Reply to the Reviewer

Re: Manuscript ID Preprint egusphere-2025-262
"Review article: Rethinking Preparedness for Coastal Compound Flooding: Insights from a Systematic Review"
Dina Vanessa Gómez-Rave, Anna Scolobig, Manuel del Jesus
Natural Hazards and Earth System Sciences - NHESS

Response to Reviewer 1
We thank Professor Cosmina Albulescu for her thoughtful and constructive second review. We have carefully considered all comments and revised the manuscript accordingly. The observations were particularly helpful in refining key concepts and improving the overall clarity and coherence of the text. Below, we provide a detailed point-by-point response.

Review Report

I appreciate the efforts deployed by the authors to improve the paper. The changes include the addition of hazard and hazard driver definitions, the number of reviewed papers, as well as clarifications on the aim, preparedness, etc. Moreover, almost all figures were edited and greatly improved in terms of expression capacity and readability. All of these additions or clarifications enhance the quality of this study.
However, there are still some issues to be addressed (the lines refer to the clean manuscript, not the one with track changes):

- **Line 9: river discharge is not a hazard driver (river flow is, not the discharge itself), and storm surges are hazards themselves. Please rephrase.**

  We respectfully note that both storm surge and river discharge are widely recognized in the literature as key drivers of compound coastal flooding. Studies—including Bevacqua et al. [2020], Zscheischler et al. [2020], Latif and Simonovic [2023], and Green et al. [2025]—consistently describe compound flood events as resulting from the interaction of multiple source variables, including these two. While we acknowledge the reviewer's point regarding language use, our approach aligns with prevailing conventions in this research domain.

  In particular, we follow the framework proposed by Zscheischler et al. [2020], which provides a well-established conceptual basis for compound event classification. This framework is widely adopted in the compound flooding literature. Given this broad and accepted usage, we suggest retaining the terms *river discharge* and *storm surge* as drivers in the revised manuscript. Nonetheless, we remain open to clarifying this choice—via a footnote or a definition box—should the reviewer or editors consider it necessary to prevent potential misunderstandings.

- **Line 27: I do not see the point of adding this ("—often exceeding existing response capacities (Simpson et al., 2023)") to the end of the phrase. It creates confusion.**

  To improve clarity, we have revised the sentence so that the reference to Simpson et al. [2023] is more seamlessly integrated into the overall meaning. The updated version now reads (Lines 26-28):

  "The greatest risks from a changing climate may not arise from single hazards, but from the interaction of multiple climatic drivers and/or hazards combined with diverse forms of exposure, intersectional socio-economic and geopolitical vulnerabilities—often challenging the capacity of institutions and communities to respond effectively (Simpson et al., 2023)."

- **Lines 49–53: ("The interplay among these components can result in compound risks, arising from single extremes or co-occurring events affecting critical systems or sectors (IPCC, 2023)"): the interplay of the stated elements makes up the risk, not the compounded risk. Compounded risks arise from multiple hazards (co-occurrent or sequential). Please read IPCC (2023) with greater attention and correct.**

  We acknowledge the comment and have carefully revisited the relevant definitions provided in IPCC (2023). The report defines compound risks as those "arising from the interaction of hazards, which may be characterised by single extreme events or multiple coincident or sequential events that interact with exposed systems or sectors." It further clarifies that compound events refer to the combination of multiple drivers and/or hazards.

  Accordingly, in the revised manuscript, we now state (Lines 43-46):

  The interplay of multiple drivers and/or hazards can lead to compound events—such as co-occurring extremes—and their intersection with exposed and vulnerable systems may result in compound risk (IPCC, 2023). This conceptual framing provides a basis for analysing how interacting climatic conditions can evolve into complex events—and how their consequences ripple through interconnected systems.

