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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "An extended stochastic method for seismic hazard estimation" *by* A. K. Abd el-aal et al.

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A point by point response for referee comments

The referee general comment: It is not clear from the text in what consists the novelty of the proposed ground-motion simulation method. The paper appears to consist of a simple application to few Egypt sites of the Boore (2003) method. The authors did not develop the method in any way (as themselves also admit, writing at pg. 12 that they simulated the ground motion simply using the SMSIM code by Boore (2009)). Moreover the text is a collection of inaccuracies and mistakes. So I suggest to reject the paper. Authors replay: we would thank the reviewer for his comment. There are some misunderstanding we should clear it. We just developed a simple tool or connection

between PSHA and stochastic method. Our technique not a kind of PSHA, but we consider it as predictor for quantitative hazard assessment could be loaded in the future. We just extend the stochastic method for prediction ground motion which happed to method or tool to predict maximum ground motion could ne happened in future from seismic sources.

Our philosophy in the new technique depends on the following facts: The stochastic method calculates or predicts ground motion with probability of exceedance of 100% (0% of non exceedance). As the method calculate the ground motion in some areas in which the earthquake recording are not available for those earthquakes that already happened in the past after implementation of source, path, site parameters. The original method missed any information about ground motion prediction in future which could be used as indictor for seismic hazard estimation in any area of interest. The PSHA method estimate the hazard in return periods (or probability levels of exceedance) depending on an earthquake catalogue, recurrence parameters and path attenuation relationships, also this applied in DSHA method as we consider DSHA as one scenario of PSHA or the worst case scenario . The method in its original form as first proposed by Cornell (1968) neglected information about variations of site effect with a certain area. Although, recently some software and authors publications implement Vs 30 and in many cases take into their consideration the type of site either rock or soil. We can see that the PSHA and DSHA methods missed some good information about variations in resonance frequency and amplifications at each depth (e.g if you have one site with two different picks of resonance of frequencies, also if you have 2 nearby sites with different picks of amplifications). Our proposed technique in this paper is result of continues development of the previous procedure published by "Abd El-Aal 2010b: Ground motion prediction from nearest seismogenic zones in and around Greater Cairo Area, Egypt, Nat. Hazards Earth Syst. Sci., 10, 1495–1511, doi:10.5194/nhess-10-1495-2010, 2010b". Our proposed technique is a connection or bridge that connect the stochastic and PSHA or DSHA with the following advantages: A simple tool or bridge connects Stochastic and PSHA. Real calculation taking into

consideration details about variations of resonance and amplifications parameters with depth in certain area even within individual sites. No probability of exceedance) for our technique. Our calculation in our proposed technique give the at least the lower boundary of PSHA or DSHA. Reality of Hazard spectrum calculated by our proposed tool. The variations in PGA curves depend mainly on variations on local site conditions. We used SMSM program and some MATLAB codes for calculations. It is very obvious in the manuscript that this tool or technique is already mainly developed basing on the stochastic simulation method of Boore (2003). Also, the manuscript describe that we applied a new developed technique to assess the seismic hazard. There is difference between the PSHA, the stochastic simulation method and the extended stochastic simulation method. PSHA, estimate the hazard in return periods (or probability levels of exceedance) depending on an earthquake catalogue. It depends on an attenuation model. The stochastic simulation method of Boore (2003) simulates the ground motion from earthquakes already happened at some sites to estimate PGA, PGD and PGV. In this paper, a new extended stochastic simulation technique is applied to estimate the hazard effect which will result from future earthquakes. This technique is developed depending on both the PSHA and the stochastic method of Boore (2003). It takes into account the effect of the site at different frequencies which will affect the hazard calculation.

