

*Thank you very much for your comments and questions on the manuscript. In the following, I tried to answer most of the issues you raised during the review process. Please find my answers highlighted in italics. I am looking forward to further discussing your interesting suggestions!*

Using historical written sources, palaeoenvironmental data, and Normalized Difference Vegetation Index (NDVI) temporal series to compare landcover change during the Little Ice Age and the reference period 2000-2018, could help us to understand the role of climate in affecting grassland. Surely, you have done a lot of work, but before further consideration, I have several questions at present.

1)" Figure 3 further visualizes the historical route patterns and the daily camps of the travels of Pater Gerbillon from 1688. From these route reconstructions, a cross-validation of hermeneutic sources and modern landcover and climate data was derived." Why modern landcover and climate data was derived from these route reconstructions? In your text, landcover in 2019 was derived from Landsat-OLI-8 satellite imagery. In addition, as we know, from 1688 to now, landcover may be changed many times.

*To evaluate the historical landcover in terms of climate extremes during the LIA, I need to contextualize the reconstructed landcover classification from the year 1688. Of course, you are totally right in emphasizing the potential landcover transformation during the period 1688-2000. But, you know, palaeoenvironmental data or historical landcover data covering such a broad region is hardly available and cannot be interpolated from scattered proxies without risking massive loss of information and creating strongly hypothetical data in peripheral areas that were lacking samples. Because I am focussing mostly on the comparison of two climate extremes (LIA and current climate change) and I want to cross-validate vegetation response during cold/dry and hot/more humid conditions, I would like to contrast the modern surface cover to the historical data.*

2)"Climatic conditions were reported to be very dry and extremely cold during October 1688, which aligns with the climatic tendency towards a drier and colder period around 1700 AD and the climate depression during the Maunder Minimum of the LIA. From the palaeoenvironmental reconstructions, 1688 can be considered an extremely anomalous year compared to the long-term average and marks the transition into a generally colder and drier phase that lasts until about 1715 AD." From this, climate of 1688 is clear, and then is it necessary to reconstruct?

*I am sorry, maybe I do not understand this point properly. If I understand correctly, you suggest that a reconstruction of climate and surface conditions during the LIA is not necessary because we know from literature that this happened? I would consider this a dangerous perspective not only in terms of scientific paradigms and research approaches in general but also because local and regional response to climate change (also in historical times) is yet not fully understood and as mentioned above, micro-regional or site-specific reconstructions from palaeoenvironmental proxy can hardly be interpolated to supraregional premodern conditions.*

*If I misunderstood your point, I am looking forward to further discussion about this!*

3) In arid and semi-arid area, plant growth may be more close to heavy precipitation events but not to total precipitation as presented in Figure 9.

*That is a very good point, which I will highlight more accurately in the paper, thank you for this. Also, I think that heavy precipitation can cause massive surface erosion and soil loss and thus amplifies the previous hot drought period and contributes to degradation processes. This, however, is also closely linked to terrain roughness and potential erosion.*

4) "According to written sources, the year was characterized by extremely low temperatures during late grazing season of September and the onset of October and extremely dry conditions and severely high temperatures during summer rainy season, which caused massive perish of livestock in the region." From what you can say 'perish'?

*This information can be extracted from the diary by Gerbillon, who documented a very strong perish of livestock during his travel.*

5) "Around the reconstructed route, a 20 km buffer was created to visualize the historical environmental conditions within a suitable range". Surface conditions are various under various topography. For example, with 20 km buffer, there are various landscapes, such as cropland, forest, grassland, shrubland, and waters. Can surface conditions from camps extend to 20 km?

*That is an interesting point, which is discussed in manifold theoretical discourses from both the sciences and the humanities. The actual 'catchment' of a site, or in this case, the scale of perception of the individual, is to a large extent biased by the performance of the individual itself. And that accounts also for potential viewshed, current physical condition, or weather conditions and time of the day. A 20 km range produces a large buffer, however, a 10 km range would produce equal results but in a smaller buffer. The reconstructions, which I would like to suggest here, are at best a realistic model of a potential past and never a reconstruction per se. A model of the landscape, in the very sense of being a simplification of characteristic parameters regarding some potential landscape variables, is not affected by the diameter of the range. It produces a stripe of landscape, which for visualization purposes, can serve as comparison data but never as a real reconstruction of past conditions.*

6) If we don't know the number of population and livestock around 1688, the human disturbances on grassland degradation can not be well understood. Climate change is only one reason that can explain grassland succession.

*That is definitely true and one weak point in any model that aims at tracing past landcover change as result of past human behaviour. In historical and archaeological*

*research, demographic numbers or the number of cattle in specific areas cannot be reconstructed with absolute certainty. However, just like in the concept of modelling past human-landscape interactions, we have to deal with the data that is available and probably this is not always accurate. And of course, climate change is one potential parameter during degradation processes but the amplification through human pressure on available resources (such as grasslands) can be considered a major trigger of extensive desertification – particularly in sensitive steppe vegetation regions.*

7) "Results show that decreasing precipitation and temperature records led to increased land degradation during the late 17th century". Does this mean land degradation occurred the late 17th century? "no major grassland recovery over the past 20 years", the reference undegradation year is?

*Please apologize but I am a bit confused by this point. Do you mean that by the end of the 17<sup>th</sup> century, climate deterioration occurred? If this is the case, I would say yes. We can see from the palaeoenvironmental models that there is a significant decline in temperature and a decreasing trend in precipitation and river runoff. That aligns with climate trends during the LIA and a general trend towards dry and cold conditions.*

*I am very sorry, but what exactly do you mean with "the reference undegradation year is"? You seem to refer to a section of the abstract, which summarizes the results from the modern comparison NDVI dataset. The references for that can be found in the text.*