

Review of Manuscript nhess-2020-48 MS Type, Natural Hazards and Earth System Sciences (NHES) 2020: Macrozonation of Seismic Transient Ground Displacement and Permanent Ground Deformation of Iran

The manuscript, written by Farahani et al., describes how to develop macrozonation maps of Seismic Transient Ground Displacement and Permanent Ground Deformation for Iran. After reading the article, it seems that much work has been done to construct these important hazard maps. This manuscript represents a nice application of the HAZUS methodology for producing suitable maps for risk assessment for the Iran authorities, and therefore has the potential for broader applications in other seismic zones in the world. There is certainly value in documenting the application of the present study methods, and I believe the paper can become a significant publication, but I think there are some issues that need to be addressed first.

Here are my comments based upon line numbers.

Line 1. The title should be shortened and restated.

Lines 20-80. The role of this paragraph and its relevance to the current study are not clear enough. If the author(s)' intention is to share their experience in developing macrozonation maps of seismic transient ground displacement and permanent ground deformation of Iran and providing further guidance to an international audience, then the paragraph needs to be better structured and should add the following:

(1) An introduction that explains the importance of developing macrozonation maps of TGD and PGD in general and in Iran in particular as a tool for earthquake preparedness. The Introduction is lacking specific claims. As a consequence, the paper seems somewhat unmotivated. What is needed is a short section that could start with the phrase 'here we show that...' where you spell out briefly what is the important contribution of the paper.

(2) A brief presentation of the earthquake hazard in Iran as well as common secondary hazards according to PGD. Add a figure showing the plate tectonic configuration of the study area with major sites present in the regional setting of Iran. The paragraph dealing with the studies in Iran should be structured following the TDD and PGD earthquake effects. The part that deals with the PGD is missing.

(3) A brief overview of the study methods followed by the implementation steps and explanation of the flowchart in figure 1. It is strongly recommended that the author(s) use and explain the flowchart (figure 1) using the methods mentioned in chapters #2 and #3 to help the reader understand how the methods were applied in the present study.

The general use of the HAZUS methodology according to TDD and PGD should be explained in this chapter.

Lines 20. Add relevant references.

Line 22. Why not use the term "permanent ground displacement", see also in Hazus methodology.

Line 61. Delete "On the other hand."

Line 86, figure 1. The main maps shown in the flowchart should be labeled. This can help the reader to follow the explanations that are mentioned throughout the methods.

Change the title "PGV" on the left of "Ground Shaking, PGV". The "USGS ShakeMap" method is not mentioned or explained in the text.

Change the caption of figure 1 to: "A flowchart for production of TDD and PGD maps".

Line 94. The authors should be aware that this map may have been produced by some manipulations from the SRTM Global (90m) map.

Line 103. The "site class" map and the other maps should be referred to throughout the manuscript by the flowchart shown in Figure 1. Check out the year in parentheses of "Allen and Wald (2009)".

If a geological map of Iran is available, why not to use it for the production of the "site class" map? Do the researchers validate the map in figure 3 by comparing it to a geological map?

Line 110. It will be helpful if the researchers add the map of "zonation of seismicity level" in the appendix.

Line 113. Scale must be added to this map and to all other main maps throughout the manuscript.

Lines 114-124, Table 2 and figure 6. Please provide more details, how the numbers in Table 2 were determined and how the map of 1-second acceleration is calculated or transformed from the map of the reflection factor in 1-second period. I wonder if no probabilistic map of SA1 or PGA for Iran are available.

Line 124. Label the maps in figure 6 by "a)" and "b)".

Line 126. Add "(1-second)" after "... peak spectral response".

Line 131. Change "HAZUS methodology" to "Eq.1".

Line 134. The term "permanent ground deformation (PGD)"

is a bit confusing. In HAZUS terminology "D" is referring to displacement.