- **Lines 90–95: The idea attributed to Armaș et al. is not actually correct. Our study aims to analyse systemic vulnerability (not risk as indicated by the authors of the reviewed manuscript) using a new Systemic Vulnerability Model. The model relies on the Enhanced Impact Chains (EIC) introduced in Albulescu and Armaș (2024), so that the vulnerability dynamics tracked using the EICs are used as a key element of capturing systemic vulnerability. In short, I advise the author to cite both sources and modify the paragraph to really convey the results of the cited papers. Please see a suggestion below:**

  Systemic vulnerability refers to the susceptibility of interdependent systems—such as infrastructure networks, governance structures, or social services—to suffer disruption under external stress, due to the cascading effects that arise from their internal linkages (Weir et al., 2024). A recently proposed definition of systemic vulnerability is that related to the persistent core of vulnerability that endures over time despite mitigation efforts, societal and technological progress, leading to reinforced impacts (Armaș et al., 2025). This core can be depicted only by studying vulnerability dynamics across space and time, using new operational tools that can trace this dynamics (Enhanced Impact Chains, as proposed by Albulescu and Armaș, 2024). Systemic risk, in turn, captures the potential for these disruptions to propagate across sectors and scales [find proper citation here], resulting in widespread and often unforeseen consequences (Armaș et al., 2025). This can further exacerbate systemic vulnerability as a persistent condition that can amplify future impacts or obstruct adaptive responses, even in the presence of mitigation efforts. Such a perspective situates compound risk within the broader dynamics of interdependence, where systemic conditions shape not only the onset of these impacts but their amplification and persistence.

  If the authors do not wish to address these issues on the topic of systemic vulnerability, I kindly ask them to not refer to such concepts at all.

  To address this point, the paragraph has been reworded in line with the reviewer's suggestion, incorporating the cited works to better reflect the intended conceptual distinctions (Lines 47-56).

- **I appreciate the detailed answer to this question in my first review report ("What were the relevant and irrelevant records that served as the foundation for training the first machine learning model?"). Your approach is indeed robust, but the manuscript's text does not leave the reader with this impression. Please add more details from this answer into the methodology section in order to ensure clarity.**

  Section *3.2 Article screening and data analysis using Active Learning Process* was revised and rewritten to incorporate these details, including the number of labeled abstracts, the use of random sampling, and the exclusion of titles to minimize bias (Lines 268-299).

- **Please check Table 2 and delete the extra commas.**

  The extra commas in Table 2 have been removed.

- **Line 703: delete the extra closing parenthesis.**

  The extra parenthesis has been corrected.

- **I recommend including the Limitations as a subsection of the Discussion.**

  Thank you for the suggestion. We have incorporated the limitations into a dedicated subsection (5.3) under the Discussion section.

Finally, I commend the authors on their work. If the editor considers that I should review the implementation of the minor revision, I am happy to do so.

We appreciate the reviewer's engagement and constructive input throughout the review process. We would of course welcome any further feedback.

References

E. Bevacqua, M. I. Vousdoukas, T. G. Shepherd, and M. Vrac. Brief communication: The role of using precipitation or river discharge data when assessing global coastal compound flooding. *Natural Hazards and Earth System Sciences*, 20(6):1765–1782, 2020. doi: 10.5194/nhess-20-1765-2020. URL https://nhess.copernicus.org/articles/20/1765/2020/.

Joshua Green, Ivan D. Haigh, Niall Quinn, Jeff Neal, Thomas Wahl, Melissa Wood, Dirk Eilander, Marleen De Ruiter, Philip Ward, and Paula Camus. Review article: A comprehensive review of compound flooding literature with a focus on coastal and estuarine regions. *Natural Hazards and Earth System Sciences*, 25 (2):747–816, February 2025. ISSN 1684-9981. doi: 10.5194/nhess-25-747-2025. URL https://nhess.copernicus.org/articles/25/747/2025/.

Shahid Latif and Slobodan P Simonovic. Compounding joint impact of rainfall, storm surge and river discharge on coastal flood risk: an approach based on 3d fully nested archimedean copulas. *Environmental Earth Sciences*, 82(2):63, 2023.

Nicholas P. Simpson, Portia Adade Williams, Katharine J. Mach, Lea Berrang-Ford, Robbert Biesbroek, Marjolijn Haasnoot, Alcade C. Segnon, Donovan Campbell, Justice Issah Musah-Surugu, Elphin Tom Joe, Abraham Marshall Nunbogu, Salma Sabour, Andreas L.S. Meyer, Talbot M. Andrews, Chandni Singh, A.R. Siders, Judy Lawrence, Maarten Van Aalst, and Christopher H. Trisos. Adaptation to compound climate risks: A systematic global stocktake. *iScience*, 26(2):105926, February 2023. ISSN 25890042. doi: 10.1016/j.isci.2023.105926. URL https://linkinghub.elsevier.com/retrieve/pii/S2589004223000032.

