Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2018-377-RC2, 2019

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Co-detection of micro seismic activity as early warning of gravitational slope failure" *by* Jérome Faillettaz et al.

Anonymous Referee #2

Received and published: 21 February 2019

General comments

The manuscript describes the use of a geophone array to measure low-frequency stress waves (micro-seismic) on slopes with the aim of interpreting mechanisms, behaviours and stability. Measurements are presented for a 2-month period taken from a study site located in the Matter Valley, Switzerland.

The contribution in the manuscript, above previously published work by the authors (e.g. Faillettaz et al. 2016), appears to be in the acquisition and presentation of the field measurements. Faillettaz, J., Or, D., & Reiweger, I. (2016). Codetection of acoustic emissions during failure of heterogeneous media: New perspectives for natural hazard early warning. Geophysical Research Letters, 43(3), 1075-1083.

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Discussion paper

The analysis and presentation of the micro-seismic data (e.g. multiple detection thresholds, joint time-frequency analysis) is rigorous and of high quality.

The reviewer's main concerns relate the authors interpretation of the slope mechanisms and behaviour, which consequently means revisions to the interpretation of seismic data are required. The terms 'exogenous failure' and 'endogenous failure' are not appropriate in the context of slope stability. All discussion and interpretation of slope behaviour should be set within the scientific literature on the topic, using well-established terminology and understanding. For example, there is currently no reference to pore pressures, mobilised shearing resistance, effective stress, applied shear stress, etc. Much of the analysis is underpinned by an assumption that micro-seismic signatures generated by 'exogenous' means should be different to 'endogenous' means; however, this is not appropriately justified and linked to physical understanding. The authors categorise rainfall as 'external forcing' (exogenous failure); however, infiltration of rainfall causes elevated pore pressures, which reduces effective stress and hence shearing resistance – this is what causes a reduction in stability and the slope to move.

In addition to the above comments, the paper needs a subsection on background/environmental/extraneous noise. The geophones monitor low frequencies («1kHz) and hence measurements will constantly be contaminated by noise. Why are the authors confident that what they are measuring is in fact slope movements (or precurser deformations)? This needs to be clearly explained. Statements are included about the geophones being covered by 'large stones' but this is not sufficient justification to exclude noise as a potential source. The only independent measurements presented to compare with the micro-seismic records are daily surface GPS measurements and periodic photographs: neither of these allow micro-seismic events to be conclusively attributed to slope movements (or pre-curser deformations).

Specific comments/questions

Abstract: The system is claimed to be low-cost, robust and autonomous. However, as stated in the conclusions, this is an area for future work. These claims should therefore be removed from the abstract as they are not a contribution of this paper.

Page 3: The measurement system should be explained in sufficient detail for readers to be able to replicate the work. For example, what pre-amplifiers were used, what gain settings, was filtering applied to the measurements?

Page 12, line 2: 'water lubricates. . .'. As stated above, water elevates pore pressures which reduces shearing resistance.

Page 12, lines 15 to 19: "analysing the spatial distribution of the sensors detecting this precursory seismic activity provides a rough estimate of the location of the potentially unstable zone" – This has not been addressed sufficiently in the manuscript; for example, no discussion has been included regarding the variable/heterogeneous nature of the subsurface and hence parameters needed for estimating wave propagation, e.g. Young's modulus, Poisson's ratio, density, are highly uncertain.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2018-377, 2018.