

Response to Reviewer 1 – Second round of revision

We thank the reviewer for her/his/their appreciation, for following through with this review in the second round, and for providing us with more suggestions to improve the paper. We are grateful for all the provided support and remain dedicated to further refining the paper.

Please find below the point-by-point responses.

The reviewers' comments are written in italics, and our responses are in regular font. We chose blue and italic formatting for citations from the manuscript.

All of the line numbers refer to the version of the manuscript reviewed in the second round.

R1: *I thank the authors for their consideration of my and my fellow reviewers' comments. I feel that the paper has become significantly sharper and improved a lot. I found the narrative and 'red thread' much easier to follow, and I believe that by reducing the papers objectives, it now does not aim to present too much work. The introduction, while I feel still needs some adjustments, is more focused and the research gap comes out more clearly. The setting the scene is now a much more appropriate length and to the point, providing enough and relevant information. The methodology is now clearer and the results are presented more strongly by reducing the number of tables and figures. This discussion has improved. I still feel the paper needs another round of revisions before it can be published in NESS. Find below my comments on specific sections.*

Abstract

'Within multi-hazards, both the impacts of hazards and the mitigation strategies can augment vulnerabilities, adding layers to the complexity of multi-risk assessments.' - This statement is also true in a single hazard context, additionally, what is meant by within multi-hazards? Suggest to change to 'in a multi-hazard context'

Response: Because of the word count constraints specific to the Abstract, we chose not to further define multi-hazard, but to change the phrase as per the reviewer's thoughtful recommendation (line 11).

Introduction

R1: *'Given the increased frequency of co-occurrent or cascading hazards, vulnerability consolidated its key position in multi-risk analysis because the impact of multiple hazards and adaptive strategies reshaped its spatial and temporal dynamics.'* – This is a rather strange formulation, as vulnerability is already key in single risk analysis. I also do not fully understand what is meant by impacts and adaptation reshaping spatial and temporal dynamics of vulnerability. This needs unpacking. I would also adjust the language in the introduction as its currently framed as if vulnerability itself has consolidated its position or done something, it should be written in the third person.

Response: We appreciate this suggestion. The indicated phrase was reformulated in the third person (lines 60-62), and the unpacking of the meaning is detailed at lines 68-82.

R1: *Review use non-scientific language including words and phrases throughout the paper such as ‘tall order’, ‘conundrum’, ‘hot topic’ ‘dwells on impact chains’*

Response: We took into consideration this recommendation of the reviewer and we have made adjustments accordingly by reducing the usage of such language throughout the paper. Nevertheless, some idioms in the English language were kept, as they are largely accepted in scientific publications.

R1: *Lines 113 – 114: ‘Such efforts are vital for elaborating post pandemic update risk management plans’ – Remove ‘Update’*

Response: The modification was implemented (line 92) as kindly suggested by the reviewer.

R1: *The paragraph between lines 120 – 130 is more of a conclusion to your work and should not be in the introduction.*

Response: After careful consideration about this suggestion, we decided to keep the paragraph in place, as it highlights the contribution of the paper to the field of research and rounds out the Introduction. We acknowledge the argument of Otto and Raju (2023) of utmost importance for motivating the need for such studies and the conceptual framework presented in the manuscript. Please note that the Introduction was restructured based on the recommendations of the second reviewer.

Setting the scene

R1: *The opening sentence here (lines 133 – 135) is not well places and should be shifted down to a more appropriate position*

Response: The indicated opening sentence was moved to lines 331-335, as part of the methodology section 3.1. Building the Impact Chain.

R1: *Figure 1 has merit and is interesting to show, however can the formatting/ size be adjusted so it is larger and more clear?*

Response: We thank the reviewer for the attention dedicated to this detail. The resolution of Figure 1 was increased to 700 dpi in order to make it clearer. Also, if possible, we will kindly ask the editorial staff to increase its size and place it on a whole page.

Methodology

R1: *Lines 286 - 288: “This approach aligns with Zebisch et al. (2021) recommendation that the “relatively linear and sectorial approach of impact chains could be widened to impact webs, which would include feedback relations and cross-connections.” -*

Suggest to include the following citation for this statement: Sparkes. E., Hagenlocher, M., Cotti, D. et al. (2023). Understanding and characterizing complex risks with Impact Webs: a guidance document. UNU-EHS, Bonn, Germany

Response: We thank the reviewer for this reference, which was included as support for the argument at line 313.

