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Review and rebuttal of the paper

## Health effects of the 2021 flooding in Limburg

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Editor handling the paper: Hans de Moel

Many thanks for reviewing our manuscript. We highly appreciate your constructive comments; these have helped us to improve the paper. Reviewer comments have been presented **in bold**, author replies in plain text.

### Reviewer 1

- **Title: of the 2021 flooding**

Good suggestion, we adapted the title accordingly.

- **Sentence 40: insert 'water storage' before buffers**

Makes it indeed clearer what we mean with a buffer. This para has been adapted and moved to Supplementary materials 1.

- **Sentence 46: Detail, check number notations; 50,000?**

Well spotted, thank you. The notation of numbers has been checked and edited throughout the document.

- **Sentence 59/60 Figure 1: a similar figure is also in the other papers of this special issue, leave out?**

We would prefer to include a map so that the article can also be understood as stand-alone. However, we agree that it may feel redundant. We have therefore created our own map (in the Methods section) that shows information on flooding, evacuations, and our respondents.

- **Sentence 61: There are also other papers, like this one <https://pubmed.ncbi.nlm.nih.gov/15958425/> aAdd?**

Thank you, we added the reference suggested.

- **Sentence 64: days to weeks?**

Correct, we added 'days to weeks'. We also added a bit more specificity for each of the phases. Immediate = within hours, Short-term = within days; Intermediate = days to weeks, when recovery starts; Long-term = weeks to months.

- **Sentence 113-126: Consider to move these parts to chapter 2, there is some overlap now.**

We moved some details of the last paragraph of the introduction to chapter 2, where the methods are detailed. However, we did keep a few lines on the selection of our methods to the general description of the phases, to better explain why we studied general health impacts (and why in this way) and why COVID. This helped us to further sharpen the introduction.

- **Sentence 166: information on what? Water quality?**

Indeed. Unfortunately, the required information on protocols, together with original results from the measurements, could not be obtained. Still, we believe the information on water quality and drinking water is interesting as background, which is why we have kept it as a supplement.

- **Sentence 191: insert '2021' between July and floods**

Done

- **Sentence 238: 'The period during which' [instead of 'when the floods']**

Corrected as suggested.

- **Sentence 249: insert '(partial) flooding and' between with and evacuations**

Corrected as suggested.

- **Sentence 251: In the discussion, flooding was relatively local (near river) and only affected a relatively small area of these larger cities. Whereas it would**

This comment seems incomplete. Indeed, the affected municipalities were only partially flooded, but more areas had to deal with evacuations. This may have had more influence on COVID-19 (and its detection) than the flooding itself. The text has been adapted and the issue of local flooding vs municipal disease data is now discussed in the Discussion section.

- **Sentence 252 Figure 4: From your expertise on covid, could you indicate how long after a „superspreading“ event you would see the signal in the general stats? What is the time lag, days, weeks?**

This is an interesting question, as the same time lag may apply to impacts of the flood. We have not discussed this in relation of the superspreading events, but did carry out additional analyses on the COVID data, applying different split dates to compare before and after. The visual presentation in Figure S4 (Supplementary materials 1) may show the effect of the superspreading events across the Netherlands in the changes from week 26 to week 27. Later, southern Limburg shows an increase between week 28 and week 29.

Perhaps also relevant: both the Alpha and Delta variants were circulating at the time of the event. These variants have a generation time of 4.5 and 3.2 days respectively and we compared a bit longer period of two weeks to capture multiple generations after the events.

- **Sentence 289: Indicate, dunea was not directly affected by flooding?**

This section has been moved to Supplement 1. Dunea is located along the Meuse and the flood water did pass the company. But due to the storage of relative clean water in the Afgedamde Maas, there were no consequences for drinking water production.

- **Sentence 327: change 'floods added to' into 'floods is expected to add to'**

Corrected as suggested; the sentence was moved and rephrased (with reference to Scheerder, 2023).

