RESPONSE TO THE REVIEWERS

egusphere-2025-4062

Reviewer 1 comment	Response
Overall comment: I very much enjoyed reading this brief communication. It is well written and it brings forward a very important research avenue. I strongly suggest the authors to strengthen the multi-hazard risk element of their manuscript. A lot of work is done in this field, especially in recent years; also in bridging to diseases and health impacts, which is currently less recognized in the manuscript.	Thank you, we appreciate the positive feedback. We recognize the significant contribution of the multi-hazard risk and disease fields to the wider multi-hazard agenda. Beyond contagious disease, the field of hazards/health and multi-hazards and health is evolving distinctly. Our commentary is about health inclusive of non-communicable illness, which is why we have not emphasized contagious disease research. However, we have added some references to both risk and disease in response to specific comments below.
While the manuscript seems to focus on "climate-driven hazards like heat and flood" many of the examples mention earthquakes and volcanic eruptions. I found this a bit confusing as these are not climate-driven.	Good point. We have made some minor revisions to clarify that while the key focus is on climate-driven hazards, we are conscious of wider narratives around environmental hazards more generally. Please see Lines 34, 38, 45, 61.
I also wondered what search terms were used. Many people working in the field of (multi-) natural hazards and disasters won't refer to them as "environmental hazards". Moreover, within the field of multi-hazards, a lot of other terminology is used (e.g. cascading hazards (see Pescaroli et al 2018), consecutive disasters (De Ruiter et al 2020), etc etc).	Thanks very much for this observation and for your suggestions. Our scoping search was not intended to be exhaustive, rather to demonstrate the paucity of multi-hazard and health research compared to singular and multi-hazard research. However, including your additional search term much better reflects the overall body of research on this important topic. We excluded 'consecutive disasters' as this term returned literature related to disasters other than those associated with natural hazards. We appreciate our search does not capture all relevant literature, however, we feel the numbers much better reflect the wider field now. We re-run our searches to include 'multi-hazards' OR 'cascading hazards' AND 'health'. We have amended the text to reflect our findings using this new approach (including reference to disease literature) as follows:

	'A preliminary scoping search on Web of Science identified more than 120,000 studies about environmental hazards published from 1970 onward. Of these, 4,096 referred to 'multi-hazards', or 'cascading hazards' with the majority (85%) published in the last decade. *Only 674 studies were identified related to 'multi-hazards', or 'cascading hazards' and 'health', with the earliest specific mention of 'multi-hazards and health' (Spencer et al., 2005) examining the impacts of volcanic eruptions, and notably appearing in this journal. More than 80% of studies on multi-hazards and health were published between 2016 and 2025; 15% of the studies addressed challenges associated with climate change, and most considered impacts on physical health with a focus on contagious disease, while only eight of the studies explored 'multi-hazard-to-health pathways' for psychiatric and psychological health.'*
In line 61 (but also P2 of Table 1), I wondered whether the authors truly meant (climate) mitigation or if they actually meant adaptation and/or risk reduction?	Thanks for this pick-up. We do mean adaptation and have adjusted accordingly. From a health perspective, we talk about 'mitigation interventions'; however, in the context of the wider narrative, this boils down to climate change adaptation.
Part of the argument made in this paper was also made in: ○ Mora et al. 2022 ○ Sairam & De Ruiter (2025; also published in EGUsphere).	Thank you. These suggestions focus on contagious disease which we have mentioned in our top priorities. Unfortunately, we do not have space for additional citations highlighting specific health issues (e.g., contagious disease, mental health) linked to multi-hazards beyond what we have already included.
Line 56 – 70: the authors could also refer to recent reports by the WHO and UNDRR and that make a similar pledge.	Thank you for this suggestion. Given the strict citation limit we have had to exclude some relevant reports, particularly given the interdisciplinary nature of the argument, and the need to include literature specific to multi-hazards and health.
Some sentences could use a bit more careful phrasing such as "while environmental scientists consider flooding and drought". Maybe the term (socio-)hydrologists is more accurate?	We have intentionally kept the term broad (environmental scientists) as flood and drought research can also include ecologists, geomorphologists etc, as well as hydrologists.

Line 70: the authors could consider reaching out to similar groups such as the RiskKAN working group on disasters, diseases and health (see also P4 of Table 1).	We welcome all suggestions for reaching out to other groups, thank you. We plan on holding our next MH2O event in the new year and invite the reviewers to make recommendations and/or to attend themselves!
Instead of Bixler et al (L. 37) (and some of the subsequent references) there are a lot of studies that support this more broadly than a study that looks at a local case in Texas… I suggest the authors reflect a bit better on the field of multi-hazard risk. Eg but by no means limited to: ○ AghaKouchak et al 2014, 2018 ○ Claassen et al., 2023, 2025 ○ De Ridder et al 2020 ○ De Ruiter et al 2020 ○ Gill & Malamud 2014, 2017 ○ Kappes et al. 2012 ○ Quintal et al (in discussion – egusphere) ○ Scolobig et al. 2017 ○ Thieken et al. 2021 ○ Ward et al 2022 ○ Zscheischler et al 2017, 2018	Thank you for these suggestions. Given the limitations on number of citations, we have made some choices for inclusion that focus on wider narratives, rather than local case studies. We have replaced the Bixler (2021) citation at (previously) Line 37 with Aghakouchak (2020). We have also added Classen et al (2023) in relation to multi-risks (Line 43) and Ridder (2020) in relation to climate change worsening multi-hazards (Line 41). We appreciate that the field of multi-hazard risk is well developed. The field of multi-hazards and health has developed distinctly, particularly where research intersects with clinical and medical specialisations. For this reason, we have elected to include literature on challenges specific to multi-hazards and health, recognizing that we have necessarily excluded some seminal literature on multi-hazards and multi-risks more generally.

