

Dear Editor,

We thank the referees for the careful read of our manuscript and the constructive comments. As detailed below, the manuscript was modified accordingly. Furthermore, we corrected typographical mistakes and added missing panel labels in several figures.

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(on behalf of the author team)

POINT-BY-POINT REPLY

Referee #1

Referee: Title: Perhaps “Fast” is better than “Rapid”

Authors: Changed.

R: Introduction: At line 10 of page 3 (and in other points) Burtin et al. (2013) is cited but it is not present in the references.

A: The citation year in the text was wrong and should have been 2014. We corrected this.

R: 3 Seismic data: At line 15 of page 7, please substitute “and” with “while”.

A: It seems that "while" is inappropriate. We changed "and" to a semicolon and hope this makes the text clearer.

R: 4 Detection and Location Scheme The writer suggests some more explanations about the use of equation (3). The quantity VR is computed for each pixel of the grid where data is $A(i)$ and fit is the second member of equation (1) computed by varying AO and a in the range 500-1500 times the... and 0.0-0.001 respectively (r_i is the distance between the pixel and the seismometer location). The summation, Σ is carried out for the n seismometers. Did the writer understand the computation of VR ?

A: Yes, this is correct. We added these explanations.

R: Moreover, the writer suggests to anticipate that the computed source location could be not in the channel (see the following section at lines 24-25 of page 11) and the position of debris flow along the channel is determined by projecting the locations on the channel (as written at following section, line 11 of page 11).

A: Done.

R: 5 Results: Seismic Noise....: About the sentence at lines 18-19 of page 11, the reason of bias could be due to the arrival of other solid-liquid waves?

A: We feel that this should be clear from the following sentence and prefer not to change this part.

5 Debris Flow Detection....

R: Why this section and the previous one have the same numbering (5)?

A: Our mistake, we changed the numbering.

R: At line 10 of page 16, it should be Figure 13b instead of Figure 10.

A: Changed.

R: 6 Discussion: Suitability for early warning: The discussion about the influence of rainfall on the triggering mechanism is not clear and confused. The sentence at line 4 of page 18 "These observations could be explained..." is not reasonably linked to the previous period. Authors should write something like: "notwithstanding the two rainfalls are comparable because of nearly the same maximum intensity over 10 minutes (data...), occurred phenomena are different because in the case of 13th of July, previous precipitation (please write the total depth and interval time, as for the that previous the 19th of July event). Then, they can add the explanation of the effect of previous precipitation.

A: We changed the text accordingly. Unfortunately, we do not have access to the entire interval time.

Figures

R: Figure 1: please reduce the size of the triangles.

A: Done.

R: Figure 5: plot of panel c of Figure 4 and of panel b of Figure 5 should be the same but they do not seem. Moreover, the ordinate of panels a and b of Figure 5 is missing.

A: Thank you for the careful read. We added the missing axes labels ("Scaled vertical ground velocity (arb. u.)"). The time series in the respective panels of Figures 4 and 5 were filtered differently and are therefore not identical. We clarified this in both figure captions.

R: Figure 10: panels a and b are inverted in the caption.

A: Corrected (thank you for catching this).

Referee #2

Referee 2: P10, L 20 – Since Table 2 shows that your Guralp 6TD's have a frequency response from 1-100 Hz, I'm puzzled by your selection of a butterworth filter edge at 0.5 Hz. In order to keep your analysis in the linear part of the seismometer response curve, shouldn't you filter it above 1Hz? Maybe 2Hz?

A: The idea was to pick up some of the low-frequency signal, which is below the sensor's flat response, but which is more robust for our purposes, because it is less prone to attenuation.

P11, L11-22, and Figure 10 – This 10-minute detection time lag at CD24 with respect to the geophone detection is interesting and important. 10 minutes is a long time for this example. Is there a volumetric component to the discrepancy? Is the ASL method detecting something like a volumetric centroid of the flow? If so, and if the flow front is just an un-energetic watery flow it is still a useful detection for hazard mitigation.

Following this theme, if a public alarm is to be disseminated as soon as possible, one would surely use the detection at or around CD1, where the discrepancy between the two systems is not great.

A: Thank you for these suggestions, which make the point more clearly. We changed the text at this part and in the later early warning discussion accordingly.

R: Figure 10, Section 5.3 – It seems possible that the lack of success using ASL to detect short-lived rock falls using short time windows may not be a good reason to avoid them for debris flows. For example, Kumagai et al (2009) used a 5-second window. Why the difference? It appears that your results using a 30-second window were similar to the 100-second window. Did you try a shorter window? Can you discuss that a little more?

A: This is a very good point, which we had overlooked. At this point, we can only speculate that this has to do with the pulse-like character of the rock-fall signals. A brief discussion is now included.

R: P8, L15-20, and Figure 6- it's not clear but it looks like a typo may have been made (station IGB3?). IGB09 does not have a very high amplitude, despite P8, L16.

A: IGB09 does have high amplitude, however, this is not apparent in Figure 6a, because amplitudes are normalized. We now point this out in the text.