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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Integration of HVSR measures and stratigraphic constraints for seismic microzonation studies: the case of Oliveri (ME)" *by* P. Di Stefano et al.

Anonymous Referee #1

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REVIEW OF THE MANUSCRIPT "Integration of HVSR measurements and stratigraphic constraints for the seismic microzonation studies: the case of Olivieri (ME)" by Di Stefano P. et al. (2014)

This paper presents a sort of seismic microzonation of the town of Olivieri based on a clusterization algorithm that should (if I understand well) 1) optimize the calculation of the HVSR curve and 2) identify the continuity of the HVSR peaks/reflectors in space. How this clusterization algorithm works is unknown: the authors readdress the reader to other 2 manuscripts in preparation about the same topic and one therefore wonders what the aim of the present paper, where results are presented as coming out a black

box, is.

MAJOR ISSUES:

The paper is very long (many concepts are repeated 3 or 4 times throughout the text) and severely unbalanced in the contents.

- Section 1 (Introduction): here we have a first description of the HVSR technique and of the nature of seismic noise (2 pages),

- Section 2: 5 pages to describe the geological settings are not interesting at all considering that the goal of the authors is not the present the seismic microzonation of the town (as they write on p. 22) but the improvement brought in by a clustering technique,

- Section 3: here the HVSR technique is described again in 6 (!) pages. This looks more like a historical review of the method but since all these concepts have already been discussed in several papers (and are already summarized, e.g., in SESAME, 2004), this section does not add anything new. Also, the different hypothesis are acritically presented as if they were at the same level why they are not: presently it is well acknowledged that surface waves are dominant in ambient noise (for the simple reason that they attenuate less with distance). What is variable and a priori unknown is the proportion of different waves but the original explanation of the HVSR proposed by Nakamura in terms of SH waves only has been abandoned. The presence of Rayleigh waves in ambient noise is recognizable in the local minima of the vertical spectral component (which cause the H/V peaks) while local maxima in the horizontal components are due to Love/S waves (see also Fah et al., GJI, 2001; Tuan et al., GJI, 2010 etc.). HVSR is mentioned as a method to estimate the resonance frequencies of buildings while this was attempted just at the initial stage and soon abandoned because rocking can modify the vertical component, thus affecting the amplitude of the modal shapes (and sometimes the frequency) calculated with this method (e.g., Todrovska, BSSA, 2009). Eigen-frequencies in structures are commonly measured through other techniques (SSR etc.).

But my main concern remains: what is the aim of this paper? At page 13 we are still dealing with the review of previous papers.

- P. 14: we arrive to the apparently central point: “an Agglomerative Hierarchical Clustering (AHC) is applied – after several tests – to split almost automatically peaks probably linked to site effects from other perhaps related to source effects”. After 14 pages of discussion the central point is described in 4 lines. How does this AHC method work? What are the input data? Why did the authors select the SC as proximity measure and AL and discarded other options? On what basis? Did they have a control set to assess the performance of the methods? How can the AHC separate between stratigraphic peaks and anthropic peaks (if this was the point, I am not even sure)? As widely discussed in SESAME (2004) and other papers quoted therein and following, H/V peaks of stratigraphic origin are characterized by a minimum in the vertical spectral component (due to the Rayeigh wave annihilation at the resonance frequency) while anthropic peaks are much sharper and show narrow maxima in all the 3 spectral components. As far as I understand, the AHC operates on the HVSR, not on the single component spectra. How can it distinguish the 2 kinds of peaks? To be the central part of the paper, the provided description is definitely insufficient.

- Section 4: a second clustering procedure is now applied to assess the lateral continuity of the seismic reflectors identified by the HVSR peaks selected in Section 3. In this case a few more lines are devoted to the description of the input parameters (essentially peak frequency, amplitude, coordinates and outcropping lithology) but the physical basis that should relate these parameters to the lateral continuity of the reflectors is not clear to me. If we observe the same HVSR peaks at 2 close sites, they are probably due to the same reflectors but this is just a supposition because they might also be linked to different reflectors at the same depth or to completely different VS-depth profiles that result in the same resonance frequency. Again: what is the aim of the authors? What does this AHC really do? Does it assess the geometric similarity of the peaks in the examined area? Why do the author link the peaks to the outcrop-

ping lithology only? H/V peaks are linked to the underground geology, not only to the outcropping material. How were the weighting factors selected? I read wper =0.4, wampl=0.2 etc... where do these numbers come from? The authors also mention the “optimal threshold”: on what basis did they assess its value? The number of clusters depends on this threshold. It is very hard to understand the physical and mathematical bases of the whole procedure because they are not described and I am not even sure that they exist if the underground geology is not know or taken into account.

- Section 5: p. 16-17... again the seismic noise composition? This is mentioned for the 4th time in the paper. On the bottom of p. 17 the concept is repeated for the 5th time.