R1: *Line 313 + Figure 3: What are on-point examples? It would be helpful to explain this*

Response: We formulated this phrase to be clearer, as we did not intend to highlight any particular examples (lines 337-339): *The first phase of the building process (Figure 3) relied on a literature review regarding the impacts of flood events and the pandemic, complemented by a supplementation of examples specific to the flood hazardous events in 2020-2021 collected from studying the grey literature.*

The elements of the Impact Chain that were extracted from grey literature sources (i.e., news reports) are visible in the [Impact Chain on Kumu](#). We also revised Sections 3.1 and 3.2 to improve the flow of the explanations and to ensure that all methodological steps correspond to Figure 3. This revision amends the confusion indicated by the reviewer.

R1: *Line 335: ‘Cumulatively, the Impact Chain drew from 46 scientific papers (including one on the feedback of first responders), one legislative document, one official press release, one Eurostat statistical dataset, 6 official reports, and 75 news reports.’ – it also drew on the feedback from 595 first responders as well didn’t it? I would include this knowledge source in this sentence as well, as it is very important*

Response: We thank the reviewer for pointing out this important aspect that was unintentionally left out. The information was added at line 364 and detailed in the next paragraph (368-373).

R1: *Lines 411-412: “Within the new conceptual framework of the enhanced Impact Chain (Figure 4), certain augmented vulnerabilities stand out also as impacts that deepen the impact that increased the vulnerability in the first place” – this sentence is hard to understand, how is an augmented vulnerability also an impact that deepened an impact that increased the initial vulnerability? Are you talking about feedback effects here? How is the ‘sharpen’ connection different from a feedback effect. I suggest to review the paragraph on lines 411 – 419 and rewrite so as it is more clear and understandable.*

Response: We greatly appreciate the reviewer for highlighting this misunderstanding. Please note that the indicated paragraph was revised to enhance clarity and understanding (lines 418-428): *Within the new conceptual framework of the enhanced Impact Chain (Figure 4), certain vulnerabilities, upon augmentation by an impact, can also act as impacts that further on deepen the very impact that increased the vulnerability in the first place. This process represents a positive feedback loop, where the initial impact augments a vulnerability that can be viewed afterwards as a (derived)*

impact that will reinforce the first impact in the future. Such augmented vulnerabilities that also act as impacts were introduced in the enhanced Impact Chain as derived impacts and linked to the vulnerability element that they share their name with by “relates to” connections. These “relates to” links are not visible within the enhanced Impact Chain in Kumu in order to reduce the visual strain. Subsequently, the derived impacts were linked with the impact that deepened/shifted the corresponding vulnerability by a newly introduced type of connection referred to as “sharpens” (Figure 4). These “sharpens” connections convey the message that the augmented vulnerability will intensify the impact that initially augmented the vulnerability, rendering this impact more prominent than before.

R1: *I feel it would be good to distinguish somewhere how you classified something as an impact and something as a vulnerability, as in the results I feel there is some overlap between the two. This would help the reader with clarification of statements on line 627 such as “When augmented, certain vulnerabilities act like impacts and reinforce the impact that increased the vulnerability in the first place.”*

Response: The classification of certain elements in the Impact Chain as impacts or vulnerabilities was based on the guidelines provided by UNDRR (2017) and by Pittore et al. (2023). This was clarified at lines 315-326: *The structure of an Impact Chain includes elements that can be considered the fundamental units of a hazard-related context and the connections established between them. The elements can take the form of hazards, impacts, exposed elements, vulnerabilities, and adaptation options, defined according to the Sendai Framework Terminology on Disaster Risk Reduction (UNDRR 2017). Given the central role of impacts, vulnerabilities, and adaptation options in the proposed vulnerability augmentation framework, we consider that their meaning should be highlighted here. In this paper, impacts particularly refer to the negative effects of a hazardous event or a disaster, while vulnerability represents the “conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards” (UNDRR 2017). Adaptation options are measures meant to attenuate the negative impacts by addressing one or more vulnerabilities or impact mechanisms (IPCC 2014a). These elements are organised in a chain-resembling structure that relies on different connection types: causes, affects, relates to, impacts, and mitigates. Detailed guidelines on how such connections were established within the Paratus Project are provided by Pittore et al. (2023) and PARATUS Deliverable 1.1 (2023).*

In addition, please note that the statements at lines 627 of the previous version of the manuscript were rewritten for increased clarity (lines 418-428).

