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Discussions

Interactive comment on "Monitoring and prediction in Early Warning Systems (EWS) for rapid mass movements" *by* M. Stähli et al.

Anonymous Referee #2

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General comments The ms presents an interesting review paper on Early Warning Systems (EWS) for different types of rapid mass movements (RMM). The paper tackles a relevant question, which definitively is within the scope of NHESS, and which is not very common in scientific literature. Thus, I strongly recommend a publication after revision.

There are three major critiques that should be taken into account revising the ms: 1) The structure and contents of some sections may be improved. The first part of the ms (section 1, 2 and 3) has a clear structure and focusses on the description of EWS and on the explanation of existing limitations. The second part is more difficult to read and there is no real connection with the statements highlighted in the first part (especially with the limitations). Some of the Sections (e.g. 4.2 and 4.3) are really specific and

might not be necessary in a review paper. In conclusion, the second part should be reorganized and partly rewritten.

2) In the present version, the work is mostly focussed on Switzerland and references to worldwide EWS and recent innovations outside of Switzerland are rarely included. In my opinion, there are two options to resolve this problem:

a) the authors decide that the review is only focussing on Switzerland. Then, this should be included in the title. I would also encourage to describe in detail one or two Swiss EWS for each type of RMM.

b) The authors decide to write a worldwide review. Then, the references of non-Swiss EWS included in Fig. 1 should be summarised in the text and compared with the Swiss ones; for example, to get global limitations of EWS. Regardless of selecting option a) or b), I strongly animate to summarise the existing EWS in a Table (including: type of RMM, type of EWS, location, institution in charge, parameters implemented, sensor/techniques used etc.). Such a Table would really help to have a complete overview of the present state of the art.

3) The authors should define at the beginning of the ms the different types of RMM dealing with in this review. In the present version, there are some kind of lists of RMM in P5L19-20 and P15L10-11, but the examples presented in the review principally focus on snow avalanches, debris flows and shallow slides. Indeed, many sections of part 2 of the ms deal with specific research on the failure mechanisms of shallow slides, although such shallow slides may not transform into RMM. This point should definitively be clarified by the authors.

Specific comments:

i) An alarm system is defined as one type of EWS. However, as written in the ms, an alarm system detects an ongoing hazard, which may contradict EARLY warning.

ii) Sometimes there is a bit confusion about the meaning of the terms "alarm", "warn-

ing", "alert", "level of danger" or "hazard level".

iii) One of the limitations states that EWS focus on simple thresholds, but then no real "solution" is proposed in the following sections of the ms. Probabilistic approaches would be an elegant way to overcome this limitation (see recent publications on rainfall thresholds. e.g. Berti et al. "Implementation of a Probabilistic Model of Landslide Occurrence on a Civil Protection Alert System at Regional Scale" presented at IAEG2014).

iv) Before describing satellite derived precipitation products (P9L1), I would introduce the possibilities of rainfall radars. There are many examples of this techniques implemented in EWS.

v) Uncertainty analysis (P9L21). Probabilistic approaches would reduce uncertainty. See comment above.

vi) Sections 4.2 and 4.3 describe very interesting research outcomes, but maybe these topics are too specific. Some results were only obtained in lab or specific field tests and thus not easily to implement in a EWS.

vii) Section 4.4 maybe divided into 2 sections: first, the seismic monitoring and then the GB-SAR monitoring

viii) P15L21: I'm not sure that we can call the current EWS "well-established", since there are still many limitations to overcome.

ix) Sections 5 and 6 (first 4 paragraphs) may be merged and better connected with section 3, where the limitations are exposed. The second part of section 6 describing a novel EWS for shallow slides maybe not necessary, due to the reason stated above: many shallow slides do not transform into RMM. In addition, the authors state that better soil information is a main challenge for future EWS (P16), while in the novel EWS presented (P18/19) exactly this information is strongly needed for a correct implementation. I would prefer a description of one or more novel / existing EWS for other RMM

like snow avalanches, debris flows or rock falls.

x) Table 1 must be improved. See general comment.

Technical corrections:

P4L11: Sättele not Saettele

P4L23: ". . .state-of-the-art of the technical part of EWS". The term "technical" may be not appropriate. I propose to use "scientific and technical".