

Reviewers' comments are given in **“bold”** font, our responses are written in “normal” font, and quotations from the revised manuscript are provided in *“italic”* font.

the authors make an improper use of some technical terms. For example, the title gives emphasis on the “Integrated seismic risk analysis”, while the abstract reports “. . .an integrated seismic hazard map. . .”.It is necessary to use properly the terms hazard and risk throughout the paper.

We agree with the reviewer and apologize for the confusion. We revised the manuscript and used “The integrated seismic risk map” term throughout the revised manuscript.

Study area (this section is not numbered in the manuscript)

The study area section were numbered as 1.1 in the revised manuscript.

Study Area The section mixes up the knowledge of the site under investigation with the state-of the-art and the methodological approach followed to perform the study (from line 12 to 22 of page 6887). All that makes unclear the path the authors considered to reach the fixed aims. I suggest moving the irrelevant parts in the proper sections (“Introduction” or “Methodology”).

Following the suggestions of the reviewer we have reorganized the Introduction and Methodology sections by moving the aforementioned sections to their correct locations.

The use of technical terms made to describe the age of alluvium sediments is inaccurate. Terms like “old” and “new” should be replaced with the actual age of the sediments. Alternatively, terms like “ancient” or “recent” should be used respectively (line 6-7 of page 6887).

We have achieved consistency by replacing “ancient” and “recent” with “old” and “new” throughout the text. Terms will be changed as ancient and recent

Only a general description of the groundwater table is given. More details are required as they are pertinent with the liquefaction phenomenon. Therefore, it is necessary to indicate the actual mean depth of the groundwater, especially in view of the fact that the authors have at their disposal a sufficient number of wells for this purpose.

Groundwater table (Figure 1) map will also be given in the final revised paper.