The referee comment: Page 2, Line 25. I never heard the definition of seismic hazard given by the authors: “the probable level of ground shaking associated to the recurrence of earthquakes”. The standard definition of seismic hazard in current literature is instead: “the exceedance probability of given levels of ground motion (or the levels of ground motion having a given exceedance probability) in a future time interval”. The authors should change the definition or give references for their own definition. Moreover, the assessment of seismic hazard does not reduce, by itself, “the effects of the earthquakes” but rather it is a tool to establish regulations that, in case they were applied, might reduce the earthquake effects. Even the subsequent discussion about PSHA and DSHA is not correct as these two approaches provide essentially different

estimates. As well the, “stochastic simulation methods” are not another category of SHA but rather a kind of DSHA. Authors replay: thank you for your comment. The definition of seismic hazard is probable level of ground shaking associated with the recurrence of earthquakes. The authors added (Hamouda 2009) as a reference for the definition. Moreover, the assessment of seismic hazard does not reduce, by itself, “the effects of the earthquakes” but rather it is a tool to establish regulations that, in case they were applied, might reduce the earthquake effects". You say in your comment "Even the subsequent discussion about PSHA and DSHA is not correct as these two approaches provide essentially different estimates". Our subsequent discussion is "Seismic hazard can be assessed using probabilistic seismic hazard approach (PSHA) and/or deterministic seismic hazard approach (DSHA). PSHA is considered as seismology’s most valuable contribution to earthquake hazard assessment (Reiter, 1990; Frankel, 1995; Woo, 1996; Giardini, 1999; Bommer et al., 2004; Deif et al., 2009; El-Hussain et al., 2010; Rafi et al., 2013; Ur-Rehman et al., 2013a, b). It uses all the available historical and instrumental earthquake data to estimate the seismic hazard. Nevertheless, when a complete earthquake catalogue is unavailable for a study area, DSHA can be utilized to estimate the seismic hazard. DSHA amounts to identify and select the worst case earthquake (McGuire, 2001; Anderson et al., 2000; Anderson, 1997) which will produce the most severe ground motion at the investigated site. Both of these analyses require previous knowledge about seismicity, tectonics, geology and attenuation characteristics of seismic waves". This discussion is correct and supported by references of a lot of authors and doesn’t refer as you say that the two approaches provide identical estimates. You also say "As well the, “stochastic simulation methods” are not another category of SHA but rather a kind of DSHA". We never said that the stochastic simulation method is a category of seismic hazard, but we developed a new extended stochastic simulation method on the basis of the stochastic simulation of Boore (2003) to assess the seismic hazard. So, our developed extended stochastic technique can be considered as a category of seismic hazard assessment.

The referee comment: Page 3. Line 6. The justification given for not using PSHA

("a complete earthquake catalogue is unavailable for the study area") is risible as it also applies to DSHA. Authors replay: thank you for your comment. The word "study area" in the sentence is not our study area. This just example. The paragraph gives information about PSHA and DSHA and the difference between them and the case of using each one of them. The paragraph is "PSHA is considered as seismology's most valuable contribution to earthquake hazard assessment (Reiter, 1990; Frankel, 1995; Woo, 1996; Giardini, 1999; Bommer et al., 2004; Deif et al., 2009; El-Hussain et al., 2010; Rafi et al., 2013; Ur-Rehman et al., 2013a, b). It uses all the available historical and instrumental earthquake data to estimate the seismic hazard. Nevertheless, when a complete earthquake catalogue is unavailable for a study area, DSHA can be utilized to estimate the seismic hazard. DSHA amounts to identify and select the worst case earthquake (McGuire, 2001; Anderson et al., 2000; Anderson, 1997) which will produce the most severe ground motion at the investigated site." Also, this paragraph which you describe it as "risible" is supported by references. The referee comment: Page 5. Lines 4-6. Declustering is usually applied to the catalog in PSHA but it is not necessary for DSHA. Moreover it is not clear from the wording if the authors apply it or not (and eventually how). Authors replay: thank you for your comment. First, it is page 6 not 5. This paragraph discusses the definition of seismic sources, a step from the definition of source parameters, a step in discussing the method of the new extended stochastic technique not the DSHA. Absolutely, declustering is applied here. The term declustering means removing foreshocks and aftershocks of from the earthquakes catalogue to satisfy the spatial and temporal principles of earthquakes independency.

