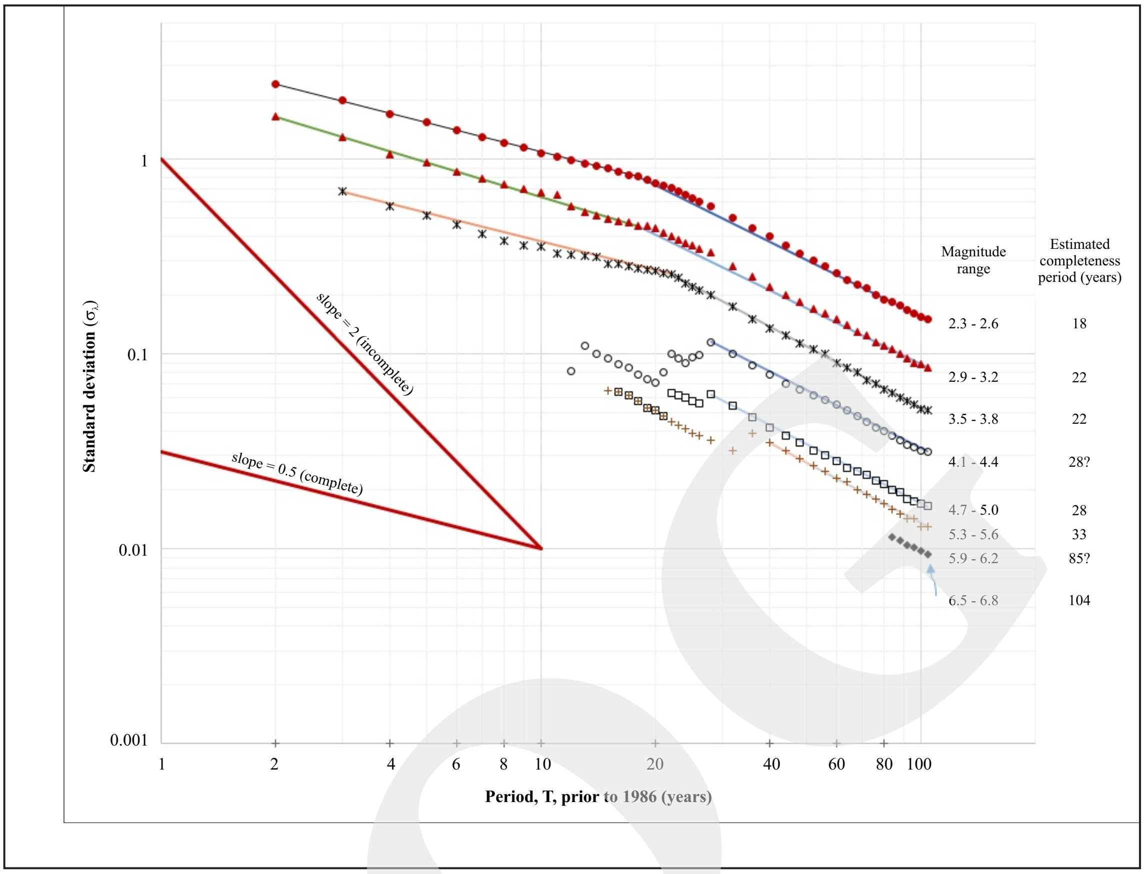

Figure 10. Seismic catalogue completeness test (from Greenhalgh and McDougall, 1990).

for magnitude above 4 is hard to conclude. However, a raw estimate of catalogue completeness for magnitude above 4 is proposed in this study, as shown in Figure 10.

By considering all aspects of the seismic data as explained above, the recurrence parameters adopted for the PSHA in the present study, as listed in Table 2, were mainly calculated by Malpas (1991). Then, the seismic risk for both the Adelaide region and Adelaide City were analyzed. Subsequently, several outputs, such as peak ground acceleration (PGA) and peak ground velocity (PGV) of both the 475 (which corresponds to 10% probability of being exceeded in 50 years) and 2475 (which corresponds to 2% probability of being exceeded in 50 years) return periods for the Adelaide region, were produced. Maps based on grid points spaced at quarter degree intervals, *i.e.* approximately 28 km intervals were developed. De-aggregation of both the 475 and 2475 return periods for the Adelaide City of South Australia are, in the order, presented in the following sections.