Line 140. It is not clear how the Iran liquefaction susceptibility map is used in Eq.2. Please provide more details and clarifications about the use of [*Liquefaction*|*PGA = pga*], *Pml*, *Kw* and *KM* parameters. For example, how the values of [*Liquefaction*|*PGA = pga*] were obtained? Is there a map or table that provides information about Liquefaction Susceptibility of Sedimentary Deposits (see Table 4.10 in Hazus, 2012)? Given that on Hazus, (2012) *KM* is the correction factor for moment magnitudes other than $M=7.5$, did the authors use any available data of moment magnitudes to get this parameter? Please, explain.

It is not clear how the values of K_w which depends on the groundwater depth (Hazus, 2012; Eq. 4-22) were determined. Did the present study use any ground water level map to get the values of K_w ? If yes, this map should be mentioned also in figure 1.

Line 145. Change "liquifaction" to "liquefaction".

Line 150. You should label each map in figure 8 and accordingly provide more explanation in the caption for each map. The caption "Probability of liquefaction for Iran zonation" does not correctly describe the liquefaction susceptibility map.

Line 152, Eq. 3. Please provide more details and explanations on this equation. In Hazus this equation is presented slightly differently (see, Eq. 4-23).

Please write that " $PGA/PGA(t)$ " is the normalized ground shaking. Do the correction factors listed in parentheses depend on the moment magnitudes (Hazus, 2012; Eq. 4-24,)? If so, please explain how the calculations took into account the earthquake magnitudes in Iran.

Line 161. Was the $PGA(t)$ map in figure 9 prepared based on figure 8a?

Line 163. Denote the levels of "liquefaction-induced PGD" (figure 10) by the standard traffic lights colors: green, yellow and red.

Line 166. Add a reference after "below 1.0 temporarily".

Line 171, regarding the "Iran landslide susceptibility map". If this map is not a product or result, it should be placed in another figure and not in figure 11.

Line 173, figure 11. You should label each map in figure 11 and accordingly provide more explanation in the text or in the caption for each map. An explanation of how the map of " ac/ais " was determined, using the flowchart of figure 1, would be very helpful.

Line 179. Add, "of ground shaking" after "number of cycles".

Lines 179-183. Please provide more details and clarifications regarding the application of Makdisi and Seed (1978) method. For example, please explain how was the calculation done with respect to the earthquake moment magnitude (see in Hazus 2012; Eq. 4-26); how were the numbers of the expected displacement factor determined, using the lower and upper bonds? Was any equation used for this purpose?

Line 195. According to the PSHA approach, is it possible to estimate the probability of the maximum displacements in figure 15?

Line 196. Add "(2014)" after " Karimiparidari".

Line 204. Is it possible to add a table in the appendix showing the moment magnitudes with respect to the active faults?

Line 211. The equation of " $\log(MD) = a + b \times Mw$ " should be explained in the text and presented separately from Table 5. Please correct the title "Critical acceleration at

any location proposed by HAZUS for susceptibility categories (ÖZTÜRK et al., 2018)” in the context of Table 5.

Line 213. Replace the current coloring of the "maximum displacement" levels (figure 15) with the standard traffic lights colors: green, yellow and red.

Lines 214-246. In fact, this chapter is almost a duplication of the "Introduction" with the exception of mentioning the advantages (lines 225-229) and the limitations (lines 240-246), of the application of the present study methods.

In order to make the paper more relevant to readers outside Iran, please mention whether the development of Macrozonation maps of Seismic Transient Ground Displacement and Permanent Ground Deformation of regional area was done elsewhere in the world and what methods (deterministic versus probabilistic approaches?) were used in these studies?

A thorough explanation of the challenges and lessons learned from this study would greatly improve the discussion and the motivation of this paper. Such an explanation can refer to other international studies and experiences.

It would be nice to see a couple of sentences in the Conclusions about how the study is actually presented to the Iranian authorities or government and if there is a plan to do this in a systematic way? It could be quite powerful in motivating investment in mitigation so it would be great to know if there is such a plan.