

## Review of Doctoral Thesis

### Arrigo Caserta: Seismic Site Effects (Data analysis and Modelling)

Review composed by  
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The Doctoral Thesis is compiled as a compendious text and an aggregate of 5 research papers. A. Casserta is the main author of four papers. Four papers have already been published and one paper is in review process. In all cases, publishing concerns respected and reviewed journals (Computer & Geosciences, Studia Geophysica et Geodetica, Journal of Geophysical Research, Bulletin of Earthquake Engineering, Annals of Geophysics). The common topic is using the seismic noise for determination of the subsurface geology, in earthquake engineering, for seismic microzoning and also for other purposes. The topic is no doubt highly up to date, especially if applied to the environment of the Roma City (3D-microarray was established there), i.e. densely populated area with high cultural-historical significance and endangered by earthquakes. Due to advance in formulating new theories how to process random wavefields one can expect advance in seismic noise measurements and processing as well. I recommend A. Casserta not to abandon this topic but to continue and to further develop relevant methods of processing and utilization of seismic noise.

The scientific level of the Doctoral Thesis is documented mainly by included copies of research papers. In all cases the papers were published in journals requiring demanding and rigorous reviewing. All these papers are interesting, beneficial for other researchers dealing with a similar topic. I highly appreciate these papers.

The text preceding copies of published papers should simply classify the solved problems, to set up relevant relations and consequences and, should help the reader with overall orientation in the topic. Unfortunately, nothing from those expectations were fulfilled well. In fact, most readers would have to read the included papers first in order to understand the introductory text. Therefore the submitted Thesis can probably never be an exemplar for future students nor a didactic tool. This is a great pity because of the importance of the topic and because of how deep and how promising this topic is. I will document several my objections next. It is impractical to present all of them. Generally, I did not find any severe error. Instead of that, I found a lot of minor-to-medium errors.

- There is the first chapter called “Seismic noise deterministic analysis: single station measurements” at the page i but, substantial part of this chapter deal with seismic arrays.
- Selected part of the text is arranged as “.. deterministic analysis...” and “...stochastic analysis...”. As far as such a classification is not commonly used for seismic noise measurements, the author should clearly define characteristic features of both approaches and what exactly is understood by that.
- “two sets of questions” are mentioned at the page 6 but, 5 items follow.
- The purpose of the figure 1 at the page 1 is unclear and, even if there is in the caption “Logical scheme...” I did not find anything logical in this figure. Moreover, this figure is quite unnecessary.

- It seems that the author is using the terms “soil shaking” and “ground shaking” as synonyms. It is necessary to keep in mind, that most geologists understand “soil” as highly unconsolidated sediment (i.e. “soil” = specific kind of rock). Since the applicability of the used methods is much broader, it is better to use “ground shaking” unless the statement is actually limited to measurements on soils.
- Frequently used formulations like “Interaction of seismic noise and near surface geology” are incorrect. Interaction is possible only provided both objects influence each other. Evidently, seismic noise has no impact on the geological structure.
- At the page 6 there is distinguished “near-surface geology” and “inner Earth structure”. Near-surface geology is also (a small) part of the inner Earth structure.
- There are typographical errors in the Table 1.1 at the page 7, the row regarding frequencies is incorrect. As postulated in the text at the page 8, this table should document the complexity of seismic noise wavefield. In fact only some qualitative differences between natural and anthropogenic noise are given there.
- There is at the page 9 “...relation with the first frequency...” but, probably correct version should be “...relation with the lowest frequency...”
- The caption regarding the figure 1.1. at the page 11 is inconvenient. It refers ambiguously to the red lines. There is no explanation what are the curves  $K_{max}$ ,  $K_{min}$ .
- The sentence at the page 12 “In order to allow a reliable ...” is quite obscure to me.
- The abbreviation CVFK at the page 12 is not explained.
- The equation 1.1. at the page 13 is incorrect, since the frequency  $\omega_m$  is summed out according the index  $m$  and, cannot be an independent variable on the left hand side at the same time.
- I did not find any reference to figure 1.2 in the text. This figure should contain also the geometry of stations and the frequency for which it holds.
- The equations (1.5), (1.6) and (1.7) combine inconveniently the symbol  $R_{th}$ . The same symbol represents different quantities due to different number of parameters.
- The caption below figure 1.3. at the page 17 contains “...vertical section of the ( $K_x$ ,  $K_y$ ) plane”, but this is nonsense. The graph in the right part of the figure cannot result from cutting 2D plane by other vertical plane.
- The figure 1.4 at the page 19 has useless colour scale, which originally defined colours in the middle column.
- The Chapter 2 is devoted to the discussion of statistic characteristics of seismic noise. There is insufficient justification of the merit of such studies.
- The Chapter 2.1. is some kind of extraction from the paper P1, but it is quite obscure. Even reading the paper P1 gives sense.
- The frequency at page 16 is denoted both as  $f$  and  $F$ .
- It is rather problematic to introduce the Brownian motion into modelling the seismic noise. The premise  $\sigma(t) \approx \sqrt{t}$  is not acceptable for seismic noise. If yes, for  $t \rightarrow \infty$  we would obtain indefinite variance, what is clearly not the case.
- Equations at pages 27-28 are difficult to understand, the symbols  $t'$ ,  $c$ ,  $\delta t$  and the expression  $[t/\delta t]$  are not explained.
- It is not clear, for which variable Eq. 2.11 at the page 30 is averaged.
- etc. etc.
- I have no remarkable objections regarding the Chapters 3 and 4.

Concluding comments regarding the doctoral thesis are as follows:

The graphical quality of many figures is poor;

The text is from time to time illogical;

Some equations have typographical errors and, in selected cases are even incorrect.

The above mentioned shortcomings seriously downgrade the submitted thesis, regardless that mostly only phrasing or presentation problems are occurring, which in principle can be eliminated by careful and patient seeking for the actual sense of statements. Despite of plenty of my objections the factual content of the Thesis is correct. I highly appreciate the application potential of the developed methods. Due to the impossibility of correcting the text later and, also due to the necessity to base the final evaluation mostly on the already published papers (which are fine), I suggest to accept this Doctoral Thesis and to classify it as successful.

In Prague, May 5, 2011

A handwritten signature in blue ink, reading "Johannes Rind". The signature is written in a cursive style with a large initial 'J' and a stylized 'R'.