Reply to RC1 (Stefan Hergarten) "Comment on egusphere-2023-1190" by Mauro Fischer et al.

In *italic*: Stefan Hergarten's comments

In blue normal font: our replies

This paper provides a hazard assessment with regard to debris flows for a small catchment in the Alps. The results are finally obtained from simulations with the debris flow version of the model RAMMS. Focus is on simulating different scenarios, defined by different amounts of precipitation and available sediment.

The manuscript is very long. I often had the feeling that it reads like a thesis rather than like a scientific paper. I guess that it is indeed a shortened version of the M.Sc.-thesis of the third author (Reto Aeschbacher). I am quite sure that the thesis was excellent and that the supervisors were delighted about it. But on the other hand, it is not concise and not to the point. Each step is expanded in great detail, which is fine in a thesis, but not in a scientific paper.

Thank you very much for your comment. We generally agree with the reviewer here and will shorten the manuscript and develop a clearer structure to highlight the crucial parts of the research. The first submitted version of our manuscript has somewhat "guidelines" character and is therefore very long. Our rationale here was to provide researchers and practitioners a workflow with detailed description of important procedures one has to work through for debris flow scenario building and numerical runout modelling, especially for pro-/periglacial catchments with inexistent or scarce past event data. To our knowledge, for pro-/periglacial debris flows triggered by precipitation dependent events, such comprehensible/understandable procedures have so far been lacking (thus the added value of our research). We kept a lot of details in the first version of our manuscript because, from our experience, important steps are often missing or unclear in existing literature on debris flow scenario building and numerical runout modelling in general, and do, to our knowledge, not exist yet in a comprehensive manner for pro-/periglacial catchments. Nevertheless, we will shorten the manuscript wherever possible and provide references for individual working steps. Where we cannot provide references to some of the details/steps in the proposed workflow, we will leave relevant additions/descriptions in the text (but as brief as possible).

As a main point, however, I feel that the results are a bit trivial. If there is more rainfall and more sediment available, the debris flow will be faster and reach a longer runout. And if we separate one big event into two smaller subsequent events, the debris flow will be weaker. For practical purposes (planning etc.), it is undoubtedly useful to have such scenarios available. For an operational application, however, the

effort seems to be quite high and the uncertainties are also high.

We think that the assumption “more rain and more sediment leads to a faster debris flow with longer runout” could be a hypothesis that needs to be tested, however, due to non-linearity, interactions and feedbacks and changing conditions along the flow path, in our opinion this is much too simplified for the behaviour of high mountain pro-/periglacial catchments. Moreover, scenario building is very important for scientific research proposals and practical purposes of disaster risk management. As stated above, for pro-/periglacial debris flows, comprehensible/understandable procedures for both scenario building and numerical runout modelling have so far been lacking (thus the added value of our research). Our proposed approach could be one step towards closing of this knowledge gap, but of course would need to be tested and further developed.

We are willing to focus on the doubts highlighted by reviewer 1 here and try to address them. However, “NHESS serves a wide and diverse community of research scientists, practitioners, and decision makers concerned with detection of natural hazards, monitoring and modelling, vulnerability and risk assessment, and the design and implementation of mitigation and adaptation strategies, including economical, societal, and educational aspects.” Thus, the scope of the journal is different from those of, for instance, ESurf or Geomorphology. In our opinion, we do consider main challenges the addressed community is confronted with, even if the manuscript is not taking up the scientific cutting edge on research for geomorphological processes. As mentioned above, we also think that exactly this kind of paper with this practical and precisely described step-by-step procedure is often missing, bringing together real live problems with propositions for a procedure and real solutions. Nevertheless, we acknowledge the valuable comments of reviewer 1 and will strengthen the manuscript accordingly.

Scientifically, the interplay of precipitation and sediment availability would be the most interesting aspect of debris flows. So what defines the intensity of the debris flow finally? Under which conditions is precipitation the limiting factor and under which conditions sediment availability? Unfortunately, the results presented here are restricted to a line in this 2-D parameter space since sediment availability is assumed to be a function of precipitation. As far as I can see, a single-phase flow model such as RAMMS would not be suitable for going deeper here.

We will take up the highlighted questions to improve the quality of the manuscript, however, RAMMS is a model widely used by both scientists and practitioners. For the purposes of our manuscript, the scenario building procedures and the definition of input parameters is more important, with a focus on application to real live problems by scientists and practitioners. Thus, being aware of the limitation of each possible available model, that are the challenges we have to deal with and these models are one important basis for decision-making. And, if we cannot manage to use a simple one-phase model sensibly enough with existing data (especially for pro-

/periglacial catchments with inherently scarce to inexistent input data), how are we going to feed the more complex models (two-phase) with solid input variables? We therefore see a great need for a detailed description of an approach that has proven to deliver satisfactory results.

In sum, I am not convinced that the manuscript in its present form provides sufficient new scientific insights, in particular in relation to its length. Sorry that I cannot be more positive at this occasion since I feel that the student's work behind was really a nice piece of work.

We hope with the new version of the manuscript we can convince you that the manuscript is worth to be published. It's not just the scientific added value that counts, but also the important information for the practical application of models in the context of risk assessments. However, we are very happy to accept constructive criticism and strive to achieve a better balance between text length and scientific added value by focusing on the central points and, where possible, working with references to existing sources.

Best regards,

Stefan Hergarten

Many thanks Stefan, all the best and kind regards, Mauro Fischer and all co-authors