

Clim. Past Discuss., author comment AC3
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Reply on CC1

Heli Huhtamaa et al.

Author comment on "Recession or resilience? Long-range socioeconomic consequences of the 17th century volcanic eruptions in northern Fennoscandia" by Heli Huhtamaa et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-147-AC3>, 2022

Dear Tim Newfield,

Thank you for the detailed comments and the kind words on our manuscript. We will respond to your review below by adding our responses in *italics* with running numbering (starting from #6 with your review).

Heli Huhtamaa, also behalf of all co-authors

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This is a very strong paper. The initial framing of it is very sharp, so too the discussion, particularly 5.2, and the figures are wonderful, especially figure 5. I agree fully with the authors that papers connecting climate cooling associated with large eruptions with socioeconomic crises are increasingly common, but almost always interregional, hemispheric or global in perspective. That is, as the authors stress, a major issue. Do those macro-scale papers ever establish causation or simply correlation? Sometimes one wonders if those papers even establish chronological and spatial correlation. What effects does volcanic cooling have and how do those effects differ between cultures, economies and societies? These are important questions asked here with consideration of three (!) large early modern / seventeenth-century eruptions in a single region of Finland. Often, I feel, such a narrow geographical scope is perceived to be a shortcoming — that is unfortunate, as we need more micro studies precisely like the ones this paper provides. On that note the title of the paper could better reflect the paper's local perspective; "Far North" is too wide.

The authors blend tree-ring, tax debt and tithe data to probe how three eruptions were felt by people on the ground in one region in the far north. They are assisted by the outstanding resolution of the E-OBS dataset the authors use; together these lines of evidence make for many intriguing observations about spatial heterogeneity of cooling events following each eruption studied (and makes one think twice about arguments made earlier about earlier eruptions) and about how we identify chains of causality, linking eruptions to societal crises. This care and detail is most welcomed. In short, this is a paper that makes novel and useful contributions. It is state-of-the-art in its approach and it advances the study of past climate-society linkages. It is very well suited to Climate of the Past.

-- #6 -- *Thank you so much for the positive feedback! We have now changed "far north" to "northern Fennoscandia" in the title.*

Lesser, though sometimes still significant notes:

- "Based on estimated global aerosol forcing, eleven out of the 20 largest eruptions of the last 2 500 years occurred between 1108 and 1815 CE" — this is an odd sentence. Why point specifically to this period? Considering the sentence that precedes this one, I would instead simply say that "Based on estimated global aerosol forcing, 23 of the 25 largest aerosol forcing eruptions of the last 2,500 years occurred before 1800, in the pre-statistical or pre-instrumental period."

-- #7 -- *We have now revised the sentence as suggested.*

- 'distal' is used often in the top paragraph on page 2. It could occasionally be replaced with 'far-flung'

-- #8 -- *Thank you for noting this out. We have now replaced the word 'distal' with 'far-flung' and 'far away from the eruption location' on page 2.*

- Perhaps reframe "To isolate the possible volcanic effect from other natural and man-made factors, one should conduct systematic longitudinal studies, covering multiple volcanic eruptions, and compare the societal impacts associated with different eruptions over time." as "To isolate possible volcanic effects from other natural and human-made factors, systematic longitudinal studies are recommended, that is, studies that span multiple volcanic eruptions and compare societal impacts associated with different eruptions over time." While I agree with this point (reworded or not) about longitude studies, I think the period studied cannot be overly long, as societies and cultures evolve, sometimes quickly — perhaps one premodern century, but not half a millennium. The authors might note this.

-- #9 -- *Thank you for the suggestion. We have now revised the sentence as proposed. In addition, we will add a short comment on the appropriate temporal length when looking historical societies.*

- In the paragraph starting on line 45 on page 2, the authors would do well to note the importance of designing a longitudinal study where local high-resolution data for a climate signal that directly affected plant / crop growth are available. That (the overlap or near overlap and the proxy been very agriculturally relevant) is far too often overlooked in climate-society studies, and in this study those data are actually available — amazing.