A measurement of seismic ground motion in term of PGA and PGV is a common practice for engineering purposes (Kramer, 1996). Many studies demonstrated a good agreement of these PGA and PGV to the magnitude (m) as well as the distance (r) of an earthquake (Campbell, 1981; Douglas, 2002; Margaris *et al*., 2002; Skarlatoudis *et al*., 2004; Petursson and Vogfjord, 2009). Seismic hazard analysis estimates the expected maximum amplitude of ground acceleration and velocity to occur once at a certain region within a particular time span. The result of the seismic hazard analysis is often displayed in the map of PGA or PGV at a constant return period.

Peak Ground Acceleration (PGA)

The seismic risk maps of PGA (g) with 10% and 2% probability of exceedance in a 50-year-period (which corresponds to an approximate

Table 2. Parameters for the Risk Analysis

Seismic source zone	a	b	BETA	N0	M_{max}	Depth (km, weight)
OODNA	2.13	0.86	1.98	68.12	6.5	(10, 0.25; 20,0.5; 5.0.25)
LES	2.68	1.07	2.46	194.26	6.5	(10, 0.5; 20,0.25; 5.0.25)
LEIGH	2.08	0.83	1.91	62.90	6.5	(10, 0.25; 20,0.5; 5.0.25)
BLNMN	2.51	0.78	1.79	180.17	7.0	(10, 0.5; 20,0.25; 5.0.25)
CURNAM	1.65	0.70	1.61	27.71	7.0	(10, 0.25; 20,0.25; 5.0.5)
HAWKER	1.93	0.71	1.63	52.062	7.0	(10, 0.5; 20,0.25; 5.0.25)
NECTAR	3.29	1.14	2.62	742.81	7.0	(10, 0.5; 20,0.25; 5.0.25)
PETER	2.73	1.01	2.32	230.92	7.0	(10, 0.25; 20,0.25; 5.0.5)
BURRA	2.79	1.08	2.48	247.94	7.0	(10, 0.5; 20,0.25; 5.0.25)
KAPUND	1.98	0.93	2.14	44.59	7.0	(10, 0.25; 20,0.25; 5.0.5)
ADEL	1.99	0.91	2.09	46.63	7.0	(10, 0.25; 20,0.25; 5.0.5)
KI	0.93	0.54	1.24	6.845	6.5	(10, 0.25; 20,0.25; 5.0.5)
EPN	2.49	0.92	2.11	145.8	6.5	(10, 0.25; 20,0.25; 5.0.5)
EPS	2.33	1.00	2.30	92.85	6.5	(10, 0.25; 20,0.25; 5.0.5)
NARAC	1.33	0.56	1.28	16.58	7.0	(10, 0.5; 20,0.25; 5.0.25)
BCKGND	2.05	0.64	1.47	76.13	5.5	(10, 0.5; 20,0.25; 5.0.25)

return period of 475 and 2475 years) are presented in Figures 11a and b, respectively. The bedrock underlying the city of Adelaide of South Australia itself falls within the 0.05g contour for the 475-year-return period (see Figure 11a). Seismic risk maps of PGA (g) with a return period of 2475 years are shown in Figure 11b. In this return period, the city of Adelaide falls within the 0.1g contour. Both the 475 and 2475-year-return period maps show that the highest accelerations occur within the source zone of HAWKER (Malpas, 1991), followed by areas near Mount Gambier and Kangaroo Island, which correspond to the source zone of NARAC and KI (Malpas, 1991), respectively.