Also in this case I think that we do not need to read 2 pages that resemble the Geopsy manual (p. 17-18) or the other quoted papers. But, more importantly, I do not really understand if to invert the HVSR curve the authors used the borehole data or not. They state that one borehole only is available but not at the surveyed sites. Then they say that they used this borehole as constraint (p. 18) but on p. 19 they state that “the evaluation of the thickness of the cover did not take into account the available down-hole data”. It is all so confusing...

According to the Occam’s razor principle, among competing hypotheses, the one with the fewest assumptions should be selected, in absence of further information. The HVSR curve presented by the authors (p. 39, fig. 9) shows essentially a single peak at 1.4 Hz. Any HVSR curve showing N peak can be fitted by models with N+1 layer (the only exception being the presence of velocity inversions). In this case a 2 layer model is enough to fit the experimental curve (see figure below). The layer at 170 m depth proposed by the inversion procedure may also ultimately prove correct, but - in the absence of information from alternative sources that we do not have here - the fewer assumptions that are made, the better.

- Section 6: after 20 pages another section with the tectonic settings at a smaller scale? There were 6 pages in Section 2 to describe this. 8 pages of geological description are

really too much and out of topic.

In conclusion, to me, this paper appears to be completely unbalanced in the contents and unclear in the goals and the methods to reach them. The first clustering procedure adopted to separate natural from anthropogenic peaks (if this was the point) is not described at all. The second clustering procedure adopted to assess the spatial continuity of the reflectors identified through the HVSR peaks is based on a number of obscure procedures (the selection of the weighting factors, the selection of the optimal thresholds, etc.) and the physical rationale is neither described nor intuitive. In both cases it is completely unknown how the authors could assess the performance of their methods and define them as “improving” and “optimal” since no control dataset is presented and no comparison with alternative methods is shown.

OTHER ISSUES

- Title: what is ME? Where is Olivieri? That it is located in Italy is mentioned only on page 7!

- P. 4: anthropic noise is dominant also at frequencies well below 10 Hz (usually the threshold is put at 1 Hz, cfr. SESAME 2004 and much older works by Gutenberg, BSSA, of the ‘50s)

- P. 5: “substrate seismic”, what is this?

- P. 9: how can the authors write MW=6.15 for an earthquake dated 1786??? We cannot use more than 2 significant digits for instrumental events (see all the problems of magnitude calculation listed e.g. in the New Manual of the Seismological Observatory Practice, P. Bormann ed.), how can they assess a magnitude with 3 digits for a non instrumental event?

- P. 9: completeness analysis of the catalogue: who and how found that the completeness threshold is ML = 2.6?

- P. 12: “capability of the HVSR curve to mimic the HVESR curves”: ?

- P. 12: “duration of the; “... something is missing here.

- P. 13:“the presence of the site effect due to a particular cause”. What is this cause that is mentioned several time? Do the authors mean a seismic reflector?

- P. 13: “3C seismic digital station“ what is 3C? 3 components?

- P. 13: using 10 s windows to see 0.1 Hz components after the FFT is quite optimistic with H/V from ambient noise. The classical signal theory (and SESAME, 2004) recommends to work on windows that contain at least 4 time the minimum frequency that one wishes to detect (i.e. 40 s in this case)

- P. 13: “to have a minimum numerosity of the sets of sampling windows selected for the analysis”, what does this mean?

- P. 17: Rayleigh, not Reyleigh

- References: acknowledging previous work is definitely important but 7 pages of bibliography for a paper which is not meant to be a review paper but an original research paper look weird to me

- Table 1: H/V frequency and amplitude values are presented with 3 digits: is this correct? Where are the standard deviations of data (they must be calculated and shown for each experimental curve and I am quite convinced that presenting them will reduce the number of significant digits to 2)

- Fig. 1: one has no idea about where this place is located in the world

- Fig. 3: we see an H/V curve but so far location of the 23 sites surveyed in the town has not been shown yet (it is shown only in fig. 7)

- Fig. 5: cannot be understood. What is the meaning of the axis?

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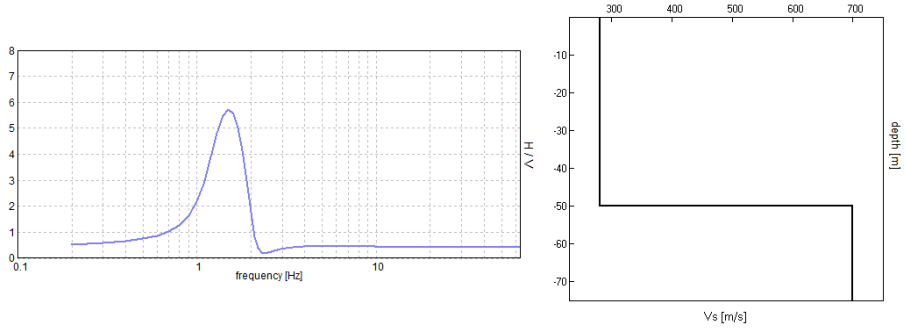
8
7
6
5
4
3
2
1
0
0.1
1
10
frequency [Hz]
A / H
300
400
500
600
700
-10
-20
-30
-40
-50
-60
-70
depth [m]
Vs [m/s]

Fig. 1.