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Earth Surface Dynamics Discussions

Interactive comment on "Characterizing the complexity of seismic signals at slow-moving clay-rich debris slides: The Super-Sauze (Southeastern France) and Pechgraben (Upper Austria) case studies" *by* Naomi Vouillamoz et al.

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1. Does the paper address relevant scientific questions within the scope of ESurf? YES.

2. Does the paper present novel concepts, ideas, tools, or data? YES.

3. Are substantial conclusions reached? Not, yet.

4. Are the scientific methods and assumptions valid and clearly outlined? Not, yet.

5. Are the results sufficient to support the interpretations and conclusions? Not,yet.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Not,yet.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Not,yet.

8. Does the title clearly reflect the contents of the paper? YES.

9. Does the abstract provide a concise and complete summary? YES.

10. Is the overall presentation well structured and clear? Not, yet.

11. Is the language fluent and precise? YES.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Not applicable.

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? YES.

14. Are the number and quality of references appropriate? YES.

15. Is the amount and quality of supplementary material appropriate? Not applicable.

More information.

-This is an interesting paper that deals with seismic signals associated to clay rich debris landslides. For the characterization of these signals the authors use well known seismological tools. The authors are very honest and prudent when presenting their results. It is a very hard work to deal with such a lot of signals; however, results are limited but not the information.

- The presentation of the paper is clear although the seismic terminology is used in a not appropriate manner. I recognise that it is difficult to use an appropriated terminology but I do not agree with the use of seismicity when the subject are not earthquakes.

We are dealing with events that produce seismic vibrations and seismic signals, but not earthquakes. Seismicity is related to earthquakes (e.g. Geological Survey or Enciclopedia Britannica definition). This observation is valid for the use of seismicity catalogue or seismicity rates.

- Landslide induced seismic signals or Seismic signals induced by landslides could be a good term.

- Regarding the localizations, in Seismology it is well known that one of the conditions for a good localization of events is to have a good and dense distribution of stations. As much as the readings you use best is the localization. The authors present a localization exercise with 4 readings, but they have more. In addition, to characterize the signals, the authors neglect the information of the horizontal components. A comment on all this will be illustrative.

- The authors in the interpretation of the different types of signals make some assertions related to their frequency content, attenuation, etc. (for example, small source, range of distances, apparent speed ...). Please, include a comment on the physics below or references.

-It is necessary an introduction on the tools used and what is the purpose of using them. Also the different roles and benefits of them or what the authors expect from their use. This would be useful for readers.

-It seems that there is redundancy in the applied methods. In addition, the explanation of the results in the text is very limited.

-In addition, the purpose of creating a catalogue can be explained in the introduction.

- As far as the FFT is concerned, this is not so trivial. Are you using the spectral amplitude or the PSD (Power Spectral Density)? The FFT of a function has a real part and an imaginary part (Phase). In addition, the units are not specified in the figure and this does not help to the interpretation.

- In general, the resolution of the figures is low. For example, in the spectrograms, a change of scale is necessary to observe in detail the behaviour of the signal. A comment on the resolution of the scale used in the analysis is needed. Or is it the same as shown in the figures?

-A Discussion section on the results is needed. A comment on the useful parameters and methods used with regard the expected. In the conclusions is indicated that information related to the frequency content and its time evolution was non relevant. This is due to the scale used? Please, an explanation on this is needed. Also relate your outputs to previous results.

-The most important contribution of the paper is the calibration of a magnitude scale (ML-SL) to the specific case of the clayey landslides for the locations of study. Also, the description of the conditions for a good study is valuable. The clarification that the magnitude scale for earthquakes is different to that used for landslides and also the differences in the ground motion parameters for their determination is a valuable contribution. A remark in this regard to the community was necessary for the proper use of seismological parameters.

ABSTRACT.

Pag. 1 L-13 The signals are generated, they are not triggered.

Pag. 1 L-15. Include a magnitude order for the duration of the longest signals (hours?).

Pag. 1 L-18 Replace ML to ML-ls in the local magnitude scale.

Introduction.

Pag. 2 L-17 Specify rock avalanches. Snow avalanches are not considered in the mentioned references.

Pag. 2 L-27. (3) sensor network geometry. Specify what type of network.

Pag. 2 L-24. The last part of the Introduction (from Pag. 2 L24) mostly corresponds to

results or discussion. Eliminate this part from here.

Pag. 2 L-28. Split the sentence: event location. Uncertainties. . ..

Pag. 2 L-31. Since the uncertainty. . . Please, explain better this sentence. What do you mean by seismicity rate? Note that you are not referring to earthquakes. And the word seismicity is specific for earthquakes.

Pag. 3 L-7. mm d-1 are not in SI units. I recommend to use SI units (m. s-1).

Pag. 3 L-10. Lindner et al., 2014 and 2016 are not included in references.

Pag. 3 L-12-14. Indicate the source of the displacement values or better explain how they are obtained.

Pag. 3 L-17. The data were collected.

Pag. 3 L-18. Please, include the references of Agécodagis (or Agéodagis ?) instruments.

Pag. 3 L-31. Replace the word seismic.

Line 25-26. This sentence is related to objectives does not correspond to data. Rephrase the sentence or move it to the introduction.

Pag. 4 L-5. Differentiate between sonogram and spectrogram in the context of this document. Both functions show the temporal evolution of the frequencies. Depending on the parameters of the display, the same information can be displayed.

Pag. 4 L-22. Complete this information explaining a little more the tools applied with respect to what you expect. This will help the reader.

Pag. 4 L-23. Indicate the aim to design a catalogue. This could be included in the introduction.

However, is design the correct word? Do you want to generate a catalogue with a good design?

Pag. 4 L-24. Replace seismic catalog by catalog of seismic signals induced by landslides or similar.

Pag. 5 L-7. Explain why the signals are expected to be severely attenuated and give references.

Pag. 5 L-17. Specify to what previous studies are you referring.

Pag. 5 L-26. landslides seismicity catalogs. Better replace by Lanslides induced sismic signals catalogs.

Pag. 5 L-32. The content of Fig. 2 should be explained in the text. In addition, somewhere in the text should include an explanation of the selection of the tools used in the Figure, their role and benefit. As far as the FFT is concerned, this is not so trivial. Are you using the spectral amplitude or the PSD (power spectral density)? The FFT of a function has a real part and an imaginary part (Phase). In addition, the units are not specified in the figure.

Pag 6 (4.4.2) and Fig 3. You affirm that in type II there are surface waves, I also observe in Type III similar shapes of better developed surface waves. This is normal because distance is longer. In the case of local microearthquake (Type IV) I observe perfectly the surface waves at 3 s from the first arrival. The energy immediately 0.2 s are S waves (although is a vertical component).

Pag. 6 L-14. Indicate the reasoning to assume that the distances are > 50 m or other in the different types of signals.

Pag. 6 L-15. SI units, 10-5 ms-1.

Pag. 6 L-18. What do you mean by later phases? Later arrivals? If they correspond to surface waves, the speed is lower, but if they are wave phases that travel in depth, the velocity must be greater although the distance affects the apparent speed. ... Explain this better or delete the parenthesis. The seismograms in figure 3 are presented following the stations code, but please, indicate which the time origin of the seismograms

is. The apparent velocity is in relation to the distance source-sensor and this is not indicated. Or is it unknown?

Pag. 6 L-22. Indicate the figure in detail (for example, Fig. 4c-5), when referring to the dominant frequencies.

Pag. 7 L-4. Please, indicate the epicentral distance. It seems to me that P and S waves and also superficial waves are observed clearly. See Fig 3d.

Pag. 7 L-5-15 this could also be part of the conclusions. Moreover, you obtained similar signals PI and PII at both sites (SZ10 and PG6). This is remarkable.

Pag. 7 L-7. Explain why a large attenuation is evidence of a nearby source.

Pag. 7 L-9- 10. Please explain why you infer these statements. Nearest source, small source ... This could be discussed in the introduction or elsewhere.

Pag. 7 L-12-16. Some explanation or references are needed to support the assertions.
Pag. 7 L-23. The mentioned publications are not indicated in the references.

Pag. 7 L-25. The mentioned publications are not indicated in the references. In addition, in figure 5 in Biescas et al, 2003 (Surveys in Geophysics, 24, 447-464) is the first time that helicopters and moving vehicles are mentioned in this context. In relation to the Doppler effect, it is necessary to vary the speed of the mobile source with respect to the stationary observer and an acceleration to observe a change in the frequencies that vary in time in the spectrogram (gliding).

