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**Prof. Philip Ward, Editor-in-Chief**

Natural Hazards and Earth System Sciences (NHESS)

**Subject:** Response to Reviewers' Comments for Manuscript "*Satellite-based data for agricultural index insurance: a systematic quantitative literature review*" (MS No.: egusphere-2024-1527)

Dear Prof. Philip Ward,

Thank you for obtaining two very helpful and constructive reviews of our manuscript, titled "*Satellite-based data for agricultural index insurance: a systematic quantitative literature review*" (MS No.: egusphere-2024-1527), submitted to Natural Hazards and Earth System Sciences (NHESS). We appreciate the constructive feedback provided by you and the reviewers, which has greatly helped us improve the quality of our work.

We have carefully considered all the comments and suggestions and revised the manuscript accordingly. Below is a summary of the major changes made:

1. We have updated the search results to November 2024, adding two keywords "parametric insurance" and "weather derivatives".
2. We have reviewed and applied a new classification to the types of index insurance, based on the data utilized to develop the index for insurance. The data sources utilized in the studies were classified into three primary groups: (i) non-satellite-based data, (ii) satellite-based weather data, encompassing studies that utilized at least one dataset from weather satellites such as CHIRPS, ESA CCI Climate Variable data; and (iii) satellite-based land surface data, involving studies that incorporated at least one dataset from land surface Earth observation satellites.
3. We have revised the discussion section to elaborate the findings and implications for the gaps in study scopes in terms of regions and crops. We have also added the numbers of hedging effectiveness to illustrate the basis risk reduction. In addition, the citations have also been revised and fixed.

Please find our detailed responses to each comment attached, along with a revised version of the manuscript. All changes made to the manuscript are highlighted in tracked changes to facilitate your review. Please kindly note that the line numbers mentioned in the responses correspond to those in the revised manuscript with tracked changes.

We have strived to address all concerns raised while maintaining the scientific integrity and clarity of the manuscript. Should there be any additional comments or requests for clarification, we would be happy to address them promptly.

Thank you once again for considering our work for publication in Natural Hazards and Earth System Sciences (NHESS). We look forward to your feedback and hope that our revisions meet the journal's standards.

Sincerely,

Nguyen Thi-Thu-Thuy, on behalf of all co-authors

### Reviewer 1

The manuscript aims at reviewing existing studies on usage of satellite data for designing index insurance products. Overall, it is very interesting and may attract large attention from various disciplines. However, the manuscript needs little more effort in few issues, in order to publish it in a high level journal. Especially analytical discussions in the manuscript needs to be improved. Below I provide more specific suggestions for further improvements.

#### Specific suggestions

1. It is not clear in the abstract if the study explores usage of satellite data for crops insurance or also for livestock. That needs to be specified.
2. I did not conduct counting number of studies, but 86 studies seem to be not complete for me. I am sure the authors should find few more if they could conduct little more research on those studies.
3. When authors cite importance and principles of index insurance, they should cite pioneers in index insurance research and not Carter et al., 2016 (Line 34). There are few earliest scientists have initiated the discussion on importance of index insurance at the onset where Prof. Carter also contributes on this topic largely following the early studies. Having nothing against this citation, earlier scientists should get valuation for their work which they initiated.
4. (What are the different types of “crop” index insurance?, 2024), seems to be wrongly cited.
5. In classification of indices (lines 135-140), the authors need to be cautious in weather index insurance since climate data could be also taken from satellite based sources.
6. When mentioning about studies on basis risk reduction, it would be useful if authors provide some number (e.g. percentage of reduction).
7. I found missing discussion on interpretation of results. For example authors need to try to interpret results why studies are coming from certain parts of the world and why mainly cereals are considered. Interpreting such results may create some more specific directions for further research.

