Dr. Vassiliki Kotroni

Editor

Natural Hazard and Earth System Sciences

October 25th, 2022

Re: Review of manuscript **egusphere-2022-498**

Dear Dr. Vassiliki Kotroni,

We are very grateful for each comment and suggestion made by the two referees, which turned our manuscript more powerful.

Our manuscript presented a systematic review of weather insurance design for food security considering multi-hazard risks. We observed that the recent literature provides little examples of multi-hazard risk analysis in weather insurance design.

Following the comments from the referees, we rendered the systematic review to highlight key findings and we expanded the section about our conceptual framework making it a separate sub-subsections and providing a study case for soybean production in Brazil.

The study case employs the methods for index calculation, loss modeling and premium pricing we found and the literature review and adds our view on how multi-hazard risk insurance should be designed when considering water deficit, heavy rainfall and extreme temperature. We applied kmean clustering to define multi-hazard scenarios and used random forest algorithms to predict losses for each scenario identified.

We suggest that this framework can be applied to more segments of the food supply chain such as transportation, storage and retail. Moreover, we identified emmering topics of weather index insurance such as hydrological and sustainable energy insurance.

We also made a very detailed revision throughout the manuscript to avoid English grammar and typos issues.

Additionally, we answered carefully point-by-point each comment made by the two anonymous Referees. Please see it below.

For this iteration of our manuscript submission we have the help of two co-authors: Prof. Dr. Patricia Marques and Dr. José Marengo. Their participation in the critical review of the manuscript was critical for us to adequate the old to the suggestions made by the referees.

We hope that the revisions in the manuscript accompanied by this supporting letter will now meet the requirements for publication in *Natural Hazard and Earth System Sciences*

Thank you for your consideration.

On behalf of all authors,

Marcos R. Benso

Anonymous Referee #1

General comments

The subject of the article 'Review article: Design and Evaluation of Weather Index Insurance for Multi-Hazard Resilience and Food Insecurity' is interesting. The review methodology is generally transparent. However, many issues need to be addressed. The overall presentation of results, discussion, and conclusions is very rough and often confusing. English is poor, with many grammatical and conceptual errors. The article requires professional editing to improve both language and readability. A major revision is needed before it can be accepted for publication in this Journal.
Response: We are very grateful for the comments and suggestions made. We reformulated the presentation of the methodology, results and discussion. In addition, we added a case study to elucidate the framework proposal. Regarding the english language editing, we made a detailed revision so it can be accepted for publication

Specific comments

Terminology is an issue. E.g. 'sustainable insurance' is used all over the article and implies insurance for sustainable energy production. However, the expression is not correct, as it actually means insurance that is sustainable. Or, the abstract's phrase 'preferred systematic reviews' probably refers to a specific review method (I assume PRISMA), but it is not evident at all the way it is used, i.e., as a common adjective.
Response: We agree with the reviewer. The terminology "sustainable insurance" was changed to "sustainable energy production insurance". We reformulated the abstract with extra attention to the reviewer's comment. The sentence was written as the following: *"There is a growing attention in the literature for the topic of weather index insurance and resilience of climate-sensitive sectors such as food production. [...]"*

The title promises a 'Design and Evaluation of Weather Index Insurance for Multi-Hazard Resilience and Food Insecurity'. However, we learn that the studied papers lack a multi-hazard approach, while the authors only refer to some examples that need to be studied. They do not propose any specific method to address this issue.

Response: Thank you for your comment. We agree about the lack of a multi-hazard approach and gave a better description of it in developing a study case. The study's methodology was described in the methodology section 2.2 (L132-169) and the results were presented in section 3.3.2 (L423-471). The study case allowed us to better discuss the conceptual framework and tackle the issue raised by the reviewer.

As in the title, the abstract also states that 'This paper aims to provide a state-of-art weather index insurance design.'This sounds quite promising. However, there is only 1 line dedicated to the design of Weather Index Insurance, in 3.2.3, L383-384: 'Finally, we present a conceptual framework derived from the literature review representing the weather index insurance design process (Figure 4).' Are this figure and the enclosed proposed design/process given as a result of the most used methods within the reviewed literature? Is this proposed design a synthesis that presents something new? How is multi-hazard resilience addressed in particular through this design? Finally, I would suggest a separate sub-section to present and discuss the proposed design, to support its effectiveness based on a case study, to highlight its effectiveness on multi-hazard index insurance, and, further, on resilience and food insecurity. Otherwise, the title and the abstract are not well connected to the results.

