

**Point by point response to the reviewer and editor's comments
on "Patterns in data of extreme droughts/floods and harvest
grades derived from historical documents in Eastern China
during 801–1910"**

Dear editor and reviewer,

We appreciate the positive and constructive comments and suggestions from the reviewer and the editor. We have revised our manuscript and all the modifications are highlighted by red color. Our point-to-point response (in red) is listed below.

Thank you for your consideration.

Sincerely yours,

Jingyun Zheng

To editor:

The manuscript did improve in all major points previously addressed by the reviewers. Still there some smaller points that should be solved: please, follow the advices of Reviewer 1. Additionally, I have two further comments that, I think, needs further consideration:

1) While drought is often a large-scale phenomenon, the impacts of floods are mostly restricted to the areas directly affected by floods. As the authors only discuss floods seemingly as a counterpoint of droughts (and it is not exactly that), in the latter case, the authors could as well mention that much precipitation / wet periods (with or without extraordinary floods) could as well be responsible for (larger-scale) bad harvest and harvest failures.

Accepted. We added the text about much precipitation could as well be responsible for bad harvest. (P12, L25-27)

Although it should be noted that these meteorological interpretations only apply for short-term extreme flood events. When it comes to long-term wet periods, it could as well be responsible for bad harvest, due to the low-temperature and short sunlight.

2) There is a clear and well-visible improvement in the 2.1 Data subchapter with examples from original source references and also with listing major advantages of the compiled dataset and indices they apply. However, the authors could also address any weaknesses of their databases, as their data are mainly available in compilations, and usually compilations are based on all kinds of contemporary and non-contemporary data mixed, with the (sometimes high) probability of misdating, doubling (tripling) events etc. Consequently, majority of the Chinese database, the paper is based on, is only available in a form that retracing the sources and the reconstruction steps are not possible. Naturally, the authors cannot solve this problem all within this article; nevertheless, in one sentence (e.g. on page 4, btw. lines 20-25, after listing all advantages of the dataset) they should refer to this general problem or weakness.

Accepted. The weakness about this database has been added. (P4, L30-32)

However, this dataset also has weaknesses. For example, the reconstruction derived from the historical documents relies highly on the accuracy of the compilation, and is only available in a form that retracing of the original sources and reconstruction steps are not same as reconstructions from natural evidences.

To Anonymous Referee #1:

The authors have accepted the key changes requested in the previous reviews. However, they have not been entirely consistent in applying those changes. It is important that throughout the text the authors carefully distinguish (1) the analysis of data in these databases of historical weather and harvests from (2) their interpretation of the underlying climatic and human history. Therefore, I would request the following minor revisions:

The abstract has added terms such as “reported” but needs to rework the language more carefully to reflect the new approach of the article. The following changes would be appropriate in order to make the meaning more precise and avoid inaccurate claims:

- “reported extreme droughts [floods] occurred” should be: “extreme droughts [floods] were reported” (or a similar phrase). The key distinction here is a report of a drought [flood] is not the same as the historical occurrence of drought [flood].
- “reconstructed grain harvest was poor [medium, high] in” should be: “the grain harvest was reconstructed as poor [medium, high] for” (or a similar phrase).
- “occurrence of reported extreme drought in any sub-region of eastern China was significantly associated with reduced harvests in the long-term average” should be: “frequency of reporting of extreme droughts was significantly associated over the long term with lower reconstructed harvests” (or a similar phrase).
- “association between harvest and extreme floods” should be: “associated between the reported frequency of extreme floods and reconstructed low harvests” (or a similar phrase).
- “other social factors” should be “other historical factors” to include other historical environmental changes, both natural and anthropogenic

Accepted. All related expressions have been revised throughout the text to distinguish “the analysis of data in these databases of historical weather and harvests” from “their interpretation of the underlying climatic and human history”.

On page 2, lines 20-34 have not been reworked to reflect the new approach of the article -- that is, to first discuss patterns in the data derived from the historical documents, and only then to discuss the interpretations of those patterns as historical climate impacts. This paragraph makes the unwarranted assumption that the reported frequencies of events in the historical documents represent real frequencies and that associations between the frequencies of reported disasters and extremes and variations in reconstructed grain harvests represent causation (i.e., climate impacts). The studies cited by Su et al. and Yin et al. present the same problems of historical method and epistemology as did the previous draft of this manuscript, as discussed in my previous review. Therefore, their results need to be qualified in the same manner. The authors may refer the reader to the discussion section for their causal interpretation.

Accepted. We revised the expression on the reconstructions by Su *et al.* and Yin *et al.*,

rephrased our objective, and highlighted that we worked with data first, and then discussed possible interpretations. (P2, L29-P3, L3)

It should be noticed that these conclusions are based on reconstructed datasets, and do not necessarily reflect actual historical connections due to several reasons as discussed in the Discussion section. These studies focused on the connection between agriculture and long-term climate change, while the effect on harvest induced by short-term extreme events (such as extreme droughts/floods) might be different. Therefore, this study aims to explore the patterns in the data of extreme droughts/floods and harvests in eastern China from 801 to 1910, using reconstructions of regional grain harvest grades and extreme drought/flood events derived from Chinese historical documents. The results from historical datasets could provide implications to improve understanding in the relationship between poor harvests and extreme drought/flood, and how cold and warm periods, such as the Medieval Climate Anomaly (MCA, 950–1250) and the Little Ice Age (LIA, 1450–1850) (IPCC, 2013), contributed to difference in that relationship.

In the sentence at the bottom of page 4 and top of page 5, it is important that the authors clarify that their method is based on an assumption that the probabilities for omitting drought and flood events in reporting and transmission of historical records were random and unbiased, for the reasons they have stated. They haven't actually proven that omissions were random and unbiased. They have merely made a reasonable argument that it would be appropriate to proceed on this assumption.

Accepted. (P5, L6-8)

Extreme drought or extreme flood years were defined in this way under the assumption that the probabilities for omitting drought and flood events in reporting and transmission of historical records were random and unbiased, despite the greater frequency of missing data in the earlier records.

Now that the authors have worked to distinguish their results (that is, the patterns and associations in their datasets) from their discussion (that is, the climate and historical

interpretation of those associations), their use of a combined “Results and Discussion” section has become more confusing. For the sake of clarity, I would encourage the authors to rename section 3 as simply “Results” and turn subsection 3.4 into a new section, “Discussion.” Their discussion of results in the bottom of page 9 to the top of page 10 as well as their discussion of results at the top of page 12 might then be moved into the new “Discussion” section, as part of the authors’ climatic and historical interpretation of the patterns in the data. The fact that these pattern makes sense from a meteorological perspective supports the case that droughts had a significant historical impact on grain harvests. The authors may wish to state this point clearly in their discussion.

Accepted. Interpretations have been moved to Discussion section. (P12, L17-P13, L8)

The statistical results from section 3.2 indicate that the reported frequency of regional extreme droughts is closely associated with poor harvests in reconstruction, while no significant pattern is found between the reported frequency of extreme floods and reconstructed poor harvests. This phenomenon might be explained by the fact that extreme droughts usually cover an immense area dominated by a single large-scale air mass, leading to significant and extensive impacts on agriculture, economics, and many other social factors. On the other hand, extreme floods were mostly caused by rainstorms induced by the confrontation of air masses, which usually occur across a relatively narrow belt. Meanwhile, rainstorms could irrigate agricultural land in areas surrounding the extreme floods and, thus, improve grain yields, leading to limited impacts of extreme floods on harvests over an immense area (Zhang, 1982). Although it should be noted that these meteorological interpretations only apply for short-term extreme flood events. When it comes to long-term wet periods, it could as well be responsible for bad harvest, due to the low-temperature and short sunlight.

Section 3.3 showed the statistical results for the different pattern in association between reported frequency of regional extreme droughts and reconstructed grain harvests between warm and cold periods. These results suggest that the simultaneously occurrence of reported extreme droughts and reconstructed poor harvests tends to be weakened in a warm climate background. Possible cause might

be that, there was low and limited adaptability during that period, and the warm climate provided more thermal resources and extended the growing season, thus increasing the multiple cropping index and providing more thermal-limited lands for growing crops. This gave people more options to adapt to climatic variation, and mitigated the impacts of extreme droughts on harvest yield. As assessed by Zhang (1982), the harvest may change by approximately 10% if the temperature changed by 1 °C on national scale based on the data from 1909 to 1979, in which the harvest increased significantly in 7 out of 8 warm years. However, a cold climate could limit multiple cropping and shrink the area of arable land, leading to the harvest becoming more vulnerable to extreme drought. Moreover, as reported by Zhang et al. (2007), limited resources could also cause social turbulence, such as famine, peasant uprising, the outbreak of war, and population decline, all of which may further increase agricultural vulnerability. Therefore, even though the frequency of reporting of extreme droughts was slightly higher in the warm period of 920–1300, the frequency of reconstructed poor harvests did not increase significantly.

The revised sections, while mostly clear, should receive further review for correct English grammar and word use before publication.

Accepted and revised.