Results

R1: *Lines 442 – 445: “This section focuses on the augmentation of vulnerability stemming from certain flood or pandemic impacts and of the adaptation options implemented to mitigate vulnerabilities and/or impacts” – Here you separate flood and pandemic impacts, but in the problem statement you say you are looking at co-occurring and compounding impacts.*

Response: We thank the editor for highlighting this nuance. Indeed, we are looking at co-occurring and compounding events (which are all included in the Impact Chain). The phrase was modified to eliminate the confusion (lines 447-448).

R1: *Lines 557 – 559: “Most of the vulnerabilities contribute to prominent multi-hazard impacts such as the flooded/damaged houses or households, the flooded/damaged/blocked roads, the displaced/(self-) evacuated people, increased stress or anxiety, and the potential increase in COVID-19 new cases” – these are not all multi-hazard impacts, the first three are flood hazard impacts, increased stress/anxiety could be considered multi-hazard, and increase in COVID-19 cases multi-hazard if you are explicit in saying flooding resulting in less social distancing, resulting in increased COVID cases, in which case it would be a cascading impact of flooding. I suggest you review here.*

Response: Indeed, the first three impacts are flood-related, and the last two are multi-hazard impacts. The potential increase in COVID-19 new cases was considered a multi-hazard impact, as it results from reduced social distancing and evacuation of the population because of the floods (please see the [Impact Chain on Kumu](#) for more details on this last impact or Albulescu 2023). We appreciate this thoughtful suggestion and revised it accordingly (lines 456-458).

R1: *Line 575: “When it comes to adaptation options, only 30.76% of the vulnerabilities were mitigated by such elements” – Do you mean adaptation options mitigated the effects/ were targeted to 30% of the vulnerabilities identified in the Impact Chain?*

Response: Yes, this is the intended meaning of the phrase. To resolve the confusion, the phrase was rewritten (lines 473-477). We are very grateful for this thread of meticulous observations.

R1: *I do not think its necessary to present percentiles to two decimal places, e.g.: “, 27.77% to the COVID-19 pandemic, and 22.22% to both hazards.” Consider just saying 28% and 22%, and integrate this throughout.*

Response: The percentages were rounded up as suggested by the reviewer throughout the paper.

R1: *Lines 629 – 634: “Some vulnerabilities were transformed into derived impacts more than once underwent multiple transformations into derived impacts, resulting in a larger number of cases where the augmentation of a vulnerability created a derived impacts (15 cases), compared to the number of actual derived impacts (9) in the chain. The explanation lies in the fact that multiple impacts can augment the same vulnerability, creating also a derived impact that reinforce the impact that generated the augmentation.” – I find this formulation very hard to understand and convoluted. I strongly suggest to look throughout the paper again when describing this effect/ phenomenon you have observed in your results and explain it in another way that is more clear and easy to understand.*

Response: We are grateful to the reviewer for indicating these confusions that we amended throughout the paper (lines 418-428, 522-528). Section 4.3 was revised and modified to facilitate the understanding of the mechanism of derived impacts. It was also improved in terms of visual support by introducing a new figure (Figure 6).

The new paragraph reads: *When augmented, certain vulnerabilities can function similarly to impacts, reinforcing the very impact that initially increased the vulnerability, forming a positive loop feedback composed of “deepens/shifts” links and “sharpens” links. Such augmented vulnerabilities with double status were duplicated in the enhanced Impact Chain and labelled as “derived impacts”, as detailed in Appendix B. Some vulnerabilities underwent multiple transformations into derived impacts because they acted as (derived impacts) in relation to more than one augmentation-generator impact (Figure 6). This resulted in a larger number of cases where the augmentation of a vulnerability created a derived impacts (15 cases) compared to the number of actual derived impacts (9) in the chain.*

R1: *Line 685: “while the low-performance medical system is specific to the pandemic” – Is it? The medical system would have also been put under strain from those injured from floods, suggest to be specific here if talking about performance for COVID-19 treatment*

Response: We agree with this keen observation of the reviewer on a general basis. However, this is not the case, as no flood injuries were reported in 2020 and 2021 in Romania. Therefore, the low-performance medical system is a vulnerability specific to the pandemic.