Pag. 7 L-27. The correct word is generated, it is not triggered.

Pag. 7 L-28. What is the reason for including this sentence in relation to the Q factor? Presented in this way does not contribute to anything. Remove it.

Pag. 8 L-7. Specify seismic network here and in all the cases.

Pag. 8 L-13. Replace 4.3.1 by 4.3.2.

Pag. 8 L-15, 16 and 22 Replace are by were.

Pag. 8 L-24. Similarly to previous sections accompany the subtitles with a dash e.g. - ETS-like signals (episodic tremor and slip); - Confirmed rockfall events. . ...

- ETS-like signals. How do you deduce that the signals correspond to episodic tremors or slip? Is it related to previous studies? You have to mention that in this subsection.

Pag. 8 L-25. seismic network.

Pag. 8 L-26. fig. 5b Specify better and give more details.

Pag. 8 L.31- Fig. 6b Specify better and give more details.

Pag. 9 L-6. Do you mean low topography or smooth topography? Perhaps a short description of the sites is necessary.

Pag. 9 L-10. This subsection is not very clear. No description of the signals is presented. The only result is that since they are very similar to ETS they can be eliminated if there is a field observation.. However, as the physical process of rocksfalls (impacts) and slip is different, if the signals are observed in more detail they can possibly be separated. Additionally, if you consider the 3 components you can observe differences between a slip and a rockfall. See fig. 3 in Vilajosana et al., 2008. The signals are different in the horizontal and vertical components.

Pag. 9 L-13. Fig. 5a and 5c Specify better and give more details.

Pag. 9 L-17. Fig. 5a -c? Specify better and give more details.

Pag. 9 L-20. Figures 5d and 6d show two signals from Walter et al., 2012. However, no reference is made to these figures in the text. A discussion or comparison of the signals with those of this contribution is needed.

Pag. 9 L-24. In Fig 7 there is quantity of information that is not explained in the text. More description of the images is needed. Maybe I am lost, but how do you know the

source situation?

Pag. 9 L-26. Why does the temporal evolution of dominant frequency content suggest a mobile source? Indicate the appropriate figures and better specify the information you want to communicate. Also indicate references.

Pag. 10 L-1. The information in this subsection is anecdotal and unnecessary. It does not contribute anything to the knowledge of the phenomenon. These signals are context-independent. And its characteristics depend on the distance from the sensor to the seismic source. Always, when the location of a station is inappropriate, there are external sources and noise. Fortunately, as mentioned in the text, in some cases they are in the high frequency range and a high pass filter eliminates it. As it is impossible to collect all kinds of signals, I recommend that the authors mention the possibility of registering external sources and eliminate this part with the corresponding figures and devote the space to analyse the signals produced by landslides.

Pag. 10 L-28. Is the coda important for the location? In addition, as indicated, the attenuation is very high, so the coda disturbs little.

Pag. 11. All the points related to geometry and distribution of the elements of the network with regard the good location of the source are well known in seismic location. This is not new. The only doubtful point is the low impact of the velocity model to locate the superficial source. Normally velocity model affects locations. Are significant these mentioned few meters with regard the distances involved? I propose the authors to construct travel time curves for the direct and reflected waves in the range of 150 m for the 3 velocity models to see the effect in the travel times and discus the result. Additionally, you are using only 4 readings. Why? Usually, more readings are necessary to obtain an over-determined system. Comments on all this are necessary.

Pag.11 L-31. Seismicity map is not an appropriate term. Seismicity map is related to the distribution of earthquake epicenters. You are dealing with other events. Perhaps a good term is "map of landslides related events location".

Pag.12 Estimation of source proximity trough waveform attenuation. This is an option, but Fig. 11a shows local site effects, which are also observed in the dispersion on Fig. 11b. It's not so easy for me to validate the distances of the source. Explanations or references are necessary.

Pag.12 L-14. seismicity rate is an inappropriate term. Perhaps Rate of landslide related events.

Pag. 12 L-16. 5.3 I agree with the authors that it is necessary to remind the origin of the magnitudes to avoid an inadequate use of this concept. Very interesting precision regarding the differences between magnitude scales.

Pag. 12 L-17. Specify: Earthquake local magnitude scale ML.

Pag. 12 L- 24. Fig 12 is the correct Figure.

Pag. 13 L-1. ..define Ao-LS and indicate its units.