Response: As we stated in the previous response, we appreciate the suggestion and create a new subsection. The subsection is "**3.3 Conceptual framework and study case**" including the sub-subsections "**3.3.1 Conceptual framework**" (L403-421) presenting a synthesis of a new idea to address the multi-hazard problem we identified in the literature review. This includes the addition of common methods we found within the reviewed literature; and "**3.3.2 Study Case**" (L423-471) where we present Figures 5, 6 and 7 demonstrating the process of selecting multi-hazard risks using the well-known machine learning clustering method k-means. We also describe tables 3 and 4 to explore the study case results . We reformulated Figure 4 to better demonstrate how to address multi-hazard resilience and to incorporate the concepts of static and dynamic resilience. In addition, we reformulated the abstract to be consistent with the content of the article.

3.2.2: the entire section requires thorough English editing and better development. It seems very draft, full of sentences without verbs, confusing the reader. Also, the sub-sections 3.2.1-3.2.2 include some same comments and results. Several consecutive paragraphs should be merged as they deal with the same subject (see for example, L346-356, and many others…)

Response: Thank you for all your suggestions and comments. We made a detailed revision in order to avoid any language problems. The section 3.2 was reformulated as we previously stated and divided into two sub-subsections.

L313: Table S3 presents loss models. Vulnerability as a title is not mentioned. Either it is a misconception, or it needs clarification. Actually, the models are called

vulnerability models; however, their objective seems to be to estimate the loss and not the vulnerability.

Response: We thank the reviewer for this comment. We clarify throughout the text and supplementary material the difference between loss models and vulnerability models. In addition, we update the table S3.

Conclusions

The conclusions summarize the results but are written in a very rough form. L420: which gaps were observed? This should be highlighted in conclusions and complemented by suggestions.

Response: This is an important point and thanks you for pointing it out. We reformulated the conclusions, included explicitly the gaps, and made recommendations for future studies.

Technical comments

Abstract

L1: what do you mean by 'preferred' systematic reviews? PRISMA is not implied here; thus, it sounds like an awkward adjective.

Response: We replaced this statement for the following: "Weather index insurance has gained growing attention in the literature. Several approaches have been employed to determine indices, model losses and calculate fair premium rates, however, little attention has been given to define generalized approach that analyzes multi-hazard risk for insurance design."

L5: please correct: to 'the' present
Response: Corrected!

L10: This sentence needs grammar correction.

Response: We corrected this statement for the following: "Despite the great focus on food security, emerging fields such as hydrological and sustainable energy were found promissory for index insurance and will require further systematization".

Introduction

L18. References should be put in parenthesis
Response: Corrected L20.

L27: please delete the second 'the'
Response: Corrected L30.

L29: consider specifying that these are amounts for premiums per capita

Response: We added the "hab" symbol to make it clear: *"In one hand, the premiums per capita (hab) of the US and Canada were 7,270 USD/hab, much higher than the world average of 809 USD/hab and the Eurozone average of 2,723 USD/hab. On the other hand, in Latin America and the Caribbean, and emerging Europe and Asia presented 203, 159 and 215 USD/hab respectively. The numbers were much lower in Africa and the Emerging Middle East, representing 45 and 93 USD/hab"*

L34: please rewrite the sentence as a verb seems missing
Response: We corrected the sentence: *"The area-yield insurance model **was adopted** in the US in the early 90s, dividing agricultural areas in the crop domain into Group Risk Plans (GRP)"*

L58: please correct the reference presentation inside the sentence
Response: Corrected L61.

Methodology

L100. Please correct: 1192 studies were selected
Response: Corrected L101

Figure 2: (a) please include a legend for series
Response: Corrected.

Results

L161: Please consider rewriting the sentence to make sense
Response: The paragraph was reformulated and during this process, we rewrote the sentence, please see L223-225.

L163-165: these sentences have to be corrected for grammar and language. The parenthesis is awkward. Which study are the authors referring to??
Response: The sentence was removed and the paragraph was rewritten.

L170: please delete 'and' before 'wind…'
Response: Corrected L253.

Figure 3. Please use consistent fonts/colors…I don't understand the meaning of the box sizes and positions.
Response: We corrected the colors and fonts using a color blind and print safe divergent color sequence. The meaning of the boxes were added to the legend. The bigger the box size the more papers the index was used.

L198-199: please rewrite. The authors 'concluded' or just 'suggested'?

Response: The authors concluded since they performed a statistical analysis of the results.

L201: please put space before the parenthesis
Response: Corrected.