R1: *Line 681: “with the goal of pinpointing those vulnerabilities expected to experience the most substantial increase” – I am still struggling here to see how your statistical analysis can be used as a projection for expected future increase. When you say increase, do you mean those vulnerabilities that were most influenced by the past event of an extreme flood co-occurring with the COVID-19 pandemic, which can then point to where risk management and preventative interventions should be targeted for future? I feel this framing would better suit what you are showing with your work.*

Response: We thank the reviewer for pointing out the need to better highlight the role of the ranking procedure. This procedure for identifying the most augmented vulnerabilities is presented at lines 431-445. By building augmentation links between impacts and vulnerabilities (i.e., deepens, shifts) and between adaptation options and vulnerabilities (i.e., rebounds, creates negative externalities), we can identify which vulnerabilities are expected to increase in the future and because of what causes (for this, please see Section 5.1. Conceptual paths of rising vulnerability). The ranking of the augmented vulnerabilities is presented in the dedicated Section 4.4. Ranking of augmented vulnerabilities.

By increase in vulnerability, we mean that those levels of vulnerability are expected to be higher in the future, providing the next hazardous events will lead to similar impacts, and that similar adaptation options will be implemented to mitigate those vulnerabilities.

This explanation was added at lines 580-585.

Discussion

R1: *“Interest in vulnerability dynamics has surfaced since 2020 0, and discussions have remained at a theoretical level (de Ruiter and Van Loon 2022), with no case study up to date.” – This is incorrect, there has been interest in vulnerability dynamics for a far longer time than 4 years, and many case studies on it.*

Response: We thank the reviewer for correcting this information. In the manuscript, it was amended as (lines 98-100): *Although vulnerability dynamics has gained traction over the last decades, interest in vulnerability dynamics within multi-hazard contexts has surfaced since 2020, and discussions have remained at a theoretical level (de Ruiter and Van Loon 2022), with no case study up to date.*

R1: *“This improved version of the chain” – I would strongly avoid using this kind of framing, your adjustments to the Impact Chain method are relevant for your own work and research context here, they do not necessarily improve impact chains per se. This very much depends on what you want to achieve.*

Response: We thank the reviewer for drawing attention to this improper formulation. The improvement refers mainly to the initial version of the Impact Chain (developed within the Paratus project). However, adapting the method to fit the purpose of analysing vulnerability augmentation can only be considered an enhancement of the method in that specific context.

R1: *“The dual functionality highlights the capability of the methodological framework to account for both changes in vulnerability and the intricacies of multi-hazard impacts” – What do you mean by intricacies of multi-hazard impacts? Interconnectivity?*

Response: Yes, this is the intended meaning. To increase clarity, we replaced “intricacies” with “interconnectivity” (line 113).

R1: *“Finally, the paper provides a limited view on the dynamics of vulnerability, relying only on two temporal pictures captured by the initial Impact Chain and the enhanced version of it.” – Unless I am misunderstanding, in your results do you not suggest that the enhanced impact chain can show vulnerabilities expected to experience the most substantial increase, thus as a predictive tool? If I have grasped this correctly your limitations contradict your results here.*

Response: We thank the reviewer for drawing attention to this unclear formulation. Our intention was to suggest that developing Impact Chains with the same multi-hazard context for multiple years and tracking the progression of vulnerability augmentation along multiple moments in time (more than two temporal pictures) would represent a more refined and comprehensive approach. This is our plan for future research works that will build upon the findings presented in this paper. This issue was clarified at lines 140-142: *In the future, the development of Impact Chains within the same multi-hazard context but for multiple years, and the tracking of the augmentation of vulnerability across multiple temporal snapshots will yield more nuanced results that can also be validated with narratives from grey literature.*

R1: *I also feel a deeper reflection on the limitations of your methodological, in particularly your classifications of vulnerabilities and impacts, and your statistical analysis to rank vulnerabilities would be more appropriate in section 5.3. rather than reflecting mostly on data limitations.*