Peak Ground Velocity (PGV)

In some circumstances, it is necessary to convert the ground acceleration into an equivalent peak ground velocity. In the present study, two different approaches were used to estimate the PGV from the PGA. The first approach incorporates the method of Gaull *et al*. (1990) to convert the PGA into a seismic intensity followed by the Newmark and Rosenblueth (1971) method to transform the intensity into a PGV as shown in the following equations, consecutively.

$$\log PGA = Intensity / 3.1 - 2.3 \quad (10)$$

$$2^{Intensity} = 7\ PGV / 5 \quad (11)$$

The second approach adopts relationships developed by Wald *et al*. (1999). This approach was developed based on seismic events in California, USA.

$$\log (PGV) = ((3.66\log(PGA) - 1.66) - 2.35) / 3.47 \quad (12)$$

The seismic risk maps specifying contours of PGV (cm/s) with 10% and 2% probability of exceedance in a 50-year-period, which were developed using the combination of the Gaull *et al*. (1990) and Newmark and Rosenblueth (1971) methods, are presented in Figures 12a and b, respectively.

As shown in Figures 13a and b, the city of Adelaide falls within the 1.7 and 1.9 cm/s contour for both the 475-year and 2475-year-return periods, respectively. The greatest ground velocities in the Adelaide region occur near Hawker, > 2.0 cm/s, in the source zone of HAWKER (Malpas, 1991). The PGV seismic risk maps, in units of cm/s with 10% and 2% probability of exceedance in a 50-year-period, developed using the Wald *et al*.

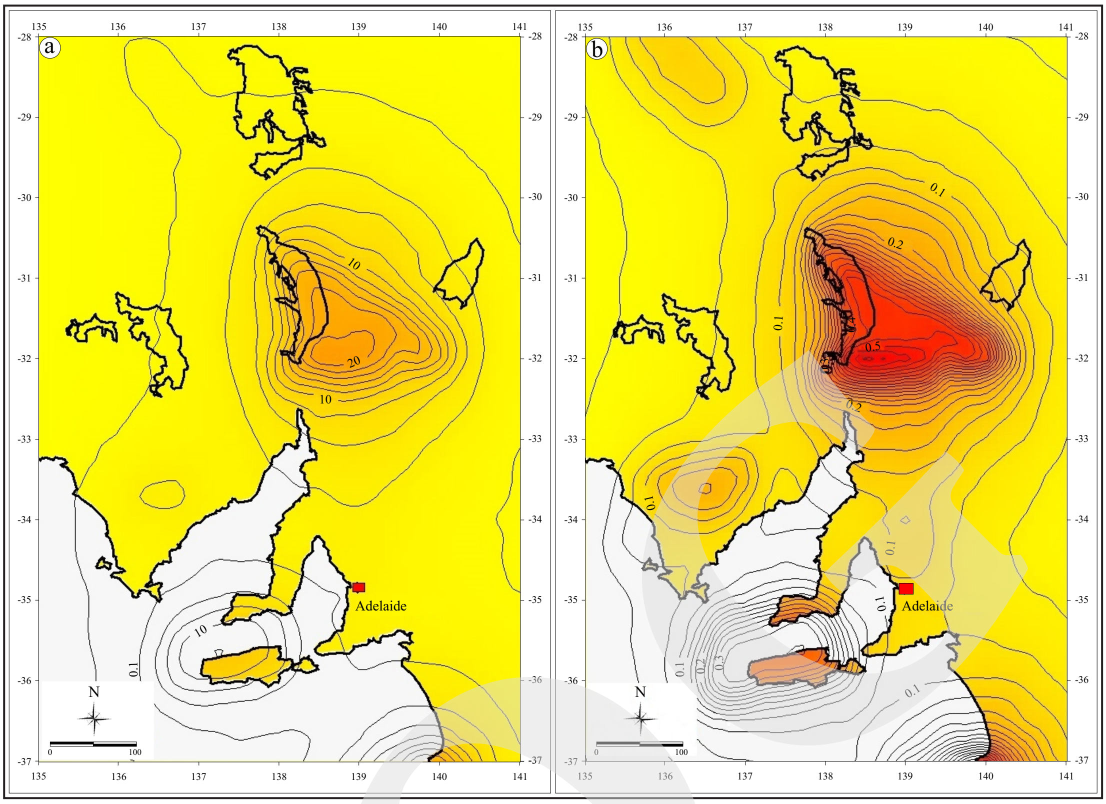

Figure 11. PGA of earthquake with (a) 475-year-return period (b) 2475-year-return period for Adelaide region in unit of g.

