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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Design of parametric risk transfer solutions for volcanic eruptions: an application to Japanese volcanoes" *by* Delioma Oramas-Dorta et al.

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We thank Referee #1 for very useful questions and suggestions, to which we have replied below:

1. I am surprised that total eruption mass is not found to be a sensitive indicator of loss and does not appear in the parametric trigger design. Obviously, for explosive eruptions there is some correlation between eruption column height and loss, but not necessarily. For example, the Eyjall (Iceland) eruption mentioned in the intro did not have a particularly high plume, yet caused loss (although not for buildings – the focus of this paper). Does the point cloud shown in figure 3 collapse significantly (or is it

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significantly different) for eruption mass rather than plume height?

Authors: We have produced a graph equivalent to that of Figure 3 of the manuscript (please see Fig.1 below), showing the relationship between total eruption mass and modeled loss. Comparison between this Figure (please find attached) and Figure 3 of the paper shows that eruption mass is, as rightly pointed out by the reviewer, a sensible indicator of loss. The reason that eruption mass does not appear in the parametric design, however, is because it does not fulfill the requisite of being obtainable on a near-real time basis (condition number 2 in Section 3) - even though it does fulfill conditions 1 and 3 mentioned in the Section. Whereas eruption column height is readily observable and can be objectively measured and reported on a real-time basis (as currently done by JMA), measurement/ estimation of eruption mass is not currently performed and reported on a real time basis. The parametric design, on the other hand and by definition, expects a non-perfect-relationship between the value of the chosen physical parameter and the resulting loss, which is incorporated in the basis risk (Section 3.2).

2. Similarly, eruption duration has a significant impact on loss and might be a useful part of the parametric trigger design. Unlike earthquakes, volcanic eruptions may have significant duration (years). The eruption duration not only impacts total load (and the ability to remove the load) but also the sectors (N,NE, etc.) likely to be impacted by the eruptions. Some mention of variable duration and its complicated influence on risk is warranted.

Authors: This is a very important observation and indeed the duration of the eruption should prove a significant driver of the loss. The reason why it wasn't included in the parametric design, however, is because it does not fulfill condition number 3 in Section 3 (eruption duration is not part of the stochastic event set in the catastrophe risk model developed). In this case, indeed, it is not possible to show the relationship between loss and eruption duration because the data is not available (contrary to the earlier case of loss versus eruption mass), although on the other hand a degree of correlation

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between eruption duration and total eruption mass is expected. Future development of more complex and complete eruption catastrophe risk models should enable further investigation of alternative parametric designs for volcanic eruptions, using different – or a combination of different- triggers. We believe it is important however to discuss these issues in the current paper and will add comment in this respect.

3. Plume height is measured remotely by satellite, and so fulfills a requirement of parametric trigger design to be quickly calculated and unbiased, compared with eruption mass. I think you should cite some important literature on this, like:

Prata, A.J. and Grant, I.F., 2001. Retrieval of microphysical and morphological properties of volcanic ash plumes from satellite data: Application to Mt Ruapehu, New Zealand. Quarterly Journal of the Royal Meteorological Society, 127(576), pp.2153-2179.

Pardini, F., Burton, M., Arzilli, F., La Spina, G. and Polacci, M., 2018. SO2 emissions, plume heights and magmatic processes inferred from satellite data: The 2015 Calbuco eruptions. Journal of Volcanology and Geothermal Research, 361, pp.12-24. Merucci, L., Zakšek, K., Carboni, E. and Corradini, S., 2016. Stereoscopic estimation of volcanic ash cloud-top height from two geostationary satellites. Remote Sensing, 8(3), p.206.

Authors: Thank you very much for pointing this work out and will include.

4. One of the authors, C. Magill, has an important paper on tephra modeling in the Toyko region using Tephra2 to forecast loss. It is important to cite that paper because it provides essential groundwork for using Tephra2 to make these models, which is not covered in the current manuscript, whereas the current manuscript goes much farther in terms of illustrating a workflow for designing the parametric trigger. Magill, C., Mannen, K., Connor, L., Bonadonna, C. and Connor, C., 2015. Simulating a multiphase tephra fall event: inversion modelling for the 1707 Hoei eruption of Mount Fuji, Japan. Bulletin of Volcanology, 77(9), p.81.

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Authors: Absolutely- it makes sense including this reference.

5. In addition to VEI, you might mention alternative eruption scales, like magnitude. See:

Pyle, D.M., 2015. Sizes of volcanic eruptions. In The encyclopedia of volcanoes (pp. 257-264). Academic Press. Rougier, J., Sparks, R.S.J., Cashman, K.V. and Brown, S.K., 2018. The global magnitude–frequency relationship for large explosive volcanic eruptions. Earth and Planetary Science Letters, 482, pp.621-629.

Authors: Thank you for pointing this out and will include in the eruption size discussion.

6. Just a few detailed comments:

Line 162. Change Kg to kg (lower case). Elsewhere in the paper, some units are capitalized. They should always be lower case.

Authors: thanks for pointing out.

Line 163. Instead of saying vertical wind speed, say variation in wind speed with height in the atmosphere.

Authors: the original sentence ("The model takes into account appropriate vertical wind speed and direction profiles") is not clear, we referred to "vertical profiles of both wind speed and direction". We can re-write as this, or else" variation in wind speed and direction with height in the atmosphere".

Around line 293 – what is the relationship of eruption column height with total mass and eruption duration?

Authors: We will include commentary on this relationship, as per discussion following from reviewer's comments 1 and 2. In this case we can look at the relationship between column height and eruption mass in a quantitative manner and from a qualitative stand-point in the case of the relationship with eruption duration since data on the latter is not available.

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Around line 510: it seems to me there is a fundamental difference between tephra fallout and these other phenomena (lava flows, pdcs, etc.). Tephra causes variable loading (depending on the eruption magnitude) so it seems more analogous to earthquake damage. The other phenomena cause complete destruction to property in their path. So how does this influence the parametric trigger design? It must be binary for these other phenomena? Wrap this discussion back to the equations you present.

Authors: This is an interesting and thought provoking observation. Whereas tephra fallout can be considered as a gradually varying phenomenon that causes varying levels of damage, volcanic mass flows tend to produce either a total loss (assets in their path) or no loss (assets away from their path). The present work focuses solely on the design of a parametric trigger for tephra fallout, which has adopted the form of a Multilayer trigger in this particular study (Section 3.2). Regarding the potential design of a parametric trigger for volcanic mass flows, this is something that would have to be thoroughly investigated in future work. It may be the case that a Binary trigger (Section 3.2) would be appropriate; however, it is our view that a Multilayer trigger cannot be ruled out in principle, and that the binary nature of the damage/loss does not necessarily warrant the selection of a Binary trigger over a Multilayer trigger. It is our view that the design of a parametric trigger for these volcanic phenomena will substantially be determined by the characteristics of the physical modelling methodology applied.

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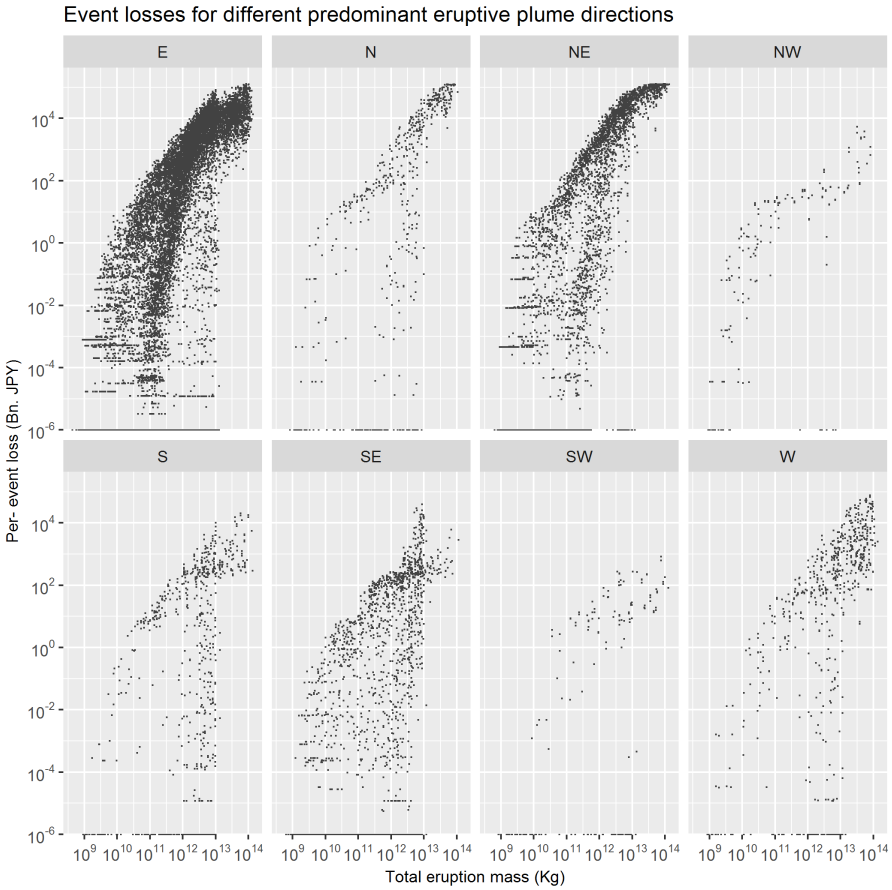
Event losses for different predominant eruptive plume directions
E
N
NE
NW
S
SE
SW
W
Per- event loss (Bn. JPY)
Total eruption mass (Kg)

Fig. 1.

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