

Interactive comment on “Dome instability at Merapi volcano identified by drone photogrammetry and numerical modeling” by Herlan Darmawan et al.

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Reviewer: This paper investigates dome instability at Merapi after the 2010 eruption. Although I agree that this kind of study is of primary importance to better assess the related hazards associated with the future occurrence of dome-collapse events at Merapi, I would only recommend this manuscript for publication in NHESS journal after major revisions. Firstly, the language used by the authors in the text is sometimes limited and confusing. Many paragraphs are not readable and/or comprehensible, too long and repetitive, and some even lack of meaning. I have outlined some of the main issues in the attached PDF but could not pay attention to every typo, grammar, repe-

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tions, waffles and sentence structure problems. I would invite the authors to entirely revise some parts of the manuscript by taking into account the comments included in the attached PDF.

Response: We appreciate this comment and made appropriate changes. We have revised and deeply re-worked the editing and language. We checked and corrected the grammar mistakes, deleted some typos and repetitive sentences, and re-phrased or deleted confusing paragraphs in order to improve the manuscript. A native speaker was proofreading the manuscript and found further language deficiencies that could be corrected.

Reviewer: Secondly, the scientific part of the manuscript is somehow incomplete in some aspects. Although some of the issues related to dome stability are correctly described and discussed, some of the concepts presented in this paper lack of new innovative ideas.

Response: Accepted comment and changes made. We further clarified the novelties of the work. We conducted the first geomorphology, thermal and structural mapping of the southern dome at Merapi. We are able to identify sub meter fractures and quantify the structural pattern of the unbuttressed dome sector in detail. The fractures are actively degassing as identified by our thermal camera. The geomorphology, structure, and thermal datasets were then used to investigate a potential hazard using two methods, factor of safety and Titan2D. Application of the factor of safety calculation from Simmons et al (2004) and Titan2D (previously used at Merapi by Charbonnier and Gertisser (2009; 2012) we are able to evaluate the hazard arising from this unstable dome sector. We therefore think that the paper contains innovations justifying publication, which we could now further clarify in the revised version.

Reviewer: The authors should rather focused on the recent structural features that developed in the entire summit area, including the crater rim and upper part of the cone, and not only the post-2010 lava dome.

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Response : Accepted comment and changes made. We re-analyzed the geomorphology, structures, thermal distribution and alteration area at the summit of Merapi. We also re-calculated the factor of safety for the south and the west flanks, which are progressively altered and thus experience structural instability in the near future.

I think the recent 2018 explosive events should be taken into account, especially for the results presented in figure 5 and 6 showing the link between water percolation and slope failure as well as the deep structure of the summit area; but also for the discussion about flow hazard assessment, given the high potential of larger hazard associated with a larger scale event!

Response: comment accepted and changes made. We added a short discussion and relationship of the 2018 explosions into the discussion section. As the dome is also subjected to hydrothermal alteration, we assess and re-calculate the flanks instability by using factor of safety of Bishop's and Swedish equation, which was also suggested by second reviewer. We further explained parameters and forces that influence the factor of safety calculation more detail in the revised version. Discussion and limitation of each parameter is also added in the revised version.

The authors also completely misunderstood the use of varying basal friction angles associated with different flow volumes, as explained in details in Charbonnier and Gertisser (2012). I suggest them to read carefully the paper and change the basal friction angles accordingly. An explanation about why Titan2D cannot model surges is also lacking...

Response : Thank you very much for the suggestion. We agree that basal friction angles should be considered with care, and we understand the limitations. We have read carefully the paper and change the basal friction angle according to Charbonnier and Gertisser (2009 and 2012). We added the limitation of Titan2D parameters in the revised version. Concerning the comment on "surges", we agree that Titan2D cannot model this phenomenon.

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Finally, the discussion section is badly written and should focus more about the results shown in section 3, particularly the structural and geomorphological data obtained, rather than just conversing on dome collapse hazards at Merapi. This could considerably straighten some of the interesting results obtained in this study by justifying the use of some new innovative techniques (TLS, SfM) to solve the issues outlined in the previous sections.

Response : Thank you for the critical comments. We thoroughly rewrote the discussion section. We added more detail about the geomorphology and structure at the summit. After the climactic eruption in 2010, the morphology of the Merapi summit has changed dramatically. As we describe in the revised version, previous study concerned the dramatic topographic changes (Kubanek et al., 2013) by comparing satellite radar data before and after the eruption and calculating the volume of the 2010 eruption. Our datasets now provides a much better resolution of the changes occurring within this newly developed crater, and could describe more realistic condition of the current morphology and structure of the Merapi summit. We now outline this aspect in our revised manuscript. In addition, geomorphology and structural mapping at a steep-sided dome building volcano such as Merapi is challenging. For this we have realized a method linking lidar and drone based mapping. Combination of TLS and SfM is very promising and provides high quality datasets to identify sub-meter fractures and slope changes. This is the first study to map geomorphology and structure at the Merapi summit by using these techniques. Advantageous and limitations toward these techniques are further discussed in the revised version. To further improve the flow and organization of the discussion section, we let it proofread by native speaking.

Please also note the supplement to this comment:

<https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2018-120/nhess-2018-120-AC2-supplement.pdf>

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