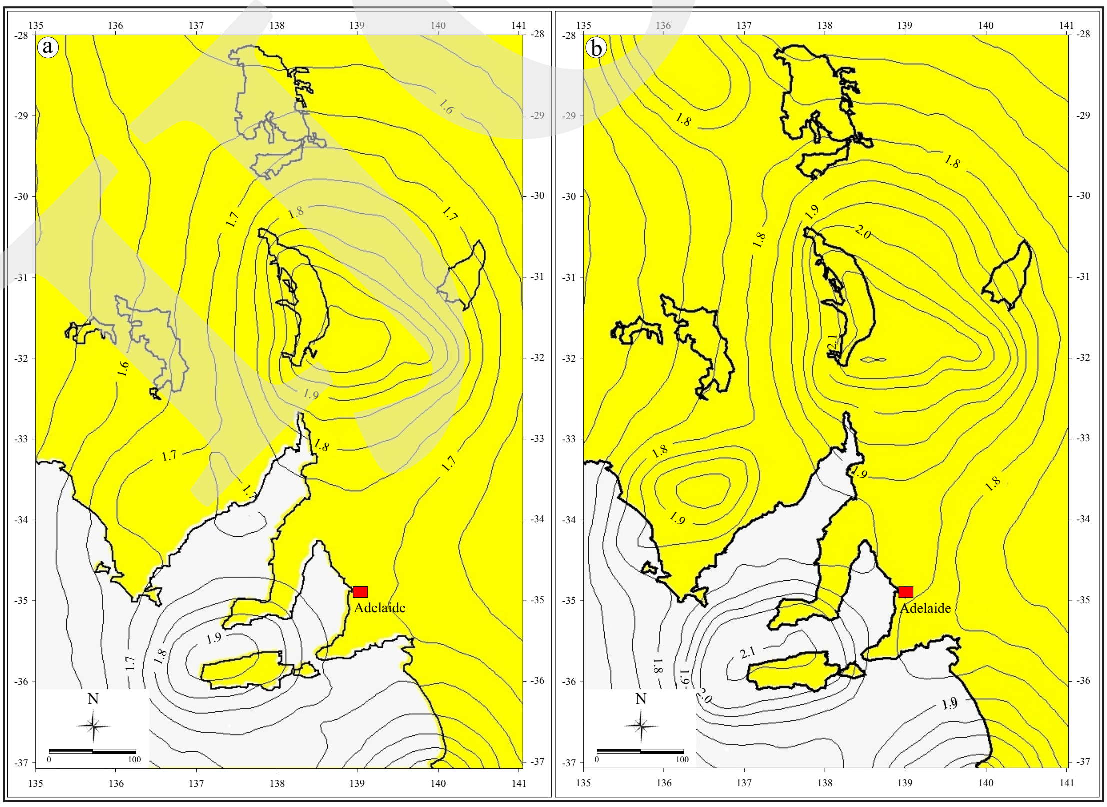

Figure 12. Estimated PGV of earthquake with (a) 475-year and (b) 2475-year-return period using a combination of the Gaull *et al.* (1990) and Newmark and Rosenblueth (1971) methods for the Adelaide region.

