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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "The Norwegian forecasting and warning service for rainfall- and snowmelt-induced landslides" *by* Ingeborg K. Krøgli et al.

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We inform that we have read the feedbacks and comments provided by the two reviewers and we would like to thank them for their careful review and their valuable comments. We have appreciated all the comments and suggestions provided. We agree with the comments. We consider them very constructive and useful to improve the quality of the manuscript. We will try to address all suggestions preparing a new version of the manuscript. Our replies to general and specific comments of Reviewers #1.

Anonymous Referee #1

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General comment / remark:

The paper "The Norwegian forecasting and warning service for rainfall and snowmelt-induced landslides" deals with the geo-hydrological EWS in use in Norway and encompasses a detail description of its functioning. The organization of the paper is good and the manuscript itself is well-structured with meaningful images and tables. The paper is quite long and therefore I suggest at least to remove section 3.1, which is interesting but not necessarily relevant for the NHESS audience. If so, you can write the joint composition of the service in the introduction, since you mention it in the abstract.

Respond: We thank Referee #1 for these feedbacks and comments. We agree that the manuscript is quite long, and we see now that section 3.1 is not very relevant for most of NHESS's readers. We will try to include just the essential information from section 3.1 in the introduction, and then remove the whole section 3.1.

On the other hand, the authors touch some very interesting topics but do not delve into them. I recommend furnishing some explanations concerning the following important points:

The communication chain 1) First, I recommend adding a chart describing the "communication chain", ie to show all the passages from the moment data are acquired and a forecast is made to the final recipients (the population). Also, who is responsible for the communication to the citizen? The mayor?

R: Thank you for this comment. We see now that this topic is not enlightened well enough. In Norway, the County have the responsibility to forward the warnings to the mayors and/or contingency responsible of the different municipalities, especially for the two highest levels, orange and red. However, in 2017, we gave everyone the possibility to subscribe and now the mayor also has the possibility to receive directly warning messages, therefore the communication chain has changed. A chart that describes the chain of communication of the warning bulletins will be very useful for the readers. We will include it in the manuscript. We will also explain who is responsible to inform

the citizens that a landslide warning is issued for their municipality.

How do you reach the population? 2) How do you reach the population? Only by voluntary subscription to SMS and email? Is there a TV or radio broadcast? Sirens or cars passing by and giving the alarm? Automatic SMSs to the people in a certain area (even to people who did not subscribed to the notification system and even tourists that do not live in the area)? Smartphone apps? If none of these methods are used, how can you reach a significant percentage of the population with your warnings?

R: Thank you for this comment. We understand that the subject concerning communication to the public/citizens is interesting for the readers. We use several communication platforms to reach the population. We will give some greater knowledge of this in the manuscript.

An example of a bulletin 3) I recommend adding an example (probably as a new figure) of a bulletin that you send to the population and/or to the local administrations. Is there an intermediation of the local administrations? If so, when you communicate an alert, do you use the same language for both administrations and population or is the communication to the administration more technical and to the population simpler?

R: Our bulletins are published at the web portal www.varsom.no, and the local administrations and others that subscribe to the notification system gets an e-mail or SMS with a short message that let them know it is a warning issued and with an URL directly to the relevant warning bulletin on www.varsom.no. We only write one version of the bulletin, in the same language. We strive to keep the language simple enough for the public, but at the same time sufficient for the local administrations/alarm personnel. Since the warnings are regional, there is not very detailed technical information provided in the bulletin. We recommend the public and the emergency authorities to make local assessment and decide the measures most appropriate, but the warning service is available for consulting by phone or e-mail. The bulletins are in Norwegian, but an English version was launched in January 2018. We will add an example of a bulletin in

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the manuscript. Thank you for this comment.

False and missed alarms 4) It seems that your yellow alert is not very conservative. Some Countries have a similar system, but yellow alerts are issued as many as 100-150 times every year, thus creating obvious false alarms issues. Do you have false alarms problems or maybe the opposite (missed alarms)? How do you cope with false or missed alarms?