The referee comment: Page 7. Line 17. Eq. (3) substantially differ from the corresponding equation (10) of Boore (2003). An explanation is needed for such difference. Authors replay: The authors thank the referee for that notice. The authors changed the equation to: G(f)=A(f) D(f).

The referee comment: Page 13, Line 15-20. The 80% probability of non exceedance in 50 years corresponds to a "return period" of 224 years (not 75). The "return period" of

75 years about corresponds to the 50% probability of non exceedance (T=-50/ln(Non Exc. Prob.)). Moreover the ground motion predicted by stochastic simulation has implicitly an associated probability of exceedance of 100% (0% of non exceedance) and a virtually null return period so IT IS NOT COMPARABLE with PSHA estimates with 90% probability of non exceedance. Authors replay: thank you for your comment. We corrected the probability of non exceedance from 80% to 51%. This just mistake in writing. We just show our obtained results with the other obtained seismic hazard results for the same area. we knew that our proposed tool is not kind of probabilistic hazed method. The results are comparable in that the main trends in increasing and decreasing the seismic hazards are the same as illustrated in the sentence "Their results demonstrate that Cairo city exposes the most hazardous effect. This hazard diminishes toward the north direction of the study area at Damietta city".

The referee comment: Abstract Line 4. In current literature it is usually not appropriate to report title and publication details of a cited paper (Boore, 2003) in the text of the article. Authors replay: thank you for your recommendation. According to many journal regulation and instruction you should write all details about the reference if you write reference in abstract part. We can delete all details if the journal allows this.

The referee comment: Abstract Lines 13-14. I do not understand the difference between "predicting the ground motion" and "estimating the maximum peak ground acceleration". Authors replay: The peak ground acceleration is a ground motion parameter and the difference in the synonyms for words just so the reader does not feel bored.

The referee comment: Page 3. Line 28. The self-citations of Abd El-Aal, 2008, and 2010a are not necessary to support the previous sentence (which is obvious). Authors replay: thank you for your recommendation. We deleted the citations. this intellectual property rights because it is a conclusion from his part.

The referee comment: Page4. Line 1. Earthquakes are only one among others natural hazard phenomena (not the "most typical"). Authors replay: thank you for your rec-

ommendation. We changed the description. Many authors described earthquakes as the most catastrophic natural phenomena of natural hazard as they can trigger fires, landslides, floods, tsunamis.

The referee comment: Page4. Line 28. The method of Boore (2003) predicts ground motion not “seismic hazard”. Authors replay: thank you for your comment. The sentence "In this paper, a new extended stochastic simulation technique is developed based on the hypothesis of the stochastic method of Boore (2003) to predict the seismic hazard." describe that the new extended stochastic simulation technique is developed to predict ground motions in future which could be loaded and we can use it as predictor for the seismic hazard assessment. And it doesn’t speak about the method of Boore (2003).

The referee comment: Page 5. Line1. Figure 1 is not particularly informative and necessary. Authors replay: thank you for your recommendation. This figure is for illustrating the steps of the developed method in a fast and easy way.

The referee comment: Page 5. Line 2. Check “is consists”. Authors replay: The authors thank the referee for that notice. And it is replaced by "consists".

The referee comment: Page 5. Line 7. P (R, f) is the path TERM. Authors replay: The authors thank the referee for that notice. The authors added the word "term".

The referee comment: Page 5. Line 22. Trifunac not Trifunace Authors replay: The authors thank the referee for that notice. The authors erased the letter "e" from the text but it is written correctly in the reference list.

The referee comment: Page 6. Lines 16-22. References for all the methods listed for determining maximum magnitude or a description of strengths and weaknesses of each of them should be provided. Authors replay: thank you for your recommendation. We added the references

The referee comment: Page7. Lines 8-9. References or a detailed description for both

method of ground motion computation should be provided. Authors replay: thank you for your recommendation. We added the references.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 7555, 2015.