L218-219: please rewrite as the indices are not grammatically connected to the rest of the sentence.
Response: Corrected L308-310

L257: please consider rewriting; the sentence is not clear in what concerns the extreme of the distribution. May a verb be missing?
Response: We rewrote this paragraph L320-327

L260: A conjunction is missing (and or while…??)
Response: We rewrote this paragraph L320-327

L263: please correct: 'evaluated'
Response: We rewrote this paragraph L320-327

L264: please correct: 'by the increase in..'
Response: We rewrote this paragraph L320-327

L271: please rephrase. 'We observed an emerging topic affecting sustainability with a focus on sustainable energy generation' does not make sense.
Response: We are sorry if this sentence was not very clear. We made some improvements. Please see L328-337.

L266-270: this has been already said in previous sections
Response: Thank you for your suggestion. We removed the duplicated information. L320-327.

L271-276: I don't understand the difference between this paragraph and the last one in 3.2.1.
Response: We reformulated the paragraph, please see Please see L328-337.

L277-280: This paragraph is not well written. E.g., moral hazards cannot be neglected, but rather the opposite. They seem to be considered. Also, 'Basis risk, and it implies…' is grammatically incorrect and the sentence makes no sense.
Response: We reformulated the section 3.3.2 Vulnerability Analysis and we decided to remove this paragraph.

L283-284: Another sentence that is grammatically incorrect…Please rephrase.
Response: We reformulated the section 3.3.2 Vulnerability Analysis and we decided to remove this paragraph.

L293: what is meant by '..and its interaction'? interaction with what?
Response: We reformulated the section 3.3.2 Vulnerability Analysis and we decided to remove this paragraph.

L299: I am not sure I understand well this sentence. What method/tool was used and how were the hazards included as independent?
Response: We reformulated the section 3.3.2 Vulnerability Analysis and we decided to remove this paragraph.

L305-307: please clarify: 'this variable should be considered to improve the model's ability…' Which variable? Why 'should' it be considered'? based on which evidence?
Response: We reformulated the section 3.3.2 Vulnerability Analysis and we decided to remove this paragraph.

L311: consider putting a comma before 'giving'. Oherwise it does not make sense.
Response: We reformulated the section 3.2.2 Vulnerability Analysis and we decided to remove this paragraph.

L320: streamflow 'is' low
Response: sub-subsection 3.2.3 Financial methods and risk pricing was reformulated and this sentence was removed.

L321: which 'extreme condition'?
Response: sub-subsection 3.2.3 Financial methods and risk pricing was reformulated and this sentence was removed.

L322: 'sustainable insurance' sounds not appropriate. Do the authors mean 'sustainable energy production'??
Response: We updated it for "sustainable energy production insurance".

L341: what is meant by 'full information'?
Response: sub-subsection 3.2.3 Financial methods and risk pricing was reformulated and this sentence was removed.

L342: please correct 'They are calculated historical data…'
Response: sub-subsection 3.2.3 Financial methods and risk pricing was reformulated and this sentence was removed.

L341-345: this paragraph is confusing. Mixing non-index and index insurance as if this is the first time index insurance is mentioned, while this is the main subject of this review paper.
Response: The sub-subsection 3.2.3 Financial methods and risk pricing was reformulated and this paragraph was reformulated.

L347-348: grammatically incorrect sentence.
Response: The sub-subsection 3.2.3 Financial methods and risk pricing was reformulated and this sentence was reformulated.

Fig4: please correct : (c) amount. Also correct the figure caption: 'fnancial risk pricing (e) and (e) and (f)'
Response: The figure was reformulated.

L386: note that Table 2 should be in parenthesis, or included correctly in the sentence.
Response: We are sorry about this formatting error.

L398: WTP, what does it mean? Please clarify
Response: Thank you for noticing it. The acronym was explained. WTP means willingness-to-pay.

Paragraph L397-409: the entire paragraph has grammar mistakes, verbs missing, language issues. It requires careful editing
Response: The sub-subsection 3.2.3 Financial methods and risk pricing was reformulated and this sentence was reformulated.

Anonymous Referee #2

With the recent emergence of index insurance papers and the myriad approaches and hazards available, a review paper is warranted. The title indicates a focus on multi-hazards and food insecurity, however the manuscript moves far beyond these topics. Significant amounts of information spanning hazard type, variables, approaches, etc., are presented, which turns out to be overwhelming instead of comprehensive. Arguably the manuscript would benefit from a greater focus; presently it has too much breadth and lacks depth. In its current form, it is unclear how readers can benefit from this contribution. A reformatting of the presentation with a clearer emphasis and concrete take-aways could lead to a valuable contribution. Additional suggestions are presented below:
Response: We would like to thank you for your kind words in support of our study and for suggesting improvements to the manuscript. We are going to address each of your comments carefully.