R: False or missed alarms is of course an issue also for the Norwegian early warning system. Our system is an expert knowledge centred-system. The expert analysed daily the thresholds and decide which warning level to send. We experienced short time after we were operational, that the threshold values for the yellow alert in some areas were too sensitive. This occurred especially in some regions or in summer with short and intense rain due to their spatial and quantitative uncertainty. In addition, because of our lack of experience, we relied too much on our thresholds. The result were too many false alarms. In the last two years we have adjusted the threshold values for two regions in Norway (The South of Norway; the area of case study in the manuscript, and the Eastern of Norway). The new and improved thresholds, together with the acquired warning experience, allow us to reduce the number of false alarms. In addition, we have lately improved the cooperation with the Met Office in Norway, working together in the preparation of prediction tools for flash floods and landslides due to heavy and intense rainfall (like thunderstorms) in summer. The Met Office issue a warning on heavy and intense rain and local flash flood and/or landslide hazard in cooperation with NVE. The results of this collaboration were concretely observed last summer when the number of false alarms was notably reduced.

Thank you for the useful remark. We will add some information on missed and false alarms and the accuracy of the forecasting service in the manuscript. Referee #2 has also commented on this.

Language The language is generally good although there are ubiquitous errors es-

pecially concerning singular and plural forms. I have corrected the text when I spotted them but, since I probably missed some of them, all the authors should carefully re-read all the paper paying particular attention to this issue. These and other recommendations are listed below:

Table 1: in the warning box change “allow” into “allows”. Page 3, line 4: replace the semicolon with a comma. Page 3 line 24: replace hazards with hazard and years with year. P3 l26: replace dike with dikes. P3 l28: add “it” after “that”. P3 l29: replace options with option. P4 l20: replace lies with lie. Also add “are” before “to be found”. P4 l28: replace fall with falls and freezes with freeze. P4 l29: add “the” before “decrease” and “increase”. Also, add the final “s” to “contribute” and “river”. P4 l30: replace rises with rise. P4 l32: replace includes with include. P5 l2: remove “s” from “frequents”. P5 l7: “gives” P5 l7: replace “the north of” with “Northern” for similarity to “Western” used before. P5 l9: please explain ice jams in the text. P5 l18: “loose” not “loos”. P6 l6: lives P6 l21: replace mill with million and add in brackets the equivalent in USD. P6 l22: numbers P6 l 32: operates Section 3.1 is interesting but not necessary relevant for the NHESS audience. Consider removing it. If so, you can write the joint composition of the service in the introduction, since you mention it in the abstract. P7 l27: needs P7 l28: define 8, 2: uses 8, 2-6: the authors should provide references fort these models and/or furnish a brief explanation. 8, 19: runs 8, 23: add “the” before “parametrisation”. 9, 14: when does the inventory date back to? 9, 30: today’s instead of todays. 9, 28 – 10, 2: this part is not clear. Please explain better. 10, 24: landslides 11, 15: delete “in”. 12, 7: flood forecasters 12, 8: leads 12, 13: if you state that forecasters are always available one would think of a 24h availability. So remove “always”. 12, 15: “Forecasters, when on duty” 12, 31: “twice a day” 13, 5: are available 13, 11: you talk here about orange and red levels, but the reader still does not know what they are. Also, here you explain who forwards the message to whom. I recommend adding a table showing the complete chain of communication from those who provide data and forecasts to the citizen. 13, 14: please furnish an explanation of what CAP is. 15, 4: consists Table 2: change “infrastructure” into “infrastructures” in the red level box. 17,

8: implies 17, 16: relies 17: 18: warns 17, 20-22: this sentence is not clear. Please rephrase. 18, 1: the first “How” should not be written in lower case. 18, 2-4: here I suggest inserting a contingency table with the number of events predicted and occurred (true positive), predicted but that eventually did not occur (false negative), unpredicted and not occurred (true negative) and unpredicted but occurred (false positive). 18, 22. Add a full-stop before “Results” and change “shows” with “show” and “consider” with “considers” (in the latter case the subject is “majority”, which is singular). 18, 26: replace “conducted”” with “carry out”. 19, 2: includes 24, 22: identifies 26, 17: replace “if” with “by” 27, 11: remove both commas from this line.

R: Thank you very much, Referee #1, for the careful review of the language in the text. We will correct the errors, read carefully through the text again, and improve the language. In addition, we will answer the other questions you raise here, like when to the landslide database date back.

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