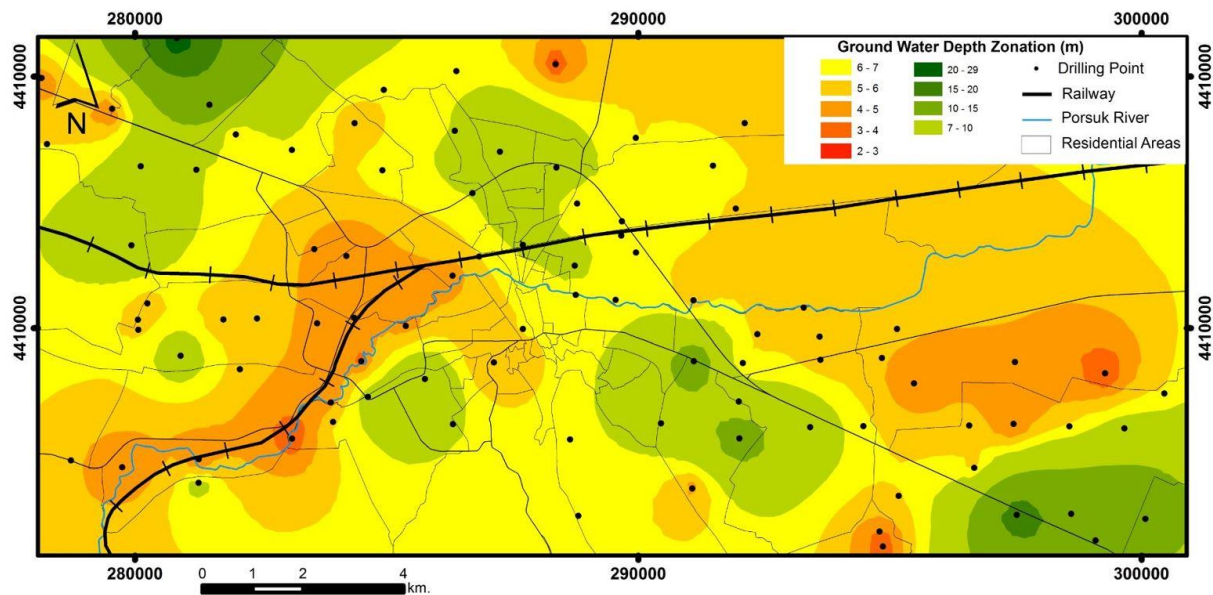


Figure 1. Groundwater Map

The section should also include a deeper analysis of the regional and Eskişehir historical seismicity. That might be useful when discussing the results of the research. Furthermore, it is strongly recommended that the authors add the seismotectonic setting of the study area due to the circumstance that the Eskişehir city is contiguous to the Eskişehir fault zone and it is located in a complex system of faults among which the North Anatolian Fault Zone.

Another section will be added as 1.2 Seismicity of The Study Area.

2. Methodology

2.1. Site amplification

The authors use the V_{s30} values to estimate the seismic amplification at the site under investigation. According to what the authors themselves emphasize in the manuscript, many researchers consider this approach as suitable to move towards the seismic amplification. However, even though the use of the V_{s30} parameter is widely considered, the literature about the subject does raise some doubts about the uncritical use of the V_{s30} parameter. The authors should discuss this in the manuscript. They can refer to the work cited in the proper section (Castellaro et al., 2008).

As the reviewer correctly stated, our group is well aware the limitations of V_{s30} data and to overcome these partially we have utilized 12 accelerometers, 3 of them built on the bedrock and 1 on the ancient alluvium, and the others on the recent alluvium formation around Eskişehir. V_{s30} has been utilized widely in several applications such as investigating the site specific effects in ground motion prediction equations (e.g. Abrahamson et al. 2008) and the basis for specifying site classes in building codes. [Dobry et al., 2000; Building Seismic Safety Council, 2003; Eurocode 8, 2004; American Society of Civil Engineers, 2010]. V_{s30} is a simple metric that can be obtained at relatively low cost compared to more detailed descriptions of site characteristics, and it is correlated with site amplification Boore et al., 1994, V_{s30} cannot, of course, capture all of the physics controlling site amplification (e.g., Mucciarelli

and Gallipoli,2006; Castellaro et al., 2008; Lee and Trifunac, 2010), and a significant amount of unexplained variation of ground motion remains after removing the site effect predicted by VS30 (by Boore, 2004a, section 4.1.2, and Bragato, 2008). We have included these points to the revised discussion section Our manuscript is mainly emphasizes an engineering approach to address part of the problem, which can be used for microzonation studies and to determine the amplification of the area using real earthquake data.

The authors declare that (pag. 6888, lines 6-7) “. . .Figure 3 shows that the site amplification formula based on shear wave velocity of Borchardt (1991) (Borchardt et al., 1991) gives a higher amplification value compared to the formulas of other researchers”...and “. . .This indicates that the site amplification calculation by using Borchardt’s (1991) formula provides more accurate risk assessment. . .”. I do not agree with the last statement. Perhaps the authors wished to emphasize that the formula taken as a reference provides a more conservative assessment of the seismic amplification. Conversely, the authors should clarify what they mean.

“The accurate risk assessment” will be replaced with conservative risk assessment. We agree with the reviewer the formula is used as a conservative estimate.

2.2. Soil liquefaction

The authors perform the soil liquefaction analysis for Eskişehir city using Standard Penetration Tests (SPTs). The literature shows that a detailed and similar analysis was already performed for the same city and approximately for the same study area (Tosun et al., 2011). Therefore the authors, which apparently seem to be unaware of that paper, should compare their work with previously published research, highlighting differences, analogies and possible improvements of their research.