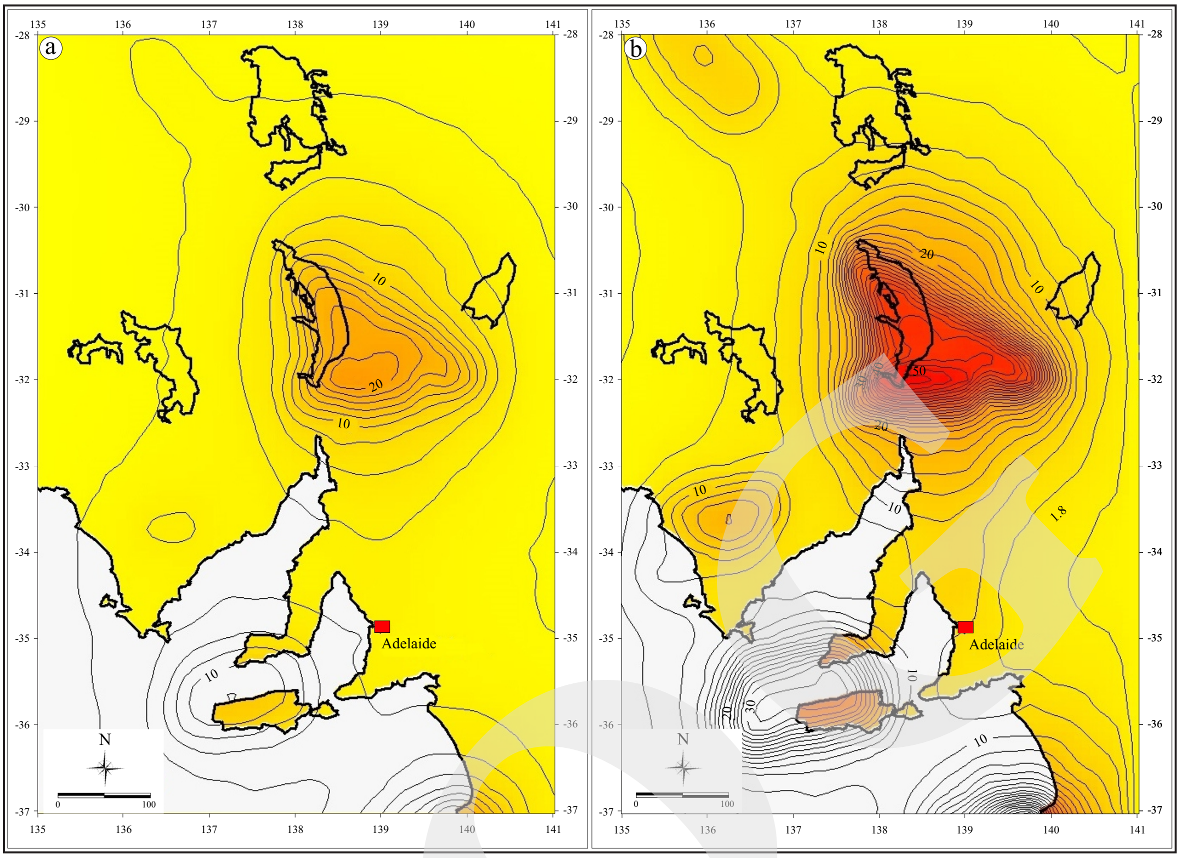

Figure 13. Estimated PGV of earthquake with (a) 475-year and (b) 2475-year-return period using Wald *et al*. (1999) method for the Adelaide region.

(1999) method, are presented in Figures 13a and b, respectively. Using this approach, the city of Adelaide is found to have a PGV of at least 3 cm/s for 475-year-return period and at least 9 cm/s for the 2475-year-return period. The largest velocities in the Adelaide region occur near Hawker, > 20 cm/s, in the source zone of HAWKER (Malpas, 1991). A considerably higher PGV estimation is observed when the Wald *et al*. (1999) approach is used to obtain the PGV of the Adelaide region.

De-aggregation of the 475- and 2475-year-return periods

For a given seismic site hazard, the annual probability of exceedance of spectral acceleration is a summation over the source magnitude (m), a summation over the site-to-source distance (r), and a summation over the applicable models of attenuation. Of interest is the estimation of m and r of a considered seismic event. Thus, the hazard results are de-aggregated in terms of magnitude and distance to investigate earthquake occurrences that contribute most to the resulting ground motion hazard impact to the site of interest which is the Adelaide City of South Australia.

The results are shown in Figure 14a for a 10% probability of exceedance in 50 years, and Figure 14b for a 2% probability of exceedance in 50 years, respectively. Figure 4a shows that there are two peaks contributing to the seismic hazard for the Adelaide City. These peaks correspond to the expected seismic events to occur in the future. As shown in Figure 14, the first event is an earthquake M5.2 from a distance of 15 km and 25 km. The second event corresponds to an earthquake M6.6 occurring 85 km away from the Adelaide City. Both expected seismic events are very obvious in the de-aggregation of the earthquake with 2475-year-return period (see Figure 14b).