Jakob Zscheischler, Olivia Martius, Seth Westra, Emanuele Bevacqua, Colin Raymond, Radley M. Horton, Bart Van Den Hurk, Amir AghaKouchak, Aglaé Jézéquel, Miguel D. Mahecha, Douglas Maraun, Alexandre M. Ramos, Nina N. Ridder, Wim Thiery, and Edoardo Vignotto. A typology of compound weather and climate events. *Nature Reviews Earth & Environment*, 1(7):333–347, June 2020. ISSN 2662-138X. doi: 10.1038/s43017-020-0060-z. URL https://www.nature.com/articles/s43017-020-0060-z.

Reply to the Reviewer

Re: Manuscript ID Preprint egusphere-2025-262
"Review article: Rethinking Preparedness for Coastal Compound Flooding: Insights from a Systematic Review"
Dina Vanessa Gómez-Rave, Anna Scolobig, Manuel del Jesus
Natural Hazards and Earth System Sciences - NHESS

Response to Reviewer 2

Reviewer 2 is acknowledged for the constructive and precise feedback, which has been carefully considered and has contributed to improving the manuscript. The following responses outline how each point has been addressed.

---

1 General Comments

The edited preprint titled *"Rethinking Preparedness for Coastal Compound Flooding (CF): Insights from a Systematic Review"* has been substantially improved based on the reviews and thanks to the effort of the authors. The edits made to date are appreciated and several additional comments are provided below.

The definitions and applications of the risk equation and the disaster management cycle are now more clearly articulated, with appropriate references, and the background has been significantly strengthened. While the paper provides a clear explanation for its use of the term "preparedness," this usage diverges from much of the existing literature. In this preprint, "preparedness strategies" is employed as an umbrella term encompassing both preparedness and adaptation strategies. This is primarily a matter of differing time scales: preparedness typically addresses response and recovery activities tied to specific hazard events, whereas adaptation refers to long-term strategies not linked to particular events. To avoid confusion, the authors could either use the more conventional phrasing "preparedness and adaptation strategies," or explicitly define their broadened use of "preparedness strategies," including clear inclusion and exclusion criteria.

This preprint on compound coastal flood risk makes a valuable contribution to the literature on disaster risk reduction and climate adaptation. With minor revisions it would be suitable for publication.

This is a relevant and appreciated remark, which we have addressed as follows. We clarified in the introduction and methods that our use of "preparedness strategies" is intentionally broad, encompassing both preparedness and adaptation actions relevant to CCF risk.

The Introduction now includes the following sentence to define the conceptual framing (Lines 124-128):

"We adopt a broad understanding of preparedness that goes beyond its conventional role in the DRR cycle—typically associated with EWS, contingency planning, and emergency readiness. Instead, it is framed as a multidimensional process encompassing anticipatory governance, infrastructural and ecosystem-based measures, and behavioural strategies aimed at reducing vulnerability prior to the manifestation of hazardous conditions. In this review, "preparedness strategies" are used in a broad sense to include both conventional preparedness activities (e.g., early warning systems, response planning) and longer-term adaptation measures (e.g., infrastructure upgrades, community capacity building). This expanded usage reflects the growing need for integrated and scalable responses to CCF risks, where the distinction between short-term and long-term interventions is often blurred in practice. This perspective aligns not only with emerging literature on integrated FM (Bark et al., 2021; Konami et al., 2021; De Silva et al., 2022; Sánchez-García et al., 2024),

but also firmly grounded in Priority 4 of the SFDRR, which advocates for preparedness actions that include inclusive governance, resilient infrastructure, public education, psychosocial support, and the incorporation of risk reduction into development planning and post-disaster reconstruction (UNDRR, 2015)".

In the Methodology, we also specify how this framing informed the inclusion criteria (Lines 238-242):

"The initial analysis of search results from the WoS database provided a broad perspective on flooding preparedness research, capturing diverse topics and approaches. A total of 874 articles met the defined criteria, addressing key themes such as disaster preparedness, resilience, and flood management across various environments, including coastal and estuarine regions. The use of the broader term "coastal flooding" was intended to capture studies published prior to the widespread adoption of the compound event framework. Consequently, the retrieved literature spans a wide range of disciplinary approaches and timeframes. Many of these contributions focus on the hazard dimension of flood risk, particularly through measures implemented during the preparedness phase of FRM. This broad scope reinforces the need to refine the analysis toward compound hazard configurations, ensuring coherence with the specific objectives of this review. In line with our broadened conceptualization of "preparedness strategies" as encompassing both short-term preparedness and long-term adaptation, we included studies that addressed either domain—provided they explicitly contributed to risk reduction in the context of CCF. This inclusive approach reflects the practical and temporal convergence between preparedness and adaptation, and guided the application of our inclusion and exclusion criteria."

2 Specific Comments

2.1 Coastal Focus

It is stated that the study focuses on Coastal Compound Floods specifically. Sometimes "coastal CF" is used and sometimes just "CF" is used. It should be clear that the statements do not apply to all compound floods broadly, but rather that you superficially address coastal compound floods. Consider using the abbreviation coastal compound flood (CCF), which is used elsewhere in the scientific literature.

The term "coastal" could also be mentioned in the research questions. As they are currently stated the research questions could cover all compound flood types.

The abbreviation "CCF" (Coastal Compound Flooding) is now used consistently throughout the manuscript, replacing the previous use of "CF" where appropriate. Additionally, this aspect has been explicitly incorporated into the research questions to better reflect the scope of the review.

2.2 Regional Analysis

The integration of case studies is now well structured by timescale and region. The outline of the three phases helps to frame the shifts that have occurred in the field along with limitations. Some comments on specific regions are found below:

- **Europe: You could comment on the fact that in Europe there is a baseline for hazard mapping and use of certain technical tools with the EU Flood Directive.**
- **Asia: You address the entire region of Asia but only mention examples from China. Your study list in Table 2 includes other countries such as Vietnam and Indonesia. They could also be mentioned here.**
- **North America: Only the USA is covered here but in Table 2 you also have a study from Canada. Some relevant aspects of the Canadian context could be covered here.**

The Asia section has been expanded to include Vietnam, Myanmar, Bangladesh, and Indonesia, reflecting the range of cases listed in Table 2. A reference to the EU Flood Directive has been added to the Europe

section to highlight the baseline for technical tools. The North America section now includes relevant aspects of the Canadian case, alongside the USA.

2.3 Methodology

The methods are now very clearly explained including limitations. As mentioned, the fact that this method uses titles and abstracts is a key limitation and as a result, there are likely many relevant papers not included here. The paper would be strengthened if the authors could comment on what would be required to apply similar tools to the entire text of the scientific publications. It would be interesting to know what the key barriers would be (e.g. computation time, less transparency etc.).

We thank the reviewer for highlighting this important limitation. Indeed, the reliance on titles and abstracts constrains the analytical depth and may exclude significant content embedded within the full texts. Our current approach was developed to balance analytical scope and computational feasibility; however, we fully agree that mining the full body of scientific publications could yield more comprehensive insights.

Recent developments in artificial intelligence — particularly the emergence of transformer-based Large Language Models (LLMs) — open new opportunities to address this gap. As reported in recent studies, LLMs have shown promise in supporting multiple stages of systematic review processes, including data extraction directly from full-text PDFs, not limited to titles or abstracts. In this regard, Hill et al. [2024] show how AI-powered tools can be effectively employed to extract targeted information from full-text documents with increasing efficiency and accuracy. These technologies can enhance granular extraction of methodological or result-related data (including figures and tables), the semantic understanding of nuanced text, enabling classification or synthesis that goes beyond keyword matching, and efficiency in systematic reviews by reducing manual screening workloads. Nonetheless, as Lieberum et al. [2025] emphasize, these applications remain largely exploratory, with variability in reproducibility and transparency, especially in complex tasks like bias assessment or full semantic interpretation. Moreover, concerns about hallucinations, prompt sensitivity, and lack of standard validation protocols persist. Scaling such approaches would require careful consideration of computational costs, access to full-text repositories, and the development of robust validation protocols to ensure interpretability and scientific rigor.

A specific note has been added in the Limitations section of the manuscript to explicitly acknowledge this potential future direction, along with the computational and methodological considerations required for safely expanding toward full-text mining (Lines 794-803):

"...Although this approach was designed to pursue methodological transparency and computational scalability, it inevitably limits the depth of the review. Recent advances in artificial intelligence—particularly in Natural Language Processing (NLP) and the development of transformer-based Large Language Models (LLMs)—have shown promise in enabling full-text mining and semantic extraction from scientific publications. These tools can enhance the identification of nuanced content and latent connections that may be overlooked when relying solely on metadata. For instance, (Hill et al., 2024) showed the potential of AI-powered tools to extract targeted methodological details from full texts, while (Lieberum et al., 2025) emphasized both the opportunities and the limitations of using LLMs in evidence synthesis, noting concerns related to reproducibility, hallucinations, and prompt sensitivity. Given these challenges, the decision to rely on abstracts and titles remains methodologically justified, though future applications of AI-supported full-text analysis may offer greater depth and coverage, provided robust validation frameworks are in place."

3 Technical Corrections

TC#	Line #	Comment
1	Abstract (Lines 9–20)	**"helps strengthening the link..." Should be "helps strengthen the link..."** The suggested correction has been made.
2	65	**Phrasing awkward: "In particular, FRM practices under occurrence of concurrent drivers must address the limitations of traditional single-hazard assumptions."** The sentence has been revised to (Line 68): "In particular, FRM practices must address the limitations of traditional single-hazard assumptions when concurrent drivers occur."
3	263	**You mention researcher and other information, is this the author of the article or the researcher using this meta-analysis method?** We have updated the text to use the term 'user' instead of 'researcher' to make it clear that we are referring to the individual performing the meta-analysis, not the authors of the articles (Line 273).
4	Table 2 (Line 422)	**"Netherland" is used, but the country is "the Netherlands."** Corrected to "the Netherlands" in the table.
5	Figure 6 (Line 430)	**In the caption: "research focused on CF and orange circles indicating those centred on coastal flooding preparedness..."** **"Centred" uses UK spelling. Elsewhere you have "centered." Pick one spelling standard: UK or US English — NHESS typically accepts UK but consistency is key.** **It seems like Figure 6 is missing a legend for the map. Either the symbols on the map should correspond to the rest of the figure or a legend is needed.** We have standardized the spelling to UK English ('centred') throughout the manuscript. We have also added a clear legend to the map in Figure 6(a) to address its symbols.
6	465	**"preparedness campaigns mainly aimed at addressing conflicts (e.g. with NGOs or other organisations questioning ecological and environmental impacts of the programme)"** **"Programme" vs "Program" — standardize spelling to UK or US.** We have standardized the spelling throughout the manuscript, using UK English ('programme') for consistency.
7	663 – Figure 8	**The style of this figure makes it hard to read with the "swirl" shape. For clarity, I would recommend a more straight branch diagram without the swirl effect.** The figure has been updated to enhance readability.

(Continued on next page)

TC#	Line #	Comment
8	780	**Lack of logical flow: "A vast majority of the analysed studies does not incorporate behavioural insights into preparedness frameworks. This omission is critical: if individuals—and institutions— simplify risk without including compound dynamics, then communication, EWS, and planning efforts must be adapted to counteract such tendencies." This section first suggests that behaviour needs to be considered but then mentioned the need to include compound dynamics. Clearly state the argument with a logical flow.** We have revised the paragraph to more explicitly connect the omission of behavioral insights with the simplification of risk and the neglect of compound dynamics. The new text now presents a more logical argument (Lines 826-829):"A vast majority of the analysed studies does not incorporate behavioural insights into preparedness frameworks. This is a critical omission because individuals—and institutions—tend to simplify complex risks, often failing to account for compound dynamics. Consequently, communication, EWS, and planning efforts must be adapted to counteract these tendencies and promote a more comprehensive understanding of risk."
9	796	**Repetition: When local perspectives are sidelined, transformative change becomes unlikely.** Repetition has been removed.
10	Multiple	**Both the American spelling "modeling" and British spelling "modelling" is used in several places.** Spelling standardized throughout the manuscript.

References

James Edward Hill, Catherine Harris, and Andrew Clegg. Methods for using bing's ai-powered search engine for data extraction for a systematic review. *Research synthesis methods*, 15(2):347–353, 2024.

Judith-Lisa Lieberum, Markus Toews, Maria-Inti Metzendorf, Felix Heilmeyer, Waldemar Siemens, Christian Haverkamp, Daniel Böhringer, Joerg J Meerpohl, and Angelika Eisele-Metzger. Large language models for conducting systematic reviews: on the rise, but not yet ready for use—a scoping review. *Journal of Clinical Epidemiology*, 181:111746, 2025.

UNDRR, United Nations Office for Disaster Risk Reduction. The Sendai Framework Terminology on Disaster Risk Reduction. Technical report, 2017. URL https://www.undrr.org/terminology/preparedness.