This document presents a review of the manuscript titled as "Development of a country-wide seismic site-response zonation map for the Netherlands" by van Ginkel et al.

As the title indicates, the research work involves the development of a new seismic zonation map for the Netherlands. The authors attempted to combine geological, geophysical, and seismological data in order to estimate and interpret site effects. This reviewer recognizes that this work is based on the analysis of a very large dataset; hence, it involves an important volume of work. Such a work could definitely contribute to the understanding of site-effects induced by shallow subsurface geology. The zonation map could also be considered as a novel contribution in the seismic hazard assessment of the Netherlands. However, it's a pity that this work has been very poorly presented throughout the article.

Firstly, the use of English language is very raw. The entire article is full of long and complex sentences, expressing multiple ideas at the same time in wrong grammatical structures. The underuse, and sometimes misuse of punctuations (e.g. comma) makes the sentences even more incomprehensible. Such a long article with tedious and incorrect English sentences can easily distract the readers. The mistakes are too many to point out. Some examples have been given below. This reviewer strongly recommends that this article must be reviewed by a proficient English user.

Secondly, the organization of the article is not up to the standards. The writing needs to be more coherent within each segment, and should present a concise and unambiguous idea. For example, the introduction is composed of generalized statements and often unrelated specific information. This section should rather state the motivation of the work and prepare readers for the structure of the article. Generally speaking, it should provide a context first, then show the need of the work, then indicate what have been done in order to address the need, and finally preview the structure of the rest of the article. The principal elements are more or less there in the current article but they are presented in an unorganized manner.

Finally, the article still lacks in scientific soundness. The methods are not outlined clearly and the calculations are not shown with proper mathematical formulations. It's not evident which sites or earthquakes have been used for which calculation. Mainly the final summary of the results are presented rather than showing the intermediate steps. The interpretations of the results are ambiguous and incomplete. Many hypotheses and assumptions have been made without any justification. Therefore, this reviewer is doubtful about the traceability of the results.

Considering all these issues, this reviewer believes that this article is not eligible for publication at its current state. However, the authors are encouraged to resubmit it after a rigorous modification and amelioration of its editorial and scientific quality.

The main remarks are elaborated below (L= Line):

Main Scientific Questions:

- L165: What is the justification for setting the reference bedrock at 200 m depth? This hypothesis has been supported neither by the geological profile nor by geophysical measurement. Is the geology at 200 m depth same everywhere? Is there any shear-wave velocity profile that shows that the formation at 200 m depth can be characterized as rock?
- The authors mention that "*This depth and corresponding average shear-wave velocity forms the basis from which the site-response and corresponding amplification factors (AFs) are estimated in the next sections."* Where is this shear-wave velocity defined? If the bedrock is defined without any justification, the estimation of amplification in the entire work becomes highly questionable. The authors did mention something about Groningen network. However, they do not show the location of this network with respect to their data. It's also very unclear how the bedrock has been identified from the G-network. How can a Vs 500 m/s be characterized as rock condition? How can this be applicable to all sites, especially in the south where there are older formations?
- Figure 1: What does the geological map correspond to? Does it show the geology at the surface or at any specific depth? The figure does not show geographical coordinates.
- The description of the geology seems a bit incomplete. Even though this work uses two 3D geological models, there is not enough discussion about the geology at depths (e.g., at the base of the Quaternary or below).
- Figure 2: Lat/Lon should be shown at least for two points on both axes.
- L 190: The AFs are calculated from the G-network but the location of this network has not been shown. Do the boreholes with SCPT belong to this network?
- The calculation of AFs need to be elaborated in mathematical terms and the signal processing aspects need to be explained better. The calculation of AFs for the event shown in Figure 3 can be presented as an example. The 1D geology and Vs profile at that location could also be presented to show if the AF could be explained/interpreted.
- Which M>2 earthquakes have been used for the AF calculation – the induced or tectonic ones? How many earthquakes are there? What are their magnitude-distance distributions? Have they been selected based on good signal-to-noise ratio?
- Why are the AFs calculated in such large frequency bands? Such results provide very little resolution for the interpretation of the amplification. Is there an estimate of the Vs of the sedimentary layer? Is it possible to verify if the fundamental resonance of amplification is captured within 1-5 Hz band?
- The authors mention that the high AFs in 1-5Hz band is due to fundamental resonances but they do not provide any evidence to support that.
- L205: Once again, which earthquakes have been used to compute the ETFs? The computation of the ETFs need to be elaborated with appropriate examples. This reviewer is not convinced by the interpretation of the ETFs. Do the ETF50 and ETF200 have similar amplitudes at all sites? Can it be supported by the geology of some example sites?

