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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Controls on the formation of potential landslide dams and dammed lakes in the Austrian Alps" *by* Anne-Laure Argentin et al.

Anonymous Referee #1

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Anne-Laure Argentin et al. entitled "Controls on the formation of potential landslide dams and dammed lakes in the Austrian Alps", present a process-based modelling approach to envision susceptibility of landslide damming and lake formation by individually simulating the process chain from the initiation probability of landslides, landslide runout, river obstruction and damming. The concept and the methods employed by the authors are thought-provoking and progressive and this manuscript would be significant for the engineering geological and natural hazard community. The idea to conceptualise the landslide dam hazard chain through a process-based modelling is appreciable. Nevertheless, the study may still need some additional elements or factors that can be considered, warranting a minor to moderate revisions to the manuscript

to be accepted and this reviewer see the following suggestions shall be followed. Major specific comments: 1. Modelling the landslide release areas: The authors adopted a slope-based criterion following Hergarten et al. 2012 to determine the probability of landslide release areas. The authors do mention the reason for their choice "The approach proposed by Hergarten (2012) still seems to be the only model in this context which is able to predict the observed power-law distribution of rockfall and rockslide volumes". However, the performance of the model in a terrain with lithological variations need to be questioned. Different rocks would have different thresholds with regards to slope angle and stability. In addition, rockfalls possess strong sensitivity towards discontinuities. I would request the authors to perform a validation of their analysis of landslide probability. Is it possible to compare the landslide probability estimated by the Hergarten et al. 2012 to actual events of landslides within different geological units of the study area? It would be nice to see the performance of the model for past cases at first and then use it to predict the future. In addition, the overall work, stressing on the importance of the chain of hazards from landslide occurrence, runout, damming and lake formation seems a bit incomplete. The authors do quantify the probability of failure of each potentially unstable rock mass but, not provide a probabilistic assessment of the conditions that might trigger such instabilities (e.g., a return period of a triggering rainfall, a return period of a triggering earthquake). I suggest the authors to refer Fan et al. (2019) and add a line of discussion regarding the limitations of the landslide simulations and the validity of the assumption adopted in this study. 2. Landslide runout simulation: The authors adopted Voellmy rheology to model the landslide runout with variables ÉŻ = 150 m.s-2 and μ = 0.12. It is common to use such constant values for different lithologies within a large area of a numerical model. However, the same need to be justified. In general, these values are obtained through back calculation of landslide runouts using known case examples. Regarding the calibration of the models, and in particular of Gerris, the authors need to discuss the choice of their parameters. Also, the authors should discuss why they think the parameters should be the same for all the subsequent events all over the study area (e.g., why should the acceleration

remain the same? and the friction?). 3. Estimation of landslide dam geometry: It is appreciable that the author attempted to simulate the landslide dam geometry at a larger scale. Their explanation of the calculation of landslide dam volume and geometry seems simple cutting down different realities but still acceptable considering the scale of the numerical simulation. However, the limitation of the approach used in this study need to be clearly mentioned. Please refer to Hungr (2011) for more insights on a comparative study on the use of landslide runout models to predict landslide dam geometries. 4. Landslide dam characterisation: In addition to the height ratio-based characterisation of the simulated landslide dams, is it possible to identify the type of dams according to Costa and Schuster (1988); Fan et al. (2020); Hermanns et al. (2011)? The authors do mention the type of landslide dams in lines 150 using simplified planform geometry. There are also other predominant types of landslide damming based on morphology though not specific to rockfall/rockslide formed landslide dams. I would like to see some discussion regarding the preciseness of the geomorphometric parameters identified and used in this study (Table 1). 5. Dam formation and stability indices: The authors mentioned that their model cannot predict the stability of landslide dams. It is okay that the authors predict only the occurrence of landslide dam and lake formation and not the dam-breach or breach-induced flooding. However, the most significant part of this study on a hazard point of view is also to envision the relative stability of longevity of a landslide dam in the future if such events occur. On a true sense, the dam-breach and the outburst flood caused is the most threatening hazard than the landslide and damming itself. In a similar study by Fan et al. (2019), the actual dam-breach and flooding was simulated for different scenarios and the same has been compared with different empirical stability indices. I suggest the authors to refer and add some lines of expressions. I also suggest the authors to add more lines of discussion regarding the performance of stability indices. The authors do mention BI, II, DBI, Is, Ia and HDSI are inconclusive in the Eastern Alps. This also depends on the availability of data as mentioned in a previous study by Fan et al. (2020). Minor comments: 1. The authors performed a well throughout study and I appreciate their

efforts. I feel the English language presentation need improvement though myself neither a language expert or a native English speaker. 2. Since the introduction part I felt many sentences are not connected to form a nice story. The authors shall imagine the geological processes in sequence and start from the conditions of landsliding and go on write about the events until for the formation of landslide dam and lakes. This will help the readers to understand the authors are focusing on an important large-scale geological hazard chain. References cited:

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