There is no scientific overlap with the liquefaction analysis that has been completed by Tosun et.al.2011. Most importantly, the study area of Tosun et al. covers only Odunpazari district, which is southern of Porsuk River while the present manuscript covers the entire Eskişehir districts. Therefore we have expanded the liquefaction area significantly as can be seen on Figure 4. The present data sets are also more resolved. Tosun et.al. employed shallow drill holes with a mean depth of 10 meters, while present study utilized 87 drill holes and calculations were made through 20 meters depth, according to Iwasaki et al. (1978, 1982). actually the depth of the drillholes are 30 m. In the revised manuscript Tosun et al. 2011 is cited referring to the above differences.

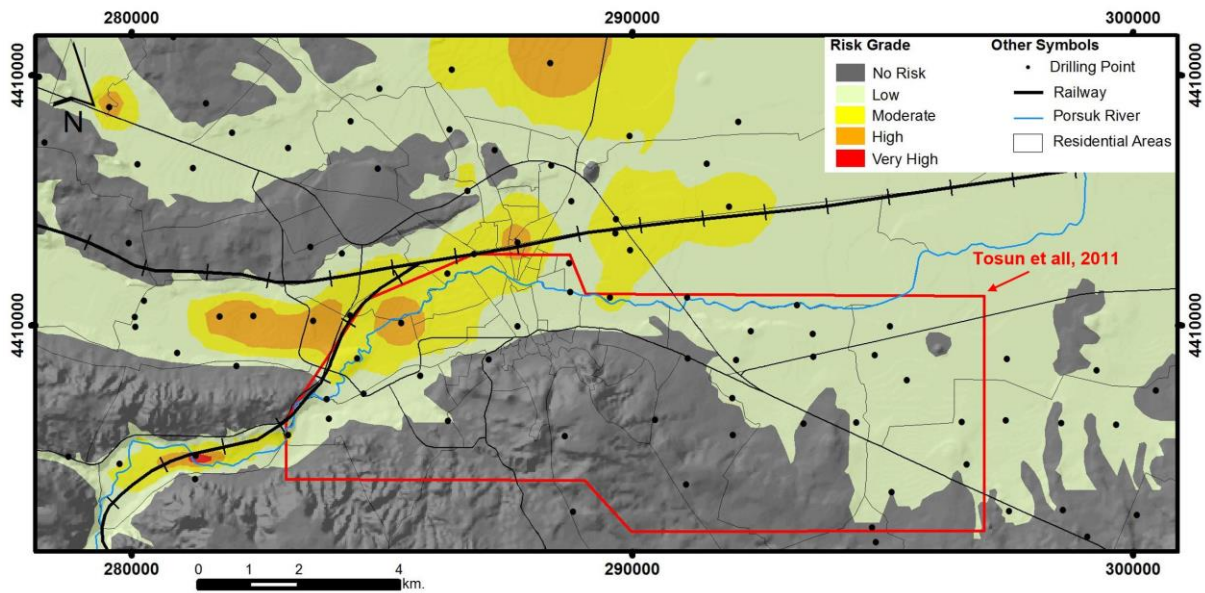


Figure 4. Study area of the Tosun et.al, 2011

It is not well clear what were the scenario magnitude and the peak ground acceleration level used for their analysis. The choice of these values should be discussed.

We have considered a scenario earthquake of magnitude $M = 6.4$, which actually hit Eskişehir on 20 February 1956. This magnitude is also thought to be the maximum earthquake that could happen in Eskişehir. For this reason $M = 6.4$ was used in the calculations. Analyses were carried out for PGA levels at 0.30 g for the second degree Earthquake areas according to Ministry of Reconstruction and Settlement: Seismic Hazard Map of Turkey, (SHMT) which was published in 1996. We have included this information to the Revised Methodology section.

The authors declare that “. . .All of the liquefaction analyses were done from the drilling that reached a depth of 20 m. . .” that seem to disagree with what the authors write in the “Introduction” paragraph, where I read that “. . .soil liquefaction analyses were conducted on 87 wells at a depth of 30m for Eskişehir. . .” (page 6885, line 25). These statements should be clarified.

The liquefaction analysis which has done by Tosun et.al.2011 was used drill holes mean depth of 10, this study we used 87 drill holes and the analyses made through 20 meters depth according to Iwasaki et al. (1978,1982).Iwasaki et al (1978, 1982) recommends the calculations for 20 meters deep. For this reason the calculations made by the Equation 1 actually the depth of the drillholes were 30 m. The LI value proposed by Iwasaki et al. (1978, 1982) is given in Equation 1.

$$LI = \int_0^{20} F(z) W(z) dz \quad (1)$$

In the equation, the $F(z)$ value reflects the severity level while $W(z) = 10 - 0.5 z$ represents the depth-based weighting function.

The General Format for Soil and Ground Study is lacking of the complete reference (page 6890, line 14)

This reference is added to the revised manuscript.

**BiNA ve BiNA TÜRÜ YAPILAR İÇİN ZEMİN VE TEMEL ETÜDÜ RAPORU GENEL FORMATI
BAYINDIRLIK VE İSKAN BAKANLIĞI YAPI İŞLERİ GENEL MÜDÜRLÜĞÜ, 2005**

4.3. Simple weighting method

The title of the paper focuses on the “simple weighting method” through which the authors analyze the seismic amplification and liquefaction, jointly. Despite that, the paper does not go through the subject in an in-depth way. As a matter of fact, considering that the authors’ intention is to centre the simple weighting method, it is useful to explain the method in details. Furthermore, the authors should include a brief literature overview on the use of the method in others or similar research contexts, discussing advantages, novelty and limitations of the approach.

The simple weighting method, also known as 'weighting and scoring', is a form of multi-attribute or multi-criterion analysis. It involves identification of attributes that are relevant to the project; the allocation of weights to each of them to reflect their relative importance; and the allocation of scores to each option to reflect how it performs in relation to each attribute. The result is a single weighted score for each option, which may be used to indicate and compare the overall performance of the options in non-monetary terms.

This process necessarily assigns numeric values to judgments. These judgments should not be arbitrary or subjective, but should reflect expert views, and should be supported by objective information. The brief literature survey will be provided in the revised version comparing the simple weighting method.

Results

As results of their analysis, the authors make some conclusions about what areas should be considered appropriate to settle a residential area. This is an important tangible output of the research. However, in order to better constrain this research output, I suggest discussing about the joint analysis of the patterns of damage caused by the recent/historical earthquakes (such as the event that hit the city on 1956) and the hazard map deriving from their study. Can the historical data about the seismic damage strengthen the author’s findings?

That is a very good point. We have access to qualitative and rather anecdotal information on 1956 earthquake and include this information to our revised manuscript. This information agrees qualitatively with the predictions of our manuscript. Limited information exists about growth and liquefaction exists in Ocalan’s report the epicenter of the 1956 earthquake is located between Çukurhisar and Satilmis villages and thus located outside of the study area of our present study. However the damage report prepared by the engineering corps indicates significant damage on the buildings located near the Porsuk river but not on the rock foundation. This information is actually gives a good correlation between the study and historical data.

Furthermore, it is important to discuss the relationship between the findings of the authors and the current urban layout. For example, what conclusions emerge from the comparison between the most hazardous zones as derived from your study and the intensity of urbanization of Eski,sehir city?

This is another good point and included in our revised manuscript. A vulnerability, defined as the expected degree of loss for an element at risk as a consequence of a certain event, is an important factor in a quantitative risk assessment. Vulnerability is highly dependent on the population and soil properties range of values for exposed elements at risk in the settlement area. In this study, the vulnerability was studied in 4 different high-risk seismic regions where varied in their degree of seismic risk for soil properties. We classify there regions in to four groups, A, B, C, and D, based on their population (Figure 3). Region A is located near the Porsuk river having both highest population and feature high story buildings that includes city center. Approximately 150K people live in this region. Likewise regions B and C are located outside of the city center but still have a significant settlement. The typical building in this region are 2 to 3 stores with relatively lower population (30,000) than Region A. Region D is located at the north of the city with almost no population. For these reasons, a vulnerability of region A is higher than other regions. The results of this study could be used for urban renewal plans. Prime Ministry Disaster and Emercency Management Presidency corps could use the results to determine the emergency plans before a possible earthquake and to find the places to be reached instantly after an earthquake.

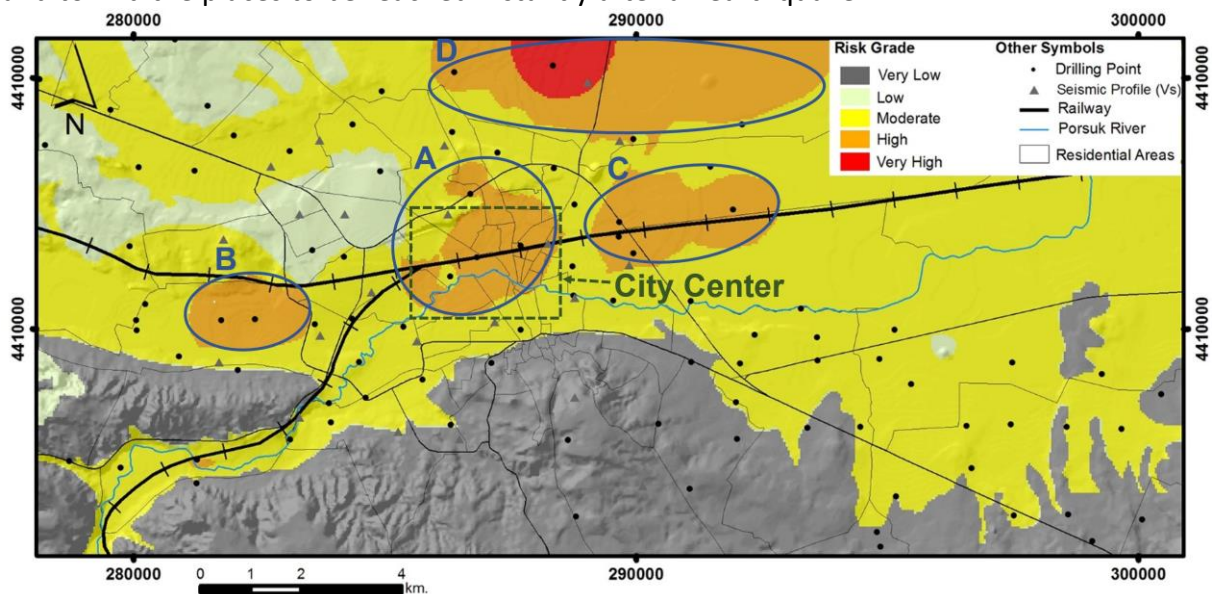


Figure 3. High Risk Seismic Regions: A area; high population with high seismic risk; Area B and C; significant population with high seismic risk and Area D; almost no population with very high seismic risk

References

The paper of Beliceli A. is not in the alphabetical order.

Figure 1

The upper box reports a blank map. It is useful to add some geographic references.

Figure 2

The Figure is partially blank. It is useful to add the location and the urban layout of Eskişehir city as well as the main cities around it.

References suggested

Castellaro, S., Mulargia F., and Rossi P. M. (2008). Vs30: proxy for seismic amplification? Seism. Res. Lett.,79,540–542.

Tosun, H., Seyrek, E., Orhan, A., Savas, H., and Turkoz, M. (2011). Soil liquefaction potential in Eskişehir, NW Turkey, Nat. Hazards Earth Syst. Sci.,11, 1071–1082,doi:10.5194/nhess-11-1071-2011

Ministry of Reconstruction and Settlement: Seismic Hazard Map of Turkey, 1996.

We have revised Figures and references accordingly.