- Figure 5: The visibility of this Figure is poor. It's difficult to verify the comparison among the curves. The X-axis is not graduated at all.
- L235: Which are the sites where HVSR, ETF and AF all are measured? Please show on the map. How many earthquakes (and their M-R distribution) are available for those sites? Figure 7 is not well explained and the Figure title is also unclear.What are the values plotted there? At which frequency?
- L 255: It seems that the Vs10, Vs20 and Vs30 values are taken from one set of sites and the Vs50 is taken from another. Is that so? Which of these sites correspond to the ones where AFs and ETFs are estimated? How far away the other sites are?
- L 259: How are the depth and size of velocity contrast derived? It's not very clear from the description. Please provide mathematical formulation.
- What is the rational of using the particular functional forms for fitting AF with Vs and VC? What are x1, x2, x3?
- L 280: Where are these stations located? They could not be found anywhere in the article?
- L 292: It's not evident to this reviewer that the borehole ETFs show most amplification within 50 m depth. Only one random example has been shown in Figure 5. The 50m, 200m depth values seem more like mere assumptions of the authors. In Figure 7, the fit between AF and Vs seems more or less similar for Vs10, Vs20, V30, Vs50. It rather seems that the functional relation could be slightly different in case of Vs10, Vs20 compared to Vs30, Vs50. As none of these results have been explained/supported throughout the paper by concrete geological and geophysical information, the summery and interpretation of the results seem very ambiguous.
- This reviewer is also doubtful about the site classification approach in this article and, hence, about the entire zonation. Replicating the HVSR-AF correlation obtained from the limited Groningen area for the entire country seems a bit heavy-handed. In other studies (e.g., Perron et al.), HVSR has been shown as a complementary parameter for amplification prediction within an area where already some estimates of AF exist. The site-specific nature of amplification must be addressed in a zonation approach.
- This reviewer suggests the authors to highlight the geology more and verify/interpret/constrain the results in terms of the geology of the measurement sites. It's important to explain the effects of the subsurface structure/geology on the amplification rather than drawing purely statistical functional correlations.

<u>Editorial Remarks (some examples from numerous mistakes):</u>

- L5: "*The shallow geology of the Netherlands consists of a very heterogeneous soft sediment cover, which has a strong effect on seismic wave propagation, ~~and~~ in particular on the amplitude of ground shaking, resulting in significant damage on structures ~~despite the fact that the events are of small magnitude.~~*" **The phrase with 'despite' makes the sentence confusing. The use of 'events' is also confusing.**

- L10: "*For this, we combine ambient vibration and earthquake recordings using resp. the horizontal-to-vertical spectral ratio method (HVSR), borehole empirical transfer functions (ETFs) and amplification factors (AFs).*" **How is it possible to combine noise and earthquake recordings?**
  "*This enables us to define an empirical relationship between ~~measured~~ ~~earthquake~~ the amplification estimated from earthquakes by using the ETF and the AF, and that ~~amplification~~ estimated from ambient vibration ~~with the~~ by using the HVSR ~~derived from the ambient seismic field~~. Therewith, we show that the HVSR can be used as a first proxy for amplification.*" **Grammatically incoherent sentence. The use of 'therewith' is not the best choice.**
- L15: "*The resulting peak amplitudes largely coincide with the in-situ lithostratigraphic sequences and the presence of a strong velocity contrast in the near-surface*." **Very confusing sentence. Do the authors means that 'the resonance frequencies of peak amplifications can be explained by the velocity contrasts in the lithostratigraphy'?**
- L 25: "*Site conditions may be retrieved from available global datasets and the ground-shaking estimation is based on ground-motion prediction equations*." **The point of this sentence is unclear.**
  "*Site-response estimation requires detailed geological and geotechnical information of the subsurface, which can be retrieved from in-situ investigations, however, this is a costly procedure*." **For the sake of clarity, the sentence needs to be split into two.**
- L47: "*Hence multiple studies were performed on ground-motion modeling including the site amplification factor for the Groningen region, which forms an excellent study area due to the permanently operating borehole seismic network*." **This sentence makes little to no sense.**
- L115: "*The Netherlands experiences two types of seismicity; firstly, earthquakes in the south-east are caused by deep tectonic processes and secondly, induced seismicity at shallow depths triggered by exploitation of gas fields.*" **Grammatically incoherent.**
- L121: "*They observed great variety in ground-motion amplitudes over different stations which is very likely a site effect of shallow sedimentary deposits.*" **Makes no sense**
- L155: "*The extensive data set recorded with the Groningen borehole network provides the opportunity to derive empirical relationships between measured amplification in the time and frequency domain, estimated amplification from the ambient noise field and the local lithostratigraphic conditions.*" **Makes very little sense**