Questions at the end of the Introduction section are very relevant, but also very broad. Perhaps focusing specifically on multi-hazards and food insecurity can help to focus the questions further (and presumably the manuscript as a whole.) Related, it's not well motivated why other sectors (e.g. energy) are included here. Unless they specifically relate to energy used in food production? Or tradeoffs between hydropower and allocations to agriculture? More specificity is strongly suggested to tighten the analysis and findings.

Response: Thank you for your comment. We believe that our work should undergo substantial improvements if we focus on multi-hazard and food security. We have enough material to focus on this aspect. We understand that trade-offs between other sectors it's a great suggestion for future work, so we discussed it briefly in the conclusions and future work.

Table 1: Are these Themes developed by authors or follow a commonly accepted methodology? More description is required on what centrality and density really mean and how best to be interpreted. Also, what is the reference for the numerical scale? 0-10? Finally, some clusters are described in numerous Themes. For example, Basic includes four clusters in the text, but only two in the figure.

Response: We thank you for your comment. We obtained these themes following the keyword clustering algorithm proposed by Cobo et al. (2011) and we determined it using the package bibliometrix in R Environment. Cobo et al. based their metrics on the concept of centrality and density of co-word analysis developed by Callon et al (1991). The method is a practical application of the Fuzzy Set Theory Field and does not have a specific scale. The values are relative to the number of papers analyzed, the number of citations in the documents, and the number of clusters generated by the co-word analysis. We described more clearly how these metrics – density and centrality – are calculated and how to interpret them in L.

The Hazard Identification section feels like a really long list, and it's unclear what the goal is in this section. Is it to essentially list the papers that go with each hazard? That could be doable in a large Table (perhaps appendix.) The descriptions of the hazards are basic enough that most readers should be familiar (and arguably aren't learning new information), perhaps with the exception of SPI or similar, but even then, most are likely to already know. It's of course necessary to identify the top hazards (e.g. Fig 3), but the text in its current form does not add much. The authors are encouraged to consider either simplifying (e.g. a Table as suggested) or taking a deeper dive into the details of hazard aspects identified and targeted in each paper.

Response: We thank you for your comment. We reformulated the entire section and described the hazard calculation in Table 2 in addition to an in-depth discussion of index selection and impacts on design and decision-making. We learned from the literature review that risk communication is much appreciated and farmers are more willing to purchase a policy when they understand risk.

The Vulnerability Analysis section appears to be a mix of discussing assets, variables, and modeling approaches. Perhaps the authors could consider an alternative presentation approach such as combining parts with the Hazard Identification section (e.g. have subheadings by hazard type that also includes assets at risk and relevant variables.) This could partially address the comment above. The description of modeling approaches does not appear to fit in this section, and is probably a stand-alone section.

Response: We appreciate your suggestion. We explained the concepts we adopted in the paper in L111-131. We believe that giving this context improves the understanding of our discussion. Furthermore, we addressed this comment and the previous by rewriting both subsections 3.2.1 Hazard Assessment and 3.2.2 Vulnerability analysis.

While the Financial Methods section relays the large number of design approaches, target outcomes, etc. It is unclear what the reader is supposed to take away from this section. Simply that there are many types? Or if a particular type sounds most appealing or relevant to their needs, then they can refer to the papers cited? Certainly some aspects are appealing, such as those that describe the pros and cons of a particular approach. The authors are encouraged to include more pros and cons to give the reader a more firm understanding and perhaps guidance for their own work.

Response: We thank you for your comment. We improved the discussion section and discussed the advantages and disadvantages of the models and potential implications in decision-making. Please see L353-401.

For the Conclusions, it may be a stretch to claim that a large number of papers (ag and crop insurance) leads to a 'high impact on index insurance'. It does mean the topic is perhaps more well studied than others, but I believe the impact is still very small. Also, I'm not sure this manuscript really points to the 'gaps in the field', and if it does, then this needs to come across much more strongly. Conclusions that point directly to multi-hazard and food insecurity should be front and center in this section. I suggest expanding this section.

Response: We thank you for your comment and agree with it. We reformulated the entire conclusion section with special attention to the gaps in the field. In addition, we expand the section to shed more light on food security and multi-hazard.

The Reviewer acknowledges that review papers are challenging to write. The authors are encouraged to highlight their motivation for assembling the manuscript, more clearly focus the topics, and articulate precisely what they want readers to glean from this contribution.

Response: We once again thank the reviewer for carefully reading our manuscript and being so insightful. We try our best to address all the questions, particularly; we will focus more on the implications of multi-hazard risks in food security.