Response: We thank the reviewer for this suggestion. The methodology-related limitations presented in Section 5.3. are (lines 133-144): *The implication of stakeholders in the construction of the multi-hazard Impact Chain is limited to the feedback provided by first responders who performed on-site emergency interventions during the floods of 2021 (Fekete et al. 2023). Future research directions focus on a broader involvement of different stakeholders in order to maximise the benefits of co-produced knowledge and refine the details specific to the multi-hazard context from a transdisciplinary perspective. A notable methodological limitation refers to the lack of testing against other case studies and external validation; which we plan to address in the future by applying the methodological framework to other Impact Chains focusing on different multi-hazard situations. Finally, the paper provides a limited view on the dynamics of vulnerability, relying only on two temporal pictures captured by the initial Impact Chain and the enhanced version of it. In the future, the development of Impact Chains within the same multi-hazard context but for multiple years, and the tracking of the augmentation of vulnerability across multiple temporal snapshots will yield more nuanced results that can also be validated with narratives from grey literature. Some of these methodological limitations are inherent to Impact Chain-based analyses, as highlighted in the literature review performed by Menk et al. (2022).*

Respectfully yours,
The Authors

Response to Reviewer 2 – Second round of revision

We are grateful to the reviewer for her positive feedback, thorough engagement in the second round of review, and for the new valuable additional recommendations. We deeply appreciate all the support and further commit to integrate the provided insights to enhance the quality of our research work. Please find below the point-by-point responses.

The reviewers' comments are written in italics, and our responses are in regular font. We chose blue and italic formatting for citations from the manuscript. All of the line numbers refer to the version of the manuscript reviewed in the second round.

R2: *I sincerely thank the authors for kindly replying to all my comments and putting valuable effort into improving the readability of their manuscript. The paper is now clearer and generally easier to read and understand. Nevertheless, I still recommend fixing the following aspects before publication:*

1. Introduction.

R2: *Despite the implemented changes, the narrative of the Introduction remains fragmented. Lines 22-32 introduce the challenges of the COVID-19 pandemic. Then, the focus shifts to the evolution of multi-(hazard)-risk approaches and the related terminology, followed by vulnerability and its dynamic nature. After several lines, the discussion returns to COVID (line 62). Furthermore, the paper's aim is presented in a disjointed manner (lines 42-44, then lines 92-94, and finally 107 onwards). I suggest the authors reorder the concepts and present them in a more linear and logical sequence. This will not only enhance readability but also strengthen the presentation of the quality and added value of the work.*

Response: The Introduction was rewritten according to the suggestions of the reviewer and enhanced for clarity.

2. Setting the scene.

R2: *I suggest modifying the title of Section 2.1 to "Flood risk occurrences in Romania".*

Response: We appreciate this recommendation, and decided to simplify by renaming Section 2.1 as "Flood Risk in Romania".

R2: *In lines 119-120, the authors state, "Other secondary hazards (e.g., strong wind, landslides) co-occurred with the other two, but their role was of lesser significance in the analyzed multi-hazard context." It would be beneficial for the authors to provide further clarification. Does "lesser significance in the analyzed multi-hazard context" imply that these secondary hazards were less impactful compared to the other hazards under consideration?*

Response: Yes, this is the intended meaning. This was clarified at lines 331-335.

R2: Line 146, “Flood risk management is not sufficiently documented in Romania, as demonstrated by the lack of databases regarding the occurrence and impacts of floods”. I think it would be more appropriate to avoid mentioning risk management here and rephrase it as follows: “Flood occurrences and the quantification of their associated impacts are not sufficiently documented in Romania, as evidenced by the absence of relevant official databases.”

Response: The phrase was modified according to the instructions (lines 236-238).

3. Methodology.

R2: Thanks to the restructuring performed by the authors, this part is now much easier to read and understand. To further improve it, I suggest clarifying the following:

It is not so immediately clear to the reader if the authors built their impact chain from zero following the methodology developed in the Paratus Project, or if they used as a starting point an Impact Chain developed in the Paratus project but based on the methodology developed outside the project by Eurac. I mainly refer to this unclear sentence: “Building the Impact Chain initially developed within the Paratus Project” (lines 201-202). I invite the authors to clarify this aspect from the beginning.