Comments	Responses
1. It is not clear in the abstract if the study explores usage of satellite data for crops insurance or also for livestock. That needs to be specified.	Thank you for your comment. The abstract was revised to clarify the four major types of crops, including cereals, pasture and forages, perennial crops, and others, classified following FAO Crop Classification (lines 17-18).
2. I did not conduct counting number of studies, but 86 studies seem to be not complete for me. I am sure the authors should find few more if they could conduct little more research on those studies.	Thank you for your comment. The searched results were updated to November 2024. The selection of the final short list of studies to be analysed followed a three-stage process as shown in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart (figure 1) with detail description in lines 116-125. The update results had 3189 searched records, but 3057 papers were excluded at stage 1 because they did not develop an index insurance, which is the focus of this study. Then, another 45 papers were excluded at stage 2 due to duplications and irrelevant topics such as pricing, demand or willingness-to-pay for an index insurance product, or crop insurance, which are not the focus of the study. At stage 3, one paper was added from other sources to reach the final list of 89 studies for SQLR analysis. We acknowledge that there are many studies related to exploring the relationship between crops and a variable

		or an index, which provides evidence and implications for developing an index insurance. However, the studies did not reach the stage of developing an index insurance with its attributes such as strike, tick values for triggers and payments. Such studies were removed from SQLR analysis as one of the exclusion criteria.
3.	When authors cite importance and principles of index insurance, they should cite pioneers in index insurance research and not Carter et al., 2016 (Line 34). There are few earliest scientists have initiated the discussion on importance of index insurance at the onset where Prof. Carter also contributes on this topic largely following the early studies. Having nothing against this citation, earlier scientists should get valuation for their work which they initiated.	Thank you for your comment. We have reviewed older publications and cited pioneers in index insurance research such as (Barnett and Mahul, 2007; Barnett et al., 2008; Skees, 2008; Chantarat et al., 2013; Turvey and McLaurin, 2012; Carter et al., 2014; Carter et al., 2016) (lines 41-43).
4.	(What are the different types of “crop” index insurance?, 2024), seems to be wrongly cited.	Thank you for your comment. The citation error was fixed (line 51).
5.	In classification of indices (lines 135-140), the authors need to be cautious in weather index insurance since climate data could be also taken from satellite based sources.	Thank you for your comment. We have reviewed and applied a new classification to the types of index insurance, based on the data utilized to develop the index for insurance (lines 149-158). The data sources utilized in the studies were classified into three primary groups: (i) non-satellite-based data, which includes studies relying on ground measurements from weather station networks, either location-based or spatially interpolated into gridded data, or integrated with reanalysis climate data, which combines ground measurements with modelling results; (ii) satellite-based weather data, encompassing studies that utilized at least one dataset from weather satellites such as CHIRPS, ESA CCI Climate Variable data; and (iii) satellite-based land surface data, involving studies that incorporated at least one dataset from land surface Earth observation satellites.
6.	When mentioning about studies on basis risk reduction, it would be useful if authors provide some number (e.g. percentage of reduction).	Thank you for your comment. The numbers of the hedging effectiveness were added in the discussion section (lines 540-550).
7.	I found missing discussion on interpretation of results. For example authors need to try to interpret results why studies are coming from certain parts of the world and why mainly cereals are considered. Interpreting such results may create some more specific directions for further research.	Thank you for your comment. We have revised the discussion sections to elaborate the findings and implications for the gaps in study scopes in terms of interested regions (lines 450-468) and crops (lines 486-520).

## Reviewer 2

In general, the topic of the manuscript is highly relevant and timely, especially given the increasing importance of climate-related risk management in agriculture and other weather-dependent sectors. The analysis presented in the manuscript has been carried out in a solid and methodologically sound manner. For these reasons, I would recommend the manuscript for major revision.

Please find my detailed comments below:

### 1. Literature Gaps and Missing Studies:

I believe the manuscript has missed many literature, which may be due to the selection of keywords during the literature review process. Some terms synonymous with index insurance, such as parametric insurance and weather derivatives. Incorporating these additional terms in your literature search could significantly enhance the scope of your review.

I would suggest revisiting your literature review and including some papers that are relevant to your topic. Here are a few studies that you missed and there few more:

Enenkel, M., et al. (2018). Exploiting the Convergence of Evidence in Satellite Data for Advanced Weather Index Insurance Design.

Hernández-Rojas, L. F., et al. (2023). The Role of Data-Driven Methodologies in Weather Index Insurance.

Eltazarov, S., et al. (2023). The role of crop classification in detecting wheat yield variation for index-based agricultural insurance in arid and semiarid environments.

Masiza, W., et al. (2022). Do Satellite Data Correlate with In Situ Rainfall and Smallholder Crop Yields? Implications for Crop Insurance.

Tarnavsky, E., et al. (2018). Agro-meteorological risks to maize production in Tanzania.

