

## ***Interactive comment on “Analysis of the ground vibration produced by debris flows and other torrential processes at the Rebaixader monitoring site (Central Pyrenees, Spain)” by C. Abancó et al.***

**O. Navratil (Referee)**

navratiloldrich@gmail.com

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Comments on the paper “Analysis of the ground vibration produced by debris flows and other torrential processes at the Rebaixader monitoring site (Central Pyrenees, Spain)” by C. Abancó, M. Hürlimann, and J. Moya

This paper aims to analyse the ground vibration produced by debris flows, floods and rock-falls in a small torrent in Central Pyrenees, Spain. The authors first propose a methodology to discriminate the torrential processes based on an analysis of the geophones signals installed along the torrent with different configurations. Next they pro-

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vide an analysis and they give advises about the geophones location along the torrent, the mounting structure and the influence of these field parameters on the geophone output signal. Finally, they propose to analyse the potentiality of the use of this signal for debris flow detection and warning purpose with a sensitivity analysis of the field condition and signal processing.

The paper presents significant field works with many measurements and original analyses. The results and advises provided by the authors should be useful for other research teams and practitioners. But several scientific points need to be clarified (see my general comments) and there are too many language approximations, so I would recommend the publication of the paper in NHESS after major revisions.

General comments: (1) The abstract is not clear for me: too many language approximations. More details and results are needed; (2) P394, L20 to P4395, L8: You mentioned that the factors that influenced the transfer of the ground vibration to the geophones are: (1) the distance to the channel, (2) the materiel in the channel/banks and (3) the mounting structure of the geophone (in the soil, on the bedrock...). Does the water content in the channel and the banks (and its evolution during the rainfall event) could also influence this transfer function? What are the influences of all these factors on the signal amplitude and frequency? Could you please provide more references and state of the art with the “debris flow” literature but also “seismic” literature? (3) P4996, L9: please provide more information about the climate (rainfall mm/yrs, mean max-min T°C), location of raingauges in the basin and rainfall events (mean, max intensities duration...), snow cover... (4) P4397 L2: you provide no information about the material used except the geophones and the datalogger; what about the video camera, ultrasonic sensor... (5) In the same way no information or methodology is given for the analysis of hydrograph you show us at Table 2; (6) It would be also useful to show pictures (maybe at Fig 4) of the debris flow events, debris flood and rock fall (if you have) as it is your “reference” method with field observation to discriminate the torrential processes; (7) Construction of the paper: could you compile all your “method” sections

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(3.2, 4.1 and 5.1) into a single one in 3.2; it would simplify the reading of the paper. In the same way you can compile all your results in a same section (section 4). In a discussion section (sec. 5) you could give your analysis about the debris flow detection and the limits of such system; (8) Why don't you present first the "high frequency" signal analysis and next the "simplified" signal analysis? I think it would be more logical; (9) P4399 L22 to 4400 L2: This paragraph should be in the section : analysis of "debris flow detection 6.3" rather than here.; (10) 6.2 and 6.3 are methodological issues; could you show them before the signal analysis in a first result's section; (11) P4402 L9: Fig 6 is too small to identify all the phases presented in the following section; please remove this section or provide a new figure; A frequency analysis would also be very interesting ;is there a change in the frequency during all these phases; at phase 2, can you identify different surges ? Is there a specific signature (amplitude/frequency) of the hyper-concentrated flows that generally follows the main debris front? (12) P4405 L21: you need to conclude; is the amplification of the metal box a problem or not? Is it only an amplification of the signal or can you also find a modification of the structure of the signal and its frequency? (13) To discriminate the processes why don't you use a frequency analysis (Fourrier analysis, wavelet...) on the raw output signals of the geophones? (14) Fig 6a and c: on the geophone signal we can identify different surges, but on the stage signal (US device), there is only one front and next the signal remains constant: is it a problem of the US device (common with such device when used with debris flow) or can you find a physical explanation? Provide details in the text. (15) You wrote that Fig6b corresponds to a debris flow but the stage time series would rather correspond to a flood as no front can be identified; please clarify; (16) Fig 6c shows a problem with the US device; the "y axis" scales are different between the figures; (17) P4406 L17 to the end of the section: it is very difficult to follow you in this section because there are so many similar abbreviates: EMth IMP, EMthdur, GVth, Dth, maxEMthIMP/s, max over EMthIMP/sec, IMP/s, EMth (18) With an alarm system do you need to have so many parameters and thresholds (amplitude and duration)? Is it possible to simplify the system? (19) At fig 9, for "y axis", is it "max EMthIM/sec" or

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"EMthdur" ?; It is also difficult to understand these figures;please clarify and simplify; (20) For this analysis, you have the raw data, so you can lead the following sensitive analysis: how many false alarms would you obtain with different systems and signal thresholds?

Minor comments: - Title: I would replace "produced" by "generated" - P4390, L3: not uncertainties. Rather "approximation" or "ambiguity". . . - L7: replace "time series" by "geophone signal output"; - L8: what do you mean by "identify events"?; - L8: provide examples, too ambiguous: "different types of torrential processes"; - L9: How many events did you observed? What is the duration of the monitoring?; - L10: What do you mean by not "registered"? "Recorded" would be better; - L10: the signals are not recorded by the geophone but by the datalogger; - L11: what does "the assembly of the geophone" mean? - L19: "the data collected by the sensor": language approximation; - L23: Please do not provide the url <http://www.....> in the text but you should add a reference; - L25: Why "Besides debris flow"? - P. 4392 L5: Why "historically"? - L22: language approximation: not "seismic data recorded" but "seismic signal recorded"; - P. 4393 L23-26: please simplify this sentence; it's not easy to understand; - L26: I invite you to read our paper which deals with this question : High-frequency monitoring of debris-flow propagation along the Réal Torrent, Southern French Prealps, Navratil et al. 2013, DOI:10.1016/j.geomorph.2013.06.017 Geomorphology; - P4394 L2: replace "certain" by "fixed" - L6: "record the signal" not the data; - L8: references are missing; - L10: problem with the syntax of this sentence; - L11: "hydrograph" or water level time serie?; - P4395 L15: please replace "registered" by "recorded"; - L18: replace "extension" by "basin area"; idem at L22; - L20: define a.s.l.; - L19: "located in", not "at"; - Fig 1: the instrumentation site is not clear: please provide a third and large figure at the local scale with the instrumentation deployed and the geophones' location; - P4396, L3: The geology of the source "area", not zone; - P4396 L16 to 19: the distinction between those two stations is not clear for me; - P4397 L13: you should explain again that FLOW-SPI is a high frequency acquisition system; what is the frequency acquisition ? idem for FLOW-WR; acronyms are not very explicit; - P4398 and next: you use the

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term “Ground velocity signal”; I suggest you to replace it by “Ground Vibration Signal” that may be more explicit? - L3: I think that this signal preprocessing is not new, so please provide references; - P4402 L22-L24: repetition: please remove “. . .and are about 100 times. . .debris flood.”; - P4403 L17: I don’t understand the first sentence, please modify it; - P4404, L5: Please provide a comparison of your results with the literature; - L14: the title is not explicit; - L19: “channel margin” or “banks”; - Fig2d : we cannot see the geophone location; - Fig 8: please recall the mounting condition of each geophone on each fig: metal box, bed rock, distance. . .

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