Response: The authors of the paper are the same as the ones of the initial Impact Chain, that was built within the Paratus project. The enhanced version of this Impact Chain is a continuation of our work that stepped outside the project. We thank the reviewer for highlighting this misunderstanding that was amended at lines 292-294: *The next section presents two distinct workflows within the methodological framework (Figure 3): building the Impact Chain initially developed by the authors within the Paratus Project (PARATUS Deliverable 1.1 2023) – which was further strengthened by first responders’ input and, secondly, its enhancement to account for vulnerability augmentation.*

R2: *The synthetic explanation of the Impact Chain construction in Section 3.1 lacks mention of all the steps depicted in Fig. 3. Furthermore, even when these steps are referenced, the text doesn't consistently use the labels that appear in the figure. To enhance the clarity of the methodology, I encourage the authors to ensure better alignment between the text in Section 3.1 and the content depicted in panel 1 of Figure 3.*

Response: We express our gratitude to the reviewer for this meticulous and important observation. We revised both Section 3.1 and Figure 3 and provided an updated description of the methodology related to the building of the Impact Chain (lines 315-373).

R2: *Section 3.2 would benefit from minor restructuring to enhance reader comprehension of the steps outlined. The authors wrote “This broadening of the original application of the Impact Chain was done by 1) introducing new types of elements (i.e., augmented vulnerabilities, derived impacts), 2) establishing new types of connections between the impacts/adaptation options and vulnerabilities, and 3) ranking the vulnerabilities in the Impact Chain based on their augmentation. These steps were implemented to construct an enhanced Impact Chain, building on the*

previous version that documented the unfolding of the selected co-occurrent hazards in Romania in 2020-2021.”, but then, a few lines later, they start saying that “The first step was to perform an in-depth analysis of the vulnerabilities in the Impact Chain.”. To ensure coherence, it is essential to present the steps in the correct order, and, also in this case, to refer more to the steps reported in Fig.3. Additionally, it would be helpful to introduce and define the new types of elements (i.e., augmented vulnerabilities, derived impacts) earlier in the text, perhaps before discussing the new types of connections. This anticipatory approach can enhance clarity and understanding for the reader.

Response: The Methodology section was revised according to the guidelines. We listed all the steps in the right order (lines 381-445). However, to introduce the meaning of augmented vulnerabilities or derived impacts earlier in the paper or section (although having the merits mentioned by the reviewer) would contradict the order of the steps in Figure 3. First, we have to present the connections that express the augmentation, and then, based on those connections, we can identify the augmented vulnerabilities and the derived impacts. Introducing these elements earlier would be confusing to the reader without firstly presenting the connections. Nevertheless, we hope that Section 3.2 reads better now and that the augmentation framework is easier to understand. Please note that we also revised the explanation of derived impacts (lines 418-428) to facilitate its understanding.

4. Results

R2: Lines 398-401: “Some vulnerabilities underwent multiple transformations into derived impacts [...] The explanation lies in the fact that multiple impacts can augment the same vulnerability, creating also a derived impact that reinforce the impact that generated the augmentation.” The concept expressed in these sentences is not so easily understandable. I invite the authors to consider rephrasing it.

Response: We appreciate this insightful observation which was also brought forward by the other reviewer. We amended the explanations about derived impacts throughout the paper (lines 418-428, 522-535). The new paragraph highlighted by the reviewer now reads: *When augmented, certain vulnerabilities can function similarly to impacts, reinforcing the very impact that initially increased the vulnerability, forming a positive loop feedback composed of “deepens/shifts” links and “sharpens” links. Such augmented vulnerabilities with double status were duplicated in the enhanced Impact Chain and labelled as “derived impacts”, as detailed in Appendix B. Some vulnerabilities underwent multiple transformations into derived impacts because they acted as (derived impacts) in relation to more than one augmentation-generator impact (Figure 6). This resulted in a larger number of cases where the augmentation of a vulnerability created a derived impacts (15 cases) compared to the number of actual derived impacts (9) in the chain.*

R2: Despite “the intricate configuration of the Impact Chain does not allow for a proper visualisation within this paper”, I think that it would be highly beneficial, even essential, to include some graphical representations of the derived impacts described verbally in Section 4.3. This section constitutes the core of the work and would be communicated more clearly and effectively by introducing some ‘extracts’ from the Impact Chains to aid in visualization.

Response: This is a valuable suggestion, and we are thankful for it. Indeed, Section 4.3 Derived impacts would benefit from visual support. This was included as the new Figure 6, and the text of the section is now linked to different parts of this figure, facilitating the understanding of the mechanism of derived impacts.

R2: *Moreover, I strongly suggest the authors double-check grammar and typos.*

Response: We thank the reviewer for flagging this issue. Please note that the paper was spell-checked and reread again, and the identified errors were corrected, as can be seen throughout the text.

Respectfully yours,
The Authors