- **Sentence 347 - 369: Add a few sentences to put this in international context, some papers have come out indicating the potential links / compounding of floods and covid. Would be good to add one or two sentences on the international context**

<https://www.sciencedirect.com/science/article/pii/S0048969720360204>

<https://wires.onlinelibrary.wiley.com/doi/full/10.1002/wat2.1509>

Thank you for these suggestions. We added both refs to the discussion.

- **Sentence 348: risk ratio instead of risk ration**

Corrected as suggested.

- **Sentence 348: insert after Groningen (see fig. \*\*)**

We added references to the figures to the discussion section.

- **Sentence 350: insert 'in the period' between cases and after**

Corrected as suggested.

- **Sentence 351: 'The flooded municipality Valkenburg' instead of 'Flooded Valkenburg'**

Corrected as suggested.

- **Sentence 351-355: In discussion, add the point that floods affected a large part of Valkenburg (surface / population), whereas a relatively small part of Venlo, Roermond etc. That would require a more in depth analysis of flood affected population etc. etc. this could be for future work**

It would have been interesting to compare information on flooding with disease incidence at a local level, e.g., by postal code (equivalent to parts of a street, if the 6-digit version is used). However, with the COVID-19 case data are aggregated by municipality, it will not be possible to carry out this interesting analysis. We did flag this issue in the Discussion and suggested future research in the Conclusions.

- **Sentence 359/360: I am not an expert, but my understanding is that healthcare facilities and hospitals act „at the end of the chain“ so have limited effect on initial spread**

SARS-CoV-2 outbreaks in hospitals and long-term care facilities typically show high attack rates (and mortality) due to the vulnerable patient population. The virus does not stop at the entrance door of the facility and can be easily transmitted by healthcare workers and/or visitors.

- **Sentence 401/402: I know Wageningen has monitored some sediments, sludge etc. in the flooded areas ([https://twitter.com/SLM\\_WUR/status/1420641935828606976](https://twitter.com/SLM_WUR/status/1420641935828606976)) not sure if there have been publications on this topic.**

Thank you for this suggestion. We contacted the Wageningen group. Unfortunately, they did not analyse the samples for nutrients or microplastics.

## Reviewer 2

**As general feedback, I miss cohesion between the different parts of this manuscript. It feels as though the authors had three different pieces of information, which were pasted together in this article, but without a clearly defined overall objective or shared methodology. For each of the components, the methods are not or not clearly described, which makes the interpretation of the findings very difficult. Specific comments on the different sections are listed below.**

We largely agree with this comment and have thoroughly revised the paper to address your concerns. We have rewritten the Introduction, which describes the various health impacts of floods in phases, and added more detail on what the subsequent focus of the paper is and why we selected a certain method. The overall objective of the study was to give an impression of immediate, short term and secondary health impacts of the floods in Limburg.

As we could not get the full methodological details or resulting data from the drinking water companies, we decided to move all text on water quality to a supplement.

For COVID-19 a completely different and more quantitative approach was followed than for the other health impacts, which were investigated through a questionnaire to health workers. We have elaborated the method section for both components. While the results are presented separately, we have now made more connections between the two components throughout the paper, with special attention to the discussion and conclusion sections.

### Methodology/Results

- **The questionnaire was sent to MDs, but no information on sampling design. Were all GPs in the mentioned region invited to participate, or only a selection? What was the response rate?**

We have elaborated the method section, with more details on development and distribution of the questionnaire. We also included the number of health workers the questionnaire was sent to. Response rate is now included under Results.

- **I don't have access to the questionnaire, but it seems that it consists of a qualitative assessment of the perceived increase in symptoms. This is not a valid method to make a quantitative assessment of the situation, as it is driven by perception (of people who were largely also victims of the event). More correct would be to ask MDs to assess any reported symptoms, as coded by ICD-10. Or to change the wording in the article and figures (e.g. figure 3), to refer to 'perceived' changes in health complaints, opposed to just changes in health complaints.**

Indeed our approach was not quantitative and we have removed the figure to avoid any impression of the questionnaire providing quantitative information. We cannot change the methodology we have applied, but we can definitely explain it better and present the results in their true perspective. Hence we indicated why we selected this method in the Introduction, elaborated the method section and adapted the wording in the results and discussion section to be clear on where the information comes from. The questionnaire itself has been added as a supplement.

