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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Roads at risk – traffic detours from debris flows in southern Norway" *by* N. K. Meyer et al.

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Final comments from the authors

We like to thank both reviewers for their positive and constructive comments on our manuscript. Your comments and suggestions regarding figures and additional references will be included in a revised version of the manuscript. As requested by the reviewers, we will provide more details about how event landslide inventories were generated and how trigger frequencies were derived. Please note, however, that we kept this part as concise as possible since this work has already been published in Meyer et al. 2012 and Meyer et al. 2014

Reviewer #1 and #2 requested clarification about the appropriateness of aggregating

data to the first order catchment scale. The median area of 1st order catchment is 8.5 kmˆ2. We aggregated landslide susceptibility data to this scale since we found it the optimal trade-off between the map scale at which our calculations are computationally feasible and the map scale that is sufficiently large to describe the physical controls on debris flow initiation and to be relevant for road authorities.

Reviewer #1 mentioned that it is not intuitive to calculate excess distance before considering the likelihood of failure, in particular from an operational perspective. We agree with reviewer #1. From an operational perspective, calculating alternative routes and excess distances following a road-blocking debris flow is more appropriate to provide site specific information. However, among our aims and part of our work flow (Fig. 4) was the characterization of excess distances of Norway's road network which required calculating the distances for all road links (Fig. 2d). Yet, we will update Fig. 4 and visualize our work flow in a way that makes it more accessible from an operational perspective.

Reviewer #1 proposed to convert the costs of vehicle km to primary fuel costs since the monetary or economic value is more useful and accessible for decision makers. As reviewer #1 mentioned, we refrained from using this metric owing to fluctuations in fuel prices. We will, however, emphasize this point more in the revised version of the manuscript. Reviewer #1 is critical with the assumption that debris flows in our 1st order catchment actually have sufficiently far runout distance to reach the road. We admit that this is a simplifying assumption, yet, as we have stated on page 6631, lines 14ff our database only includes debris flows that have impacted on the road network. Hence, we are rather confident that violations to our assumption do not strongly impact on the conclusions of this study.

Reviewer #1 mentions an important issue related to the interaction of road building and debris flow susceptibility. We have not explicitly included roads as additional factors for debris flow initiation in our susceptibility map (Meyer et al., 2014). As aforementioned, this was not possible and required in our case, since our database only includes debris

flows that hit the road network. Investigating the feedback mechanisms between road building and debris flow would require us to have a database on debris flow occurrence distant from roads, which is not available for this region at similar quality to our knowledge.

Reviewer #1 and Reviewer #2 both asked for a more detailed explanation for the mismatch between observed failure rate and the computed values. Besides the short data coverage the generalization of the debris flow susceptibility to the order of 1st order catchments averages out higher failure probabilities in the more frequently affected debris flow channels. This may thus add to the differences in observed and computes values. We will consider this idea in the general discussion in section 5 in the revised version of the manuscript.

With kind regards, Nele Kristin Meyer on behalf of all coauthors

References

Meyer, N.K., Dyrrdal, A. V., Frauenfelder, R., Etzelmüller, B., and Nadim, F.: Hydrometeorological threshold conditions for debris flow initiation in Norway, Nat. Hazards Earth Syst. Sci., 12, 3059-3073, doi:10.5194/nhess-12-3059-2012, 2012.

Meyer, N.K., Schwanghart, W., Korup, O., Romstad, B., Etzelmüller, B. (2014): Estimating the topographic predictability of debris flows. Geomorphology, 207, 114-125. [DOI: 10.1016/j.geomorph.2013.10.030]

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