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# JOURNAL OF COASTAL AND RIVERINE FLOOD RISK

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Review and rebuttal of the paper

## Flood-related fatalities in July 2021 in North Rhine-Westphalia, Germany: what can be learnt for future flood risk management?

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Editor handling the paper: Hans de Moel

**Response letter**

Submission to Journal of Coastal and Riverine Flood Risk: "Fatal incidents during the flood of July 2021 in North Rhine-Westphalia, Germany: what can be learnt for future flood risk management?"

NEW TITLE: "Flood-related fatalities in July 2021 in North Rhine-Westphalia, Germany: what can be learnt for future flood risk management?"

Thank you for the positive evaluation of our manuscript and the valuable comments, which enabled us to further improve it. Please find below our point-by-point response as a Table.

**Reviewer A:**

This is a very valuable paper, which documents an important (and tragic) case, and presents a novel and thorough classification approach of flood fatalities. I highly recommend publication. This is important work!

*Thank you very much for this positive evaluation of our work.*

I have a number of suggestion for presentation / wording / embedding by line (L) number. These are all minor in my view and mainly relate to presentation and explanation.

*Please find our point-by-point responses in the following table.*

Comment	Response
L4, title, "flood (related) fatalities" instead of "fatal incidents"?	Although "incident" and "incident management" are established terms in risk management in companies, this is not as common in flood risk management. Hence, we changed the title according to the reviewer's suggestion into: "Flood-related fatalities in July 2021 in North Rhine-Westphalia, Germany: what can be learnt for future flood risk management?" In the manuscript, we now use the term "accident" where applicable.
Abstract: I was a bit confused about the relation between the statement "8 of 25 people who died in a building were surprised by water entry into basements" and the statement "14 people died in their basements" are these the same groups?	No, these are different groups of people – 14 died in a basement and 8 in their flats (which were located in one case in the basement, too, but in the other cases on the ground or upper floor). We rephrased the sentence in the abstract to make this clearer. Please note that we updated the total number of fatalities in Germany to 190. In June 2023, one missing person was declared dead.

	Numbers in Table 1 were updated, too.
Abstract: “Exceptional event magnitude”, do you also have a concern about coverage /quality of flood hazard maps?	We added “and shortcomings of existing hazard maps” in the respective sentence of the abstract.
Table 1 detail, check abbreviation, RLP or RP is sometimes used	We apologize for this confusion and now used RP consistently, which is a more common abbreviation for this state. Note that some numbers in the Table were updated as mentioned above.
Table 1: “natural deaths” define or describe? (in footnote)	We added a footnote and a reference. In fact, according to Rothschild (2005) the manner of death (i.e., natural, unnatural, unclear) is a legally relevant term since an unnatural death initiates an investigation by a coroner or public prosecution. It does not (necessarily) describe the medical cause of death, but reflects the circumstances. We provide some more information in the footnote.
General / introduction, I feel the paper could benefit from a short paragraph giving a bit more context about which rivers flooded (and some references to more comprehensive work), Figure 4 comes relatively late, which is no problem, but good if the reader knows which areas were flooded.	We added a reference to (new) Fig. 5 and some more information on the flood in the introduction. However, since reviewer 2 requested to shorten the paper, we kept this addition brief.
Page 3, L8-27, fully agreed with this. However, I suggest this paragraph is included later in the paper (conclusion / discussion?)	In fact, we consider this as state-of-the-art and motivation for the research presented in this paper. We would therefore prefer to keep this in the introduction.
Pr Around L38, you may indicate that the number of case histories describing flood fatalities for riverine / pluvial flooding is scarce (e.g. the Harvey case: <a href="https://nhess.copernicus.org/articles/18/1073/2018/#:~:text=It%20is%20estimated%20that%20more%20than%20100%20000%20people%20were,et%20al.%2C%202009).">https://nhess.copernicus.org/articles/18/1073/2018/#:~:text=It%20is%20estimated%20that%20more%20than%20100%20000%20people%20were,et%20al.%2C%202009</a> ).	Added; it now reads: “These examples demonstrate how an analysis of the circumstances that led to fatalities can help improve flood risk management. However, cases analyzing flood-related fatalities for particularly fatal events are still scarce (Jonkman et al. 2018), although their insights could contribute to achieving the first target of the Sendai Framework for Disaster Risk Reduction 2015–2030, i.e., the substantial reduction in global disaster-related fatalities per 100 000 people by 2030.”
Line 43 p3 check adjective, “parliamentary?”	Corrected throughout the paper.
Pr Line 39 – 46, add reference to the original German report	This was added; however, by this the paper is not anonymous anymore.
P4 L2, datasets one word?	According to some online dictionaries two words are correct. Checked throughout the paper.

<p>P5, fig. 1, add “assignment of location” under assignment?</p>	<p>The text in the box on the right was rephrased and now reads: „assignment of relevant text passages and locations (place of residence and accident or discovery site) to the individual flood fatality”</p>
<p>P5/6 I propose to upload the newly created “spreadsheet” / query as supplementary material</p>	<p>Thank you very much for this suggestion, which we are happy to follow. Please note that we can just provide the template, not the actual data of the analyzed cases.</p>
<p>P6 line 16, explain here which “two levels of detail”</p>	<p>This is explained in the method section (p. 5): first level: in-/outdoor; second level: detailed location. To avoid confusion, we rephrased the sentence at the beginning of section 3.1 into: “The accident locations revealed that 25 people died indoors and 24 outdoors. In the buildings...”</p>
<p>P6, “internal causes” – explain what these are</p>	<p>Heart attacks are explicitly mentioned in the text as an example of internal medical causes.</p>
<p>P6 and beyond, you perform a statistical test, could you include a few words what you tested? E.g. whether the indoor and outdoor datasets are different?</p>	<p>Yes, it’s tested whether variables differ between in- and outdoor cases. The information is explicitly mentioned in the text. We now mention this more explicitly at the end of the method section, which now reads: “In particular, it was tested whether the medical causes of death, timing, detailed locations and flood hazard zones of the accidents, the victims’ activities and the accident dynamics differed between in- and outdoor cases (see section 3.1), gender and age groups (see section 3.2) as well as different geographic sub-areas that reflect differences in event magnitude and landscapes (see section 3.3).”</p>
<p>P7 line 14/15, last sentence, “note that each line represents one or more person(s)”.</p>	<p>We made the description clearer which now reads: “Note that each line initially represents one person, but similar cases were merged as indicated by the numbers following the item descriptions.”</p>
<p>P8 L30 “extreme flood scenario” add that this relates to 1000 year return period?</p>	<p>Added</p>
<p>General, I do not know if this is possible, but It would be very valuable to present a map of the flood hazard zones and the “dots” representing fatality locations (indicating whether they are in or out the flood zone)</p>	<p>That is a good idea, however, due to data privacy regulations we are not allowed to show such a map.</p>
<p>P8 L39 “these 17 cases” not clear which one</p>	<p>Information added. The sentence now reads: “It is assumed that a lack of warning played a</p>

	<p>role in these 17 cases, i.e., the eight people caught by surprise indoors and the nine people who died outdoors on their way home or while trying to leave the flood zone (too late), i.e., in a third of the fatal incidents.”</p>
<p>P9 around L30, here you may be a more clear that men tend to get involved in “rescue or mitigation action” e.g. go into the basement, to save belongings etc.</p>	<p>We rephrased this part. Please note that in the literature search and rescue operations are distinguished from risky behavior, which is often not so clear when reading the documentations. We now mention this in the paper, too.</p>
<p>P12, L27, “darkness was a factor” I lack a bit of context here, explain whether floods occurred at night or not. – also relates to panel Fig5-B.</p>	<p>We added some information and context.</p>
<p>Figure 6, this figure would better fit at the end of Chapter 3, it need a bit more explanation (pick out one example). What do you consider as a “relation”? (e.g. what does it mean I have two stars ** for activity for gender, age and subarea).</p>	<p>We shifted Fig 6 (now 3) to section 3.2 and added some explanation and references in the further text. The number of stars reflects the level of significance (see legend). This is now stated clearer in the heading.</p>
<p>I feel conclusions may benefit from a summary of a few key findings, (that are now in the abstract). Just to consider.</p>	<p>In fact, all findings that are mentioned in the abstract, were already stated in the conclusions. We now highlighted some findings clearer, while trying to shorten the conclusions according to the suggestion of reviewer 2.</p>
<p>I was a bit confused by the last paragraph (p15 L39-43). L41 “but is hampered” what is hampered? Systematic documentation of past event and translation into policy and practice recommendations for operational flood management? Perhaps these last lines can be clarified a bit.</p>	<p>We rephrased the whole paragraph which now reads: “Finally, some fatal pathways could have been already detected in earlier events and lessons could have been learned if structured event documentations and impact data recordings were in place. In fact, this is requested by the Sendai Framework for Disaster Risk Reduction 2015-2030, whose implementation is challenged in Germany since civil protection as well as water management are responsibilities of the states (Länder). Hence, joint efforts are needed to achieve consistent data and documentation procedures.”</p>
<p>I do not want to give the authors too much extra work, so up to them to consider what is feasible.</p>	<p>Thank you very much for your valuable comments which helped to further improve the paper.</p>

Recommendation: Accept Submission

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**Reviewer C:**

This study revealed fatal situations from flooding caused by the millennium rainfalls in Western Germany in July 2021 and provided lessons that individuals and society should learn from the event. The authors focused on the federal state of North Rhine-Westphalia (NRW), where several occasions of deaths could be considered, and organized the detailed situation of 49 victims from a vast amount of government documents. Then, the authors examined the relationship between those situations and socio-demographic factors, and in a later section regional differences were investigated. The systematic approach of reproducing the death situations through the thorough investigation of documents and allowing statistical discussion is impressive. The categorial elements used in the approach not only serve as a coding scheme of the proposed statistical analysis, but also suggest a possible format for casualty statistics to be used for future disaster management, which could be a lesson, especially for the governmental and political side.