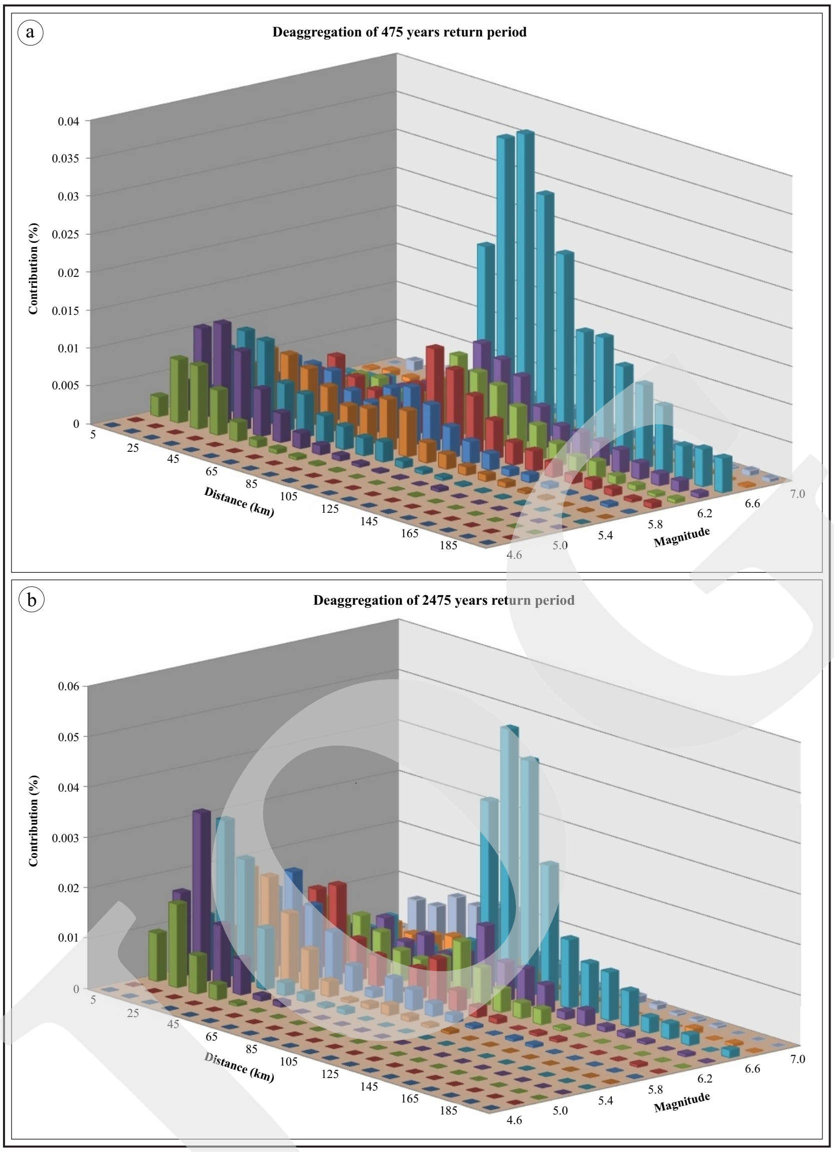

Figure 14. De-aggregation of (a) 475- and (b) 2475-year-earthquake return periods for the Adelaide City.

Conclusion and Future Work

The seismic hazard analysis (SHA) is commonly used for assessing the seismic vulnerability. The probabilistic seismic hazard analysis (PSHA) is one of methods to quantify the expected ground motion level due to the most expected severe future seismic events. The Monte Carlo simulation has been incorporated for this PSHA and applied in the region of Adelaide, South Australia. The results of the analysis using this method produce the likelihood of seismicity in term of peak ground acceleration and peak ground velocity of the Adelaide region. The results clearly display the seismic ground motions in term of peak ground acceleration and peak ground velocity of the Adelaide region. De-aggregation of the analysis suggests that there are two peaks contributing to the seismic hazard for the Adelaide City. The first contribution peak is an earthquake M5.2 from a distance of 15 km and 25 km. The second peak corresponds to an earthquake M6.6 occurring 85 km away from the Adelaide City. However, the results of this analysis must be treated carefully due to a difficulty to justify the completeness of seismic catalogue of Adelaide region for seismic magnitude of more than 4.1.

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