- **There was no control group, so it is impossible to assess whether any increase in psychosocial symptoms related to this particular event. As stated by the authors, the events coincided with an overall increase in COVID cases, which is also a trigger for mental health impact**

Good point! The first two paragraphs of this subsection have been rewritten to put the qualitative nature of the results better in perspective. For the various answers and statement, it has been made clearer that these are subjective perceptions of the respondents. In line with this, the discussion section has also been largely rewritten.

One of the respondents had mentioned (in response to question 14) that “the long-term uncertainty due to the COVID-19 pandemic had led to a reduced psychological resilience”. We referred back to the potential link between COVID-19 and stress in the Conclusions section.

- **The following sentence is included in the results, but it is not clear whether this was based on the study results or whether this is just a hypothesis: *“For the elderly, the memory of previous floods may cause extra stress, and sometimes the social network has disappeared because friends died, and children no longer live in the area and can therefore not offer care.”***

This was a literal (if translated) quote from one of the respondents. The text has been adapted to state this more clearly.

- **As seen in Figure 4, COVID-19 cases were already clearly increasing before the flood event, which makes it less likely that it is related. How the comparison between provinces was performed is not clearly described by the authors, and is not valid without taking into consideration other circumstances (e.g. vaccination rate in different provinces)**

You have, rightly, raised some very serious concerns here. Hence we have completely redone the statistical analysis with more information (adding sewage monitoring data, as well as data from Germany). The comparison between affected locations and control groups (municipalities and counties without floods or evacuations) was made using standard statistical methods. These included a comparison of confidence intervals and applying different split dates; see new figures 2, 3 and 4, as well as Supplementary materials 3. The new analyses have been elaborated in the methods section. The results and discussion sections on SARS-CoV-2 has been almost entirely rewritten. Other factors were indeed not taken into account because the data were not detailed enough. This has been added to the discussion as a limitation.

On vaccination: the vaccination rate for inhabitants of Limburg was similar to that of the rest of the Netherlands. By June 12<sup>th</sup> (2021), 60% of people over 18 years were fully vaccinated with 3 doses in Limburg, compared to 59% as average for the Netherlands. By the end of July these percentages increased to 73% in Limburg and 72% in the Netherlands.

- **The methodology for the collection of information on water quality and drinking water supply is not very clear. Was a specific tool or questionnaire used for this? It seems like anecdotal information was provided by each of the three stations, and I’m not sure if such information is suitable for a scientific publication. Also for qualitative research, a specific protocol is expected to be followed in terms of data collection and analysis.**

We agree with your comments. The information on water quality and drinking water supply lacks clarity on methods (particularly the protocols for water quality measurements and its quantitative results).

Unfortunately, it was not possible to gather the detailed information needed for a scientific paper. Still, we believe the (indeed largely anecdotal) information provides interesting background, also on the perceived relatively low rate of additional gastro-intestinal complaints. Hence we have moved this entire component to a Supplement. In the introduction and discussion sections we left just a few sentences on water quality and the relation to health in Limburg.

- **As the title of the manuscript is on health effects, and the section on water quality and drinking water did not measure an impact on health (but on water quality, which finally did not have an impact on health), the section also does not seem immediately related to the rest of the manuscript**

Agreed. Therefore, we have now moved all text on water quality and drinking water to a Supplement, as a background illustration rather than part of the paper.

### Discussion

- **The first part of the discussion refers mainly to news sources, which does not seem to fit well with a scientific article. For example, this sentence seems to refer to anecdotal (and unverified) information: *“For instance, a patient from an elderly home in Valkenburg died the day after the evacuation possibly due to the stress of the event and the evacuation, while another patient, with a history of psychological problems, committed suicide (Nieuwkoop, 2021).”* The same applies to information obtained from RTL Nieuws.**

You are right. We have removed all ‘journalistic’ references and did a new search for relevant (now available) scientific or at least verifiable (grey literature) publications. We have also added a bit more context on COVID-19 in the Netherlands and what this means for our results.