Eltazarov, S., et al. (2021). Mapping weather risk – A multi-indicator analysis of satellite-based weather data for agricultural index insurance.

Incorporating these works will give your manuscript a broader perspective on the role of satellite-based data and other methodologies in weather index insurance.

### 2. Improving the Structure of the Literature Review:

I recommend organizing the literature review more systematically by categorizing the data sources. Specifically, the literature could be structured into the following categories for better clarity:

- Satellite-based land surface data (NDVI, LAI, soil moisture, ET, etc.)
- Satellite-based weather data (CHIRPS,IMERG, CMORPH, CHIRTS, etc.)
- Non-satellite-based data (in situ data, ground measurements, reanalysis data)

This division would help readers better understand the different types of data available and their applications in weather index insurance.

### 3. Integrating Meta-Analysis Tools:

To enhance the analytical rigor of your literature review, I recommend integrating all the cited literature into

NVivo or another similar qualitative data analysis tool. This will allow you to systematically analyze trends, keywords, and methodologies across studies, offering a more meta-analytical perspective on the body of research. This could be an excellent way to identify common themes and gaps in the literature, further strengthening your manuscript.

Comments	Responses
<b>1. Literature Gaps and Missing Studies:</b>	
1.1. missing keywords: parametric insurance and weather derivatives	Thank you for your comment pointing out the missing keywords. The analysis was updated to November 2024 with the missing keywords. The method (lines 106 and 110) and the PRISMA flowchart (figure 1) was also updated accordingly. The manuscript has been revised with new results accordingly.
<p>1.2. suggested papers</p> <p>Enenkel, M., et al. (2018). Exploiting the Convergence of Evidence in Satellite Data for Advanced Weather Index Insurance Design.</p> <p>Hernández-Rojas, L. F., et al. (2023). The Role of Data-Driven Methodologies in Weather Index Insurance.</p> <p>Eltazarov, S., et al. (2023). The role of crop classification in detecting wheat yield variation for index-based agricultural insurance in arid and semiarid environments.</p> <p>Masiza, W., et al. (2022). Do Satellite Data Correlate with In Situ Rainfall and Smallholder Crop Yields? Implications for Crop Insurance.</p> <p>Tarnavsky, E., et al. (2018). Agro-meteorological risks to maize production in Tanzania.</p> <p>Eltazarov, S., et al. (2021). Mapping weather risk – A multi-indicator analysis of satellite-based weather data for agricultural index insurance.</p>	<p>Thank you for your suggestion. The suggested papers were identified through the search over databases. However, such studies were focused on either exploring the relationships between crops and various variables, or developing an index that can capture the crop loss and damage, to provide evidence and implications for developing an index insurance. They did not develop an index insurance solution with its attributes such as strike, tick values for triggers and payments, which is the focus of this study, and thus, they fall into the exclusion criterion at stage 1 of the process.</p> <p>While these papers did not meet the specific criteria for inclusion in our analysis, we recognize their importance and have incorporated some of them into the discussion section. These references helped us revise the discussion section and are now cited at relevant discussion points, specifically at line 572, and lines 575-576.</p>
<b>2. Improving the Structure of the Literature Review</b>	
<ul style="list-style-type: none"> <li>- Satellite-based land surface data (NDVI, LAI, soil moisture, ET, etc.)</li> <li>- Satellite-based weather data (CHIRPS, IMERG, CMORPH, CHIRTS, etc.)</li> <li>- Non-satellite-based data (in situ data, ground measurements, reanalysis data)</li> </ul>	Thank you for your suggestion. The authors have updated the analysis with the suggested classification in the methodology section (lines 148-159). The manuscript was revised accordingly with the updated analysis results.
<b>3. Integrating Meta-Analysis Tools:</b>	
To enhance the analytical rigor of your literature review, I recommend integrating all the cited literature into NVivo or another similar qualitative data analysis tool. This will allow you to systematically analyze trends, keywords, and methodologies across studies, offering a more meta-analytical perspective on the body of research. This could be an excellent way to identify common themes and gaps in the literature, further strengthening your manuscript.	Thank you for your comment. In the study, we applied the method of Systematic Quantitative Literature Review as mentioned in the Methodology section. The suggested NVivo is for qualitative data analysis while we are doing quantitative analysis. Still, we do agree that this is an important potential avenue for future research and so we have mentioned this point in section 4.5 (lines 625-628).