-- #10 -- *Thank you very much for this comment. We will add a note on the importance of local high-resolution written and climate proxy material in the revised manuscript.*

- Paragraph starting on line 90 of page four, a hyphen is needed between "17th" and "century Sweden/Finland", so too line 106 on page five and line 137 on page 6, etc

-- #11 -- *We have now added a following hyphen if the "17th century" phrase describes a noun throughout the manuscript.*

- Lines 177-178 of page 7, the authors might also note that cooling of the 1690s, at least in some NH regions, preceded the eruption of 1695, this seems to come up only in the discussion

-- #12 -- *We decided to focus on the section four on presenting our own results only and*

provide supplementary/controversial evidence from related studies in the "Discussion" chapter in the section five.

- Is the crisis of the 1690s dated in this paper as starting in summer 1695 or earlier? That could be discussed especially on lines 210-212 on page 8 and perhaps in regards to Figure 6 (which does not of course show markedly cool winters).

*-- #13 -- The tree-ring and tithe evidence presented in the paper suggests that the onset of the crisis of the 1690s started in summer 1695 in **Ostrobothnia**. However, we are aware that the cold spell of the 1690s started earlier, e.g., in Central Europe. Thus, we will include a line about this matter in the discussion. Furthermore, we raised the matter of extremely cold (non-volcanic-induced) winter temperatures prior the summer 1695 contributing to the crises on page 12 (lines 254-277).*

- Lead sentence of section 5.1 is confusing and I would delete it. Why reference the VEI? Or introduce the complexity (frequent misuse on the part of historians) of using it? It has not been previously mentioned in the paper and as the authors know well, the VEI and Toohey/Sigl databases are not exactly comparable. I would at most just note that scholars have long thought many major climate-impacting eruptions occurred in the seventeenth century, initially using the VEI, which has been problematized, and now Toohey/Sigl. Perhaps do note erroneous previous attempts to discern climate impacts from the VEI, but if a paragraph needs to be cut, this is the first paragraph to cut.

-- #14 -- Thank you for raising this matter. Indeed, we agree that the VEI parameter has been misused. However, we have to disagree here about the fact that the use of VEI has been clearly problematized in previous research – especially among us historians. Thus, we felt the importance of clearly stating that societal impacts to volcanically-forced cooling using evidence of VEI estimates should be avoided. Please, see also our answer #20 to the third reviewer and the preceding comment.

- Why are some terms italicized on page 13?

-- #15 -- We decided to use italics to indicated the components that determined the societal and/or individual sensitivity (Figure 7). However, we agree that this practice can be misleading, as we use italics also with non-English vocabulary. Perhaps having these matters highlighted with bold fonts would be more reasonable. Therefore, we will consult the journal editors about the matter.

- Where was the grain imported grown? Those regions were not affected by the eruptions? I would be clearer on that (line 320 page 14)

-- #16 -- Thank you for noting this out. We will deepen the discussion on this matter based on previous research (such as studies conducted by Martin Seppel).

- Missing, I felt, in 5.2 was agricultural technology. It was discussed earlier, but in brief. Were there no advancements or marked changes across this period in the region that could have made certain subregions more resilient or more vulnerable?

-- #17 -- Overall, there was not that much changes in agricultural technology in the 17th-century Ostrobothnia. However, we will go through the relevant literature again, and add specific insights on the topic in the revised manuscript if needed.

- I am not certain the policy section of the conclusion is needed or works. Is there a way to improve it? What steps might we have to take to make a study like this policy-friendly or more easily applicable to policy makers? That said, the paper offers a lot already, it may not need these policies linkages. If it does, the micro focus, overlap of

discrete evidence types, and the nuances in the historical social contextualization the paper offers are what make this paper more usable in the policy world compared to the macro studies that are so common and popular.

-- #18 -- *Thank you for this insight. Indeed, we will include the notion of the micro focus and the notice of the historical contextualization in the conclusions of the revised manuscript.*

- Once the authors seem to slip: from the abstract, "These factors influenced societal vulnerability and resilience to cold pulses and the resulting harvest failures caused by the eruptions." — That eruptions simply cause harvest failures is an overly simplistic statement that this paper, and Figure 6, in fact disproves (it also seems at odds with the sentence before this one in the abstract). I would change to something like "These factors influenced societal vulnerability and resilience to cold pulses and associated harvest failures."

-- #19 -- *Thank you for noticing this. We have revised the sentence as suggested.*