

Response from the authors to the comments by referee Ivan Vergara.

GENERAL COMMENTS:

The manuscript "Groundwater fluctuations during a debris flow event in Western Norway – triggered by rain and snowmelt" analyses the behaviour of the groundwater level during the occurrence of a debris flow and compares it with the behaviour during other extreme events and with the typical groundwater situation. It is considered that the research is novel because the analysis of these data is not common and the results are very important for the study of shallow landslides by allowing to know the situation of the ground before, during and after the failure. Moreover, the manuscript is well written and has fine and clear figures. Then are some comments that could improve understanding of the work.

We appreciate that you find our paper well written with fine and clear figures, and also that you have provided many suggestions, listed below, that will improve our paper. We will comments on each of them below.

SPECIFIC COMMENTS:

L19-20. Saying that Storm Dagmar did not generate debris flows without giving the reason does not provide much information to the reader. I think the sentence is missing a conclusion.

The sentence gives the reader the important information that in spite of a very similar groundwater situation, a debris flow or slide was not triggered during the storm Dagmar. Unfortunately, we do not know the reason for that and cannot give it. In the discussion section of the paper we discuss this, but are not able to come up with a specific explanation.

L82-87. It would be useful to describe somewhere in the manuscript (perhaps here) some other important characteristic of the study area... E.g., Mean annual precipitation, climate, vegetation.

Yes, we will do so; add a few sentences that will describe the vegetation and climate in the area.

L234-237. I don't understand the relationship between this sentence and Fig. 6. On the other hand, I do not understand the arguments to infer that the peak occurred before 23 o'clock... If the intensity of the rain and the air temperature did not change, it would not be explained either because the groundwater reached the peak between 8:30 p.m. and 9:30 p.m. and then it started to decrease.

Sorry, there is a type error here in our text, it should not say "see Fig. 6" in our text, but it should be "see Fig. 8."

L237-238. In Fig. 8 this extrapolation is not plotted... It is important to plot it.

Yes, we agree, good idea. We will plot the extrapolation in Fig. 8.

L269-272. Is there any hypothesis why this event did not generate landslides? There is some information throughout the manuscript that could explain the non-occurrence and it could be useful to comment on them in the same paragraph (e.g., the 2013 peak could have been greater, the distance between where the debris flow is triggered and where the groundwater is measured, artesian conditions).

Yes, we agree. We will give some ideas here to why there were no landslides triggered during the storm Dagmar.

TECHNICAL CORRECTIONS:

L14-16. I think it should talk about precipitation and not rain, considering that until 3:00 p.m. the precipitation fell in a solid state; and only if it is possible (considering that in the Abstract each word counts) to clarify that a fraction of the melted snow came from the same event of precipitation.

Yes, agree. We will change from "rain" to "precipitation" – and also clarify in the abstract that some of the melted snow came from the same event.

L38-39. "The mean(?) maximum rainfall intensity was 80–100 mm in 24 hours, locally up to 129 mm." Currently the sentence is contradictory to me.

Yes, we see that this phrasing is not good and we will rephrase it.

L39. "Most of the landslides were debris slides and flows" is clearer. Slide is a type of movement of landslides (Hung et al. 2014) and using it as a synonym for Landslide can be confusing. . . The comment applies to the whole text.

Yes, we will replace the word "slides" to "landslides".

L41-42. In order not to use the word "slide" and not repeat "landslide" it could be said something like this: "The number of mass movements makes this one of the largest landslide events in Norway during. . ."

Yes, we agree, we will use the word "mass movements".

L44-47. Many people are unfamiliar with Jan Mayen Island. With Fig. 3 it is clearer what its position should be, but it could be clarified in the text at least that it is an island.

Thanks for pointing this out. Instead of relating the location of the low atmospheric pressure to the island Jan Mayen, we will refer to Iceland, most people are familiar with the location of Iceland. We will change our text to (changes in red text and strikethrough):

“The pressure configuration, with a very low-pressure system northeast of ~~Jan Mayen~~ Iceland and a high-pressure center southwest of the UK, generated a strong north-south pressure gradient and induced a southwesterly flow of moist warm air towards western Norway (Fig. 3).”

L92. Is it necessary to clarify the brand?

Maybe not. It is important to give information about the equipment used here in the method section. We do not think it is a necessary to mention the brand of the data logger we used, but it does not hurt to mention it either. Our sentence is: *The data logger, a mini-diver (DI 501) manufactured by Van Essen instruments, was attached to a wire and inserted into the pipe.*

L160. I understand that it is explained below but I don't think it is convenient to describe the shape ("much sharper") and not describe the difference in amplitude. I think it is better to either describe the two characteristics at the moment or just mention that they have different characteristics and then detail them in the following sentences.

We agree. We will change to:

“The peaks and troughs of the oscillations occur simultaneously upslope and in the valley bottom (piezometer at the weather station), but the peaks upslope are much sharper and have higher vary in amplitudes (Fig. 7).”

L168. Perhaps a more technical term than "the big picture" can be used... Such as "the typical/mean annual cycle".

Yes, we agree.

L252-253. Do you define peak duration as the time the groundwater was less than 50 cm from the ground? I think it is important to clarify.

Yes, we agree – this is important to clarify, and we will do so in the revised manuscript.

L261-263. It may be helpful for the reader to indicate the date May 26 in Fig. 6.

Yes, good idea. We will indicate May 26 in Fig. 6.

Figure 1. Snow avalanches are not landslides and it is better to use the full terms. . . Landslide instead of slide and rockfall instead of rock.

Yes, we agree. We will change the legend in Fig. 1.

Figure 1. A minor issue in the legend: the precipitation is a continuous number. This

should also be reflected in the legend. Better write: 0-30; >30-60; >60-90;. . . etc.

Yes, we agree.

Caption Figure 1. "114 debris flows and slides".

Yes, we agree. We will change from "114 debris flows, slides,...." to "114 debris flows and slides" – as suggested.

Figure 2. To respect the structure: "Photo: Jan Helge Aalbu on 16 November 2013."

Yes, we will change so the structure is the same.

Figure 4. Try to improve the sentence so as not to repeat "aerial photo". One possibility is: "Map and aerial photo from 2018 of the site near Anestølen. A. The contour interval is 100 m. B. The eastern slope is prone to. . ."

Good idea. We will change it as suggested. Instead of "solid rocks" say "rocks".

Figure 5B. It is not necessary to clarify that the rocks are solid.

Agree – we will change this in Figure 5B.