Pag. 13 L-1. is logfit a MATLAB script? Indicate.

Pag. 13 L-7. In units SI is KJoule not KiloJoule.

Pag. 13 L-11. Better to express A= 5.10 -3 m/s (SI units).

Pag. 13 L-14. A is the absolute value (include <0 values).

Pag. 13 L-17. Homogenize terminology in Pag.12 L-19 and here.

Pag. 13 L-26. Consider my previous comments on the use of the term seismicity. Catalogs of clayey landslides events.

Pag. 14 L-1 and L-4. Consider my previous comments on the use of the term seismicity. Landslides-induced events or landslides-induced seismic events are more corrected terms than seismicity.

Pag. 14 L-5. Section 5.4.1 is too short. I recommend the authors expand the explanation to give value of the results. Figure 14 shows amount of information that needs

comments. Pag. 14 L-5. Consider my previous comments on the use of the term seismicity. landslides-induced seismic events rates. Although, I recognise is a long title. In addition, what do you mean by seismicity rates, activity of seismic events?.

A Discussion section on the results is needed. A comment on the useful parameters and methods used. As it is indicated in conclusions information related to the frequency content and its time evolution was non relevant. Please, an explanation on this is needed. Also relate your outputs to previous results.

Pag. 14 L-7. indicate Fig. 14 a and c.

Pag. 14 L-10. SI units (?).

Pag. 14 L-13. landslides-induced events.

Pag. 14 L-14. Conclusions and outlook .

Split the content and include it in the discussion section to give it more.

Pag. 15 L-5. indicate ML-LS.

Pag. 15 L-6. Where are the mentioned displacements?

Pag. 15 L-24. Consider my previous comments on the use of the term seismicity.

Figures and Figure captions.

Figure 1. Seismic arrays Si should be presented before. Not in e) A better explanation of the colours will improve the understanding of the figure Higher and lower dynamics of what? To help the reader, indicate what 3C seismometers are. S1.1, S3.0 and S2.1 in SZ (c) and S1.1, S3.1 and S2.1 in PG (d)

Figure 2. -Show first, in a), your time series. These are your data. Indicate that is the vertical component

-a) sonogram of the vertical component. Explain the sonogram in the text and not in the legend of the figure; the same for the spectrogram.

-e) Specify amplitude spectra or PSD instead of FFT and indicate the units.

-Include the colour scales in a) and b). There is certain incongruence between the information for the sonogram and the spectrogram. I do not understand what the utility of the spectrogram is.

-The information of the spectrogram and sonogram must be the same with an appropriate scale and a correct overlap.

-Moreover, what is the role of the different filtered bandpass signals if you do not mention them in the text?

- Also, because the frequency content of the earthquake is up to 40 Hz, showing the scale up to 250 Hz is meaningless and leads to loss of information. Similar comments for figures 4 and 6.

Figure 3. What is the disposition of the seismograms? Which criteria have you follow?. Replace rectangles by bands.

Figure 4. Number columns 1-5 in each row to help the description in the text, Could you explain the difference in the frequency content of the sonogram and the spectrogram? Is there a filter between the two calculations?.

Figure 5. Indicate that the number of the stations is on the right. As regards the amplitude, note or specify that it is the absolute value. Events a) and c).

Figure 6. Consider my comments for figures 2 and 4. Indicate the distance to the sensor of the confirmed rockfall to help readers. Are the signals reproducible and repetitive? A comment on this is necessary in the text.

Figure 7. Consider my comments for figures 2 4 and 6.

Figure 8. This figure shows some of the external sources, the series is not complete and the signals depend on the cases and distances. It does not contribute anything to the paper. Remove it.

Figure 9. Consider the comments in Figure 8. Remove it. If you present these signals, you should explain their characteristics fully in the text, not just showing the plots.

Figure 11. If I understand correctly, data in a) correspond to experiments showing different amplitudes for similar distances. (e.g. squares in 40-60s in a) possible due to local effects. How do you correct the site effect in this process? An explanation is needed in the text. Replace dotted lines in the figure caption by dashed lines.

Figure 12. a) Specify that it is for regional earthquakes

Figure 13. Better to place empty symbols because grey is difficult to see. Replace the word seismicity.

Figure 14. Figure very interesting that corresponds to the results. More explanations in the text are needed. Replace the word seismicity.

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