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# *Interactive comment on* "Mapping the susceptibility of syn-eruptive rain-triggered lahars at Vulcano island (Italy) combining field characterization and numerical modelling" *by* Valérie Baumann et al.

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This is an interesting paper that tackles an archetype of a cascading hazard (rainfall-induced remobilisation of volcanic deposits) in a specific contect (Vulcano).

As a strength it deploys a wide range of analytical and modelling techniques from across volcanology and geotechnical studies to understand the likely susceptibility of the generation of rain-triggered lahars following an eruption of Vulcano. The paper is generally well written and each individual element of data is carefully described and the



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approach justified, and limitations carefully thought through. It provides some useful primary data on hydraulic conductivity and other relevant characteristics of the deposits and promises to 'provide a new innovative treatment of the cascading effect between tephra fallout and lahar susceptibility'.

The weakness in this paper comes in the integration of these elements and in considering whether there is sufficient information to consider the conclusions of the parametric analysis to be robust. I have several broader comments to make here, in the hope that addressing these might improve the integration of data and thus the robustness of the conclusions.

One thing that may particularly help with some of the issues around choices to be made with parametrisation and applicability of the system is via the inclusion of any contemporary accounts of lahar activity from the 1888 eruption. Observations of lahars (or even immediate geomorphological change) are not included in the paper (just the discussion of existing 'undisturbed' lahar deposits left on the island now). Even if the population was evacuated it may be that there are some contemporary accounts which might help to validate some of the choices you have made in terms of analytical focus and also provide something against which to measure your conclusions, and might also help with the interpretation of those deposits you have encountered. Similarly, do you have contemporary accounts of weather patterns following this eruption?

Introduction: A distinction between lahar archetypes that is more generally made is that described in Pierson et al., (2014) – which is between 'primary' and 'secondary' lahars – this more obviously has a similarity in mechanism than the examples you give. I'd suggest you would use this more commonly used typology here and throughout – it might make things less confusing. I realise that you regard these as 'syn-eruptive' but really these are secondary lahar generated via syn-eruptive rainfall? (see also lines 0-7 on p. 4).

2.1 and Figure 1. Eruptive history. To allow an evaluation of the validity of your choice in eruptive scenarios a summary figure of the last 1000 years of activity as a function of eruption size and duration would be useful (in a similar way to how you have synthesised typical rainfall in Figure 2). 2.3 Recent lahars. This and the description September 2017 lahar (p.10) are a little distracting/confusing. They describe the cumulative morphological change and the nature of flows some 120+ years after the last eruption. It would be more salient here to describe some of the observations of any laharic activity or immediate morphological changes following the 1888 eruption, as mentioned above. A critical feature here of the eruption is the extent to which 30cm of deposit is representative of different eruptive phases. If the triggering mechanism is landsliding, then different eruptive stages might supply significant mechanical discontinuity. Section 3.3 – would be easier to evaluate the 'likelihood' of the scenarios used here with a easier to read eruptive history than currently provided in 2.1 3.4 TRIGRS model. . .. This would be easier to follow to the uninitiated reader if the content of paras 2 and 3 was earlier than paragraph one. Section 4,3 modelling. I was not sure of the justification for only one rainfall scenario here. It was also not clear to me the extent to which you had evaluated the influence of deposits from differing eruptive phases (discontinuities in deposits mechanical characteristics). You do discuss in detail the influence of a fine-grained layer on the infiltration (and thus likelihood of instability controlled lahar initiation) but there are more insights available here from the experimental set upo of Jones et al., (2017) – this would point to the influence of antecedent rainfall (in generating armouring conditions for subsequent intense rainfall too) – to go with the observational record from other lahar episodes. This would suggest that the overland runoff via Hortonian flow may be significant even immediately following an eruption. This could be compared for example to observed rainfall patterns which then may help assess the likelihood of the failure mechanism you explore (whether the possibility of both means lahars are even more likely). I think the nature of this analysis such that a summary diagram, considering the interacting dimensions of tephra thickenss, antecedent and contemporaneous rainfall and hydraulic conductivity (as a function of grainsize, porosity and saturation) may be more important in 'suggesting windows' of eruptive behaviour and rainfall where lahar generation may become a significant hazard. The conclusions drawn may then be more robust as given all the caveats and unknowns I am not sure the thresholds and % you present here are fully defensible.

References Used Pierson, T.C. et al (2014) J App Volc. 3:16 Jones, R et al., (2017) Geomorphology 282:39-51

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