Reviewer 2 comment	Response
This paper addresses a critical and under-researched area at the intersection of hazards and health, and I'm glad to see much needed attention on this topic. The focus on multi-hazard to health outcome pathways is timely and the paper makes a useful contribution by foregrounding complexity, uncertainty and research priorities. The topic is clearly novel and of relevance to NHESS readers.	Thank you for the very encouraging feedback.
That said, some key concepts require further refinement and clarification to strengthen the paper's analytical contribution. In particular, several terms and framings risk oversimplifying existing bodies of work on vulnerability, participation and knowledge production. Addressing these issues would make the paper	Thank you for this observation. We have addressed specific comments (below) on this point.

more robust and more clearly situated within interdisciplinary hazard research.	
Use of the term "amenable health condition" I am uncertain what is meant by "manageable health condition" in this context, for who/in what geography. If the intention is to refer to chronic or long-term illness, this should be stated more explicitly, or perhaps explain the term. For many people, particularly those living in rural settings or in low and middle income countries, illness often fluctuates between being manageable and unmanageable depending on environmental, social and infrastructural conditions. The current wording risks implying stability or access to consistent care that may not exist in practice.	Thank you, we agree our terminology could be clearer. We have replaced 'manageable' with 'underlying' health conditions.
Compounding, co-occurring and cascading impacts The paper would benefit from a clearer distinction between hazards and health impacts that occur simultaneously, cascade from one another, or accumulate over time. Which typology is this paper focusing on. These distinctions are important for understanding preparedness, response and recovery, as well as the interrelated effects of repeated or overlapping hazards on health outcomes. Making this explicit would strengthen the framing.	The paper considers all variations of compound/co-occurring/cascading multi-hazard-health pathways. Often, terminology is used interchangeably in the same literature/manuscript (e.g., compound/cascading/multi-hazards). Differentiating immediate/cascading/cumulative hazard-health chains for individual MH2O pathways is beyond the scope of the perspectives piece. However, we have added text to clarify that our focus is inclusive: 'Thus, understanding transitions between single and multiple hazards, the multi-risks resulting from compound and consecutive *or cascading* multi-hazards, and specifically MH2Os' is central to climate adaptation.' (L40-45). We have also added reference to *cascading* as well as co-occurring/cumulative and interrelated hazards to the 'Closing remarks' and 'Introduction' to make clear that the focus is holistic.
Hazard inclusion criteria It is unclear if or why hydrological and geophysical hazards are excluded from the conditions examined. Flooding and earthquakes, for example, are common globally and have well-documented health implications. Flooding in particular increases damp and mould exposure and is strongly linked to	Flooding is mentioned in the abstract and the introduction at multiple points (e.g., context of the UK and Australia L45-55). Geophysical hazards like landslides are also mentioned (L35-40).

respiratory conditions such as asthma. Please explain the rationale for excluding these hazards, especially given the stated interest in multi-hazard pathways.	
Relatedly, the paper appears to focus primarily on climate change related hazards. It would be helpful to clarify whether non-climate related geological hazards and their health impacts are considered within scope, and if not, why this boundary has been drawn.	Changes have been made to the introduction to clarify that the paper focuses on environmental hazards, including climate driven hazards, rather than exclusively climate driven hazards. Geological hazards are mentioned throughout, including earthquakes and landslides.
Participation and knowledge production I would caution against the characterisation of participatory paradigms as a response to vaguely defined "complex phenomena defining human history". Much of this work emerges from specific emancipatory struggles and calls for equity, including decolonial, anti-ableist and disability justice approaches. Framing participation in abstract or universal terms risks obscuring these political and historical roots.	We understand that the legacy of participation is varied and complex. In the context of the manuscript, we suggest that participation is an appropriate approach for multi-hazard-to-health-outcomes research, and demonstrate the relevant origins and benefits of this approach for our MH2O Working Group. Due to the prescribed length of a perspectives manuscript, we are unable to go into detail about the multi-faceted origins and purposes of participatory paradigms. However, we have made the following addition to section 3 'Iterative co-production': "Paradigms of participation (Chambers, 1994), engagement, inclusion, and co-production (Jasanoff, 2004; Norström et al., 2020) have emerged in response to the increasing complexity of phenomena defining human history, *including the impact of natural hazards on the health and wellbeing of societies, decolonial (Lenette, 2022) and social-ecological justice narratives (Forsythe, 2008)*."
Similarly, the suggestion that the current climate can be understood as a "natural process" (around line 100) is underdeveloped and could be misinterpreted, specifically relating to well-established arguments about anthropogenic climate change and responsibility. Participatory and emancipatory approaches in health research often centre place-specific, non-scientific and/or Indigenous knowledges, rