

## RC1 / AC

This study presents “an algorithm to identify multi-hazard events which uses the information on associated hazards as well as spatiotemporal relationships between disaster records in EM-DAT.” The topic is both relevant and timely, and the manuscript is generally well-written.

We thank the reviewer for taking the time to read the manuscript and for providing constructive feedback that will help us to improve the clarity of the manuscript.

However, I recommend that the authors address the following points before the manuscript is considered for publication:

- The authors assert that there is a lack of understanding regarding historical multi-hazard impacts, yet the introduction does not adequately explain why assessing multi-hazard impacts is particularly challenging. I recommend the authors provide a more detailed explanation of the complexities involved in evaluating multi-hazard impacts. **This is a good point. We have included such an explanation and add relevant references in lines 67-74 of the introduction.**
- The introduction would benefit from restructuring. After outlining the study's aim, the authors introduce uncertainties associated with the use of EM-DAT, as well as how this global dataset is utilized in the current study. I suggest removing the text from lines 75–99 and incorporating it into sections 2.1 EM-DAT and 5 Discussion for better clarity and flow. **Agreed. Uncertainties related to EM-DAT are incorporated in the data section (section 2.1) in lines 130-136 and in the discussion (section 5) in lines 403-409 as well as lines 415-420.**
- The criteria for multi-hazard classification in this study are unclear. In section 3.1.2, the authors mention restricting multi-hazard events with an intersecting area smaller than 50%. However, previous studies have outlined various types of multi-hazard events, including preconditioned, triggering, multivariate, spatially compounding, and temporally compounding events. Multi-hazards can also occur in multiple interconnected locations within a limited timeframe. Given this, I am unsure how the authors justify the following statement: “We reason that the smaller the intersecting area of two footprints, the less likely that the actual disaster impact zones overlap. The idea behind the threshold is to keep only those combinations that have a reasonable likelihood of actually having overlapping disaster zones.” **Thanks for pointing this out. We have included lines 91-94 to clarify the scope of the study.**
- Figure 1 requires further elaboration. Including only subsection headings does not sufficiently clarify the overall methodological approach used in the study. I suggest the authors develop a more comprehensive methodological flow

diagram to better explain the proposed approach. Agreed. RC2 pointed this out as well. We have developed an expanded flow diagram (Figure 1) that provides more content. This made us realized that the original steps 3.2.1 and 3.2.2 could better be merged into one step (now step 3.2.2) and that an additional step 3.2.1 would be helpful. We have also included a corresponding section 3.2.1. Step 3.2.3 is new following RC2's suggestions to include the archetypes in the method section.

## **RC2 / AC**

This study makes a valuable and timely contribution to disaster risk science by developing an algorithm that identifies multi-hazard events, utilising information on associated hazards as well as spatiotemporal relationships between disaster records in EM-DAT. The statistical analysis reveals that hazard pairs often lead to greater or at least equal impacts compared to isolated single hazards, although the patterns of impact vary depending on the hazard type and the impact metric. The study proposes developing generic archetypes of multi-hazard risk dynamics to enhance risk analysis and decision-making. While acknowledging the limitations of the EM-DAT database, it demonstrates the database's utility for identifying global patterns of multi-hazard impacts and recommends improvements in data reporting.

The manuscript is generally well-written and addresses an important topic, but several revisions could enhance its clarity, structure, and impact.

We appreciated the reviewer's time and effort in reading the article and providing helpful comments to strengthen the manuscript before publication.

I recommend the following adjustments to strengthen the manuscript before publication:

### **Methodology and Detail:**

The methodology is sound, but providing more detail about the "statistical methods" previously used (Lines 94–95) would offer readers a clearer understanding of previous research. Agreed. We will added more information in lines 61-65 on Budimir et al.'s statistical methods (2014).

Additionally, the manuscript would benefit from justifying the focus on spatial overlap within a single country (Section 3.1.2). For instance, the author could explain why potential transboundary, spatially compounding events, such as those across northern Europe, were not considered (e.g., Fang et al., 2024; De Luca et al., 2017; Berghuijs et al., 2019). Agreed. We have added lines 214 – 220 to explain our considerations for making this simplifying assumption.

The inclusion of Figure 1 is valuable, but expanding its caption to provide more context would help readers understand it without needing to refer back to the main text. Agreed.

RC1 pointed this out as well. We have developed an expanded flow diagram (Figure 1) that provides more content. This made us realized that the original steps 3.2.1 and 3.2.2 could better be merged into one step (now step 3.2.2) and that an additional step 3.2.1 would be helpful. We have also included a corresponding section 3.2.1. Step 3.2.3 is new following RC2's suggestions to include the archetypes in the method section.

### **Structure:**

The manuscript would benefit from a more cohesive structure.

For example, moving background information currently placed in the results section (e.g., Line 279) into the methods section would help maintain continuity and allow the results section to focus more directly on presenting findings. Does the reviewer mean lines 285 – 287 rather than line 279? These lines have been placed in the data section (lines 152-155).

Additionally, keeping the discussion and results sections distinct would improve the paper's flow. Any interpretive content (e.g., Line 301) could be relocated to the discussion. Agreed. We have moved the discussions on sensitivity to the discussion section (lines 401 and following paragraphs).

Furthermore, separating recommendations from the conclusion would also allow the paper to finish on a stronger note, with a distinct conclusion leaving a lasting impression. Agreed. We have created a separate conclusion and recommendations section.

Finally, introducing the archetypes (Line 427 onwards) in more detail in the methods section could help readers appreciate their relevance from the start, enhancing the manuscript's overall coherence. Thanks for pointing this out. We have introduce the archetypes in the method section (section 3.2.3) and present them in the results (4.3). We have also changed their names to be more coherent among each other and highlighted them explicitly in the abstract.

### **Writing Style:**

The clarity of the manuscript can be improved by adopting a more concise and direct tone across all sections. For example, removing phrases like "not surprisingly" (e.g., Line 338) and simplifying explanations (e.g., Line 384 regarding spatiotemporal overlaps) would make the writing more focused. Writing all sections more concisely will help maintain a tighter narrative; for example, understanding Lines 480–484 currently requires multiple readings.

Here are three specific examples that would benefit from revision for clarity and conciseness, although consider making changes throughout the manuscript:

- Line 137 – Correct the typographical error "other the other."

- Line 141 – Consider rewriting this sentence to improve its flow.
- Line 488 – Ensure consistent tense usage throughout the text.

Thanks for pointing this out and providing some examples for clarification. We have re-read the entire manuscript with a focus on concise and direct language. We have streamlined the entire manuscript leading to many track changes throughout. The changes are mainly reordering paragraphs and sentences, removing duplicate information and being more consistent and concise in use of terminology in the text as well as in the headings. This has also led us to include two more sub-figures to Figure 2 in order to keep the different terms and concepts used distinct and clear as well as to merge Tables 3 and 4 into one (now Table 3).