

Clim. Past Discuss., author comment AC4  
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## Reply on RC3

Heli Huhtamaa et al.

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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-AC4>, 2022

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Dear Katrin Kleemann,

Thank you for the detailed review on our manuscript. We will respond to your review below by adding our responses in *italics* with running numbering (starting from #20 with your review).

Heli Huhtamaa, also behalf of all co-authors

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### Summary/General remarks:

The paper of Huhtamaa et al. analyzes the long-range impact of three large, tropical volcanic eruptions in the seventeenth century (the 1600 Huaynaputina, 1640/1641 Koma-ga-take/Parker, and 1695 unidentified eruptions) by narrowing down on one specific region, in this case on Ostrobothnia in today's Finland. As these eruptions took place far away from Finland, the authors analyze the distal societal consequences these volcanic eruptions have had. The source materials for this paper are natural and written records, consisting of tree ring data and taxation / grain tithe data.

Studying the distal societal teleconnections of volcanic eruptions has been a lesser focus of scholarship so far, mainly because less data is published for this kind of analysis, particularly for the premodern era. In this sense, the paper by Huhtamaa et al. is an addition to the scholarship in this field: it showcases that tropical volcanic eruptions can have different impacts on regions far away from the volcano, which largely depends on a variety of factors, including the general climatic regime during the time, as well the socioeconomic and political conditions, all of which influence societies' vulnerability and resilience.

In the past, studies that analyze the aftermath of large volcanic eruptions and their impacts have often focused on famine and societal collapse and chose a supra-regional or hemispheric focus, which did not always address the question of causation or coincidence critically enough. By selecting a more localized regional focus, the authors of this paper address this issue.

The authors argue convincingly why they chose these three volcanic eruptions. Although

recent studies (Toohey and Sigl, 2017) have identified twelve significant eruptions for the seventeenth century, only three eruptions produced significant volumes of sulfur (>5 Tg of sulfur). Huhtamaa et al. argue for relying on the estimated Volcanic Stratospheric Sulfur Injection (VSSI) rather than the Volcanic Explosivity Index (VEI), which is still often used in similar studies (lines 230-244). This is a very relevant argument that should receive more attention in future studies on volcanic eruptions.

-- #20 -- *Thank you for this comment. We agree with the sentence above. Therefore, we decided to leave the notion about the misuse of the VEI estimates (please, see also our response #14 to the second reviewer).*

Similar to the local or micro-regional spatial focus adopted by the study by D'Arrigo et al. (2020) on Scotland in the 1690s, which is also mentioned in the paper, Huhtamaa et al. employ a regional focus on Ostrobothnia that looks at three volcanic eruptions that occurred during the seventeenth century and show that this approach can provide a deeper understanding of the spatio-temporal and socioeconomic consequences. However, in contrast to the paper by D'Arrigo et al., the approach followed by Huhtamaa et al. allows for a comparative perspective. This is useful as they are able to show that the effects of these three eruptions and the socioeconomic response differs over the course of the seventeenth century, and they illustrate convincingly that various factors are responsible. To name only a few examples that are mentioned in the paper: For instance, the Maunder Minimum created different climatic conditions during the first two eruptions (lines 413-416), the Thirty Years' Wars influenced the tax burden and military circumstances during the second eruptions (lines 302-306), and with the third eruption, tax deferments limited the desertion rate (lines 317-321).

The paper addresses scientific questions that are within the scope of CP and fit well into this special issue that addresses the volcanic impacts on climate and society. The paper presents novel ideas based on taxation records that were previously published (Huhtamaa and Helema, 2017) but extended for this paper to cover the entire study area. The paper reaches substantial conclusions: The authors show that the findings of their paper could prove useful for policymakers in the present and future concerning the "various long-range human consequences of future volcanic eruptions" (line 435).

The authors outline their scientific methods, and the results are sufficient to support the conclusions. The authors also cite relevant work in the field and indicate their original contributions. The abstract provides a concise and complete summary of the paper. The study is structured well and written clearly and well.

-- #21 -- *Thank you kindly for this encouraging and comprehensive summary.*

### **Questions/Comments:**

I agree with Joseph Manning (Reviewer 1) that the "recession" in the first part of the title is not ideal. Recession is only discussed once in the paper (line 145); perhaps you could amend the first part of the title or expand the discussion on recession within the paper.

-- #22 -- *After careful consideration, we decided to keep the word "recession" in the title. However, we will consult the MS editor of the mater as well (please, see also our response #2 to Joseph Manning).*

Overall, the figures used in this paper are helpful; in particular, Figure 5 is very helpful to understand which regions are affected how much by harvest failures and to visually understand at a glance which regions see how much desertion of farmsteads in the aftermath of the different volcanic eruptions. This clarifies to the reader that harvest failures and desertions in particular regions correlate sometimes, but not always.

Figure 4b: Here, I wondered how come the desertion rate went up in the first year after an eruption if a farmstead is only marked as öde if the taxes are not paid three years in a row? Does this stem from the consequences of the eruption or from other conditions prior to the eruption?

-- #23 -- *Yes, indeed, the desertion rates stem from the "pre-eruption" socio-environmental conditions. We discussed these matters in the section 5.2. Nevertheless, we will include more discussion on the matter on the revised manuscript.*

I wondered about the deserted farms: What happened to the deserted farms that are included in the percentage; will the farmers on them either be evicted or become farmers for the crown (but not inherit the farmstead to their children)? Do other people ever come and buy a deserted farm? In other words: Do deserted farms remain in the statistic over this ~95-year time frame?

-- #24 -- *We aimed to include this information in the Figure 4b. The deserted farms remain in the statistics over this period, but with much less share prior the "pre-crisis" years.*

The authors mention the uncertainty for the 1695 eruption with regard to the season, as we do not yet know which volcano produced the eruption and when exactly it took place. When looking at these eruptions and their impacts on Ostrobothnia, did you observe in your analysis whether the time of year (the season) of these eruptions plays a role for the harvest?

-- #25 -- *This is an extremely interesting question. However, unfortunately, at this point we cannot say anything about the connection between eruption seasonality and the climatic & harvest impacts over Ostrobothnia. This is because 1) we do not know the location of the volcano nor the intraseasonal dating of the 1695 event; 2) the 1641 cold pulse originated (at least) from two eruptions (see Stoffel et al. 2021, doi.org/10.5194/cp-2021-148); and 3) – to our knowledge – only the 1600 Huaynaputina eruption originated from a single known eruption (although there is also contradictory evidence, see, e.g., de Silva & Zielinski 1998, doi.org/10.1038/30948).*

### **Minor points:**

I would delete the "Needless to say" in line 434.

One stylistic remark: You have both curly and straight quotation marks in your paper.

-- #26 -- *Thank you for noting these matters. We will go carefully through the manuscript to remove these inconsistencies.*

Figure 6 confused me a little, mostly because of the order of the colored rings/years above the graphic, as the order doesn't correlate with the graphic directly below. I would suggest listing the three years above one another rather than next to one another and placing them either above the graphic or on the side of the graphic. (See below for a quick draft of what I'm suggesting.)

-- #27 -- *Thank you for pointing this out. We will consult the editorial team about the matter.*