The reviewer appreciates the authors’ future-oriented approach and looks forward to further development of this research. However, before the acceptance, there are several points to improve regarding the data interpretation and the structure of the current manuscript.

*Thank you very much for this positive evaluation of our work. Please find our point-by-point responses in the following table.*

<b>Comment</b>	<b>Response</b>
The entire manuscript is a bit too long (over 10,000 words). Since one of the objectives of the study is to understand the detailed fatal situations, it is understandable that the manuscript will be long. However, please try to remove unnecessary information as much as possible.	We tried, but I guess we failed except for the conclusion.
I am wondering about the typical situation of people in NRW during a series of events. Did most people there stay at their homes or go outside freely (for work, school, etc.)?	This is a very interesting point. However, there’s no meaningful information available. Note that the event happened during the summer vacation. So, schools were closed.
Among the coding scheme, I think “time of accident” could be related to other factors and thus should be treated with care. Timing would determine who is around you (colleagues, family, or alone), which significantly affects your decision-making.	Sure. We added this in the discussion.
Were elderly victims in the target area living alone or living with their families?	We did not retrieve this kind of information since it was not clear in all cases. With regard to the indoor cases, most of the elderly lived alone or together with their (elderly) partner in a flat. Occasionally, their (adult) children lived in the vicinity or had regular contact (in person or by

	<p>phone). Since we did not retrieve this information, we added the following sentences to the discussion: “Further socio-demographic factors like the level of education, income or household size might also play a role for a person’s vulnerability, but could not be retrieved for all cases due to missing information. The template could be expanded by these variables.”</p>
<p>How should the concept of “family” be addressed in this type of research? For example, if entire young family members follow their father’s (mother’s) decision and all die as a result of it, it is very difficult to interpret the situation. Focusing too much on the number of deaths might over-/under-estimate certain factors.</p>	<p>This topic is related to the previous comment. However, there is no case where children followed the advise of their parents and ended up in a dangerous situation. On the contrary, (adult) children advised their parents to go upstairs or to avoid the basement, but the parents made their own (dangerous) decision. However, this is anecdotal evidence and is only captured by the item “ignored warning” which could be assigned since communications about warning and what to do was documented. To address your comment we added: “Particularly, the social network and advise given by other family members, neighbors or friends could play an important role to show certain behaviors. This topic needs further investigation.”</p>
<p>(Related to Figure 3A) In my opinion, a fatal situation during equipment checks could also occur regardless of age. How can I interpret the difference in the age groups regarding this situation? Does that mean where elderly people live, equipment tends to be aged as well and requires a longer time to amend?</p>	<p>We agree that fatal incidents during equipment checks do not necessarily depend on age. Still, the data show that elderly performed this activity (with a fatal outcome) significantly more often than younger people among the deceased. The reasons are not that clear, but could also be due to the fact that elderly tend to live in their own house or care more about property-level flood adaptation. In addition, their poorer health status might play a role. Since this is pure speculation, we did not change the text.</p>
<p>The conclusion section is a bit lengthy. There are many overlapping parts with the body sections, so I suggest removing the description of specific numbers.</p>	<p>Just partly done, since this was a bit contrary to the comment of reviewer 1. However, large parts of the conclusion were rewritten.</p>
<p>In my opinion, Figure 6 and related info should be moved to Result and Discussion.</p>	<p>We shifted Fig 6 (now 3) to section 3.2 and added some explanation and references in the further text. The number of stars reflects the level of significance (see legend). This is now stated clearer in the heading.</p>

<p>(L41 in P15) It seems that the states in Germany cannot swiftly tackle issues of flood disaster prevention. Is this due to jurisdiction affairs?</p>	<p>We rephrased the whole paragraph which now reads: “Finally, some fatal pathways could have been already detected in earlier events and lessons could have been learned if structured event documentations and impact data recordings were in place. In fact, this is requested by the Sendai Framework for Disaster Risk Reduction 2015-2030, whose implementation is challenged in Germany since civil protection as well as water management are responsibilities of the states (Länder). Hence, joint efforts are needed to achieve consistent data and documentation procedures.”</p>
<p>[Minor remarks]</p>	
<p>- (L13 in P7) medical</p>	<p>Corrected</p>
<p>- (L5 in P13) life-saving</p>	<p>Corrected</p>
<p>- (L19 in P15) Remove “to”</p>	<p>Corrected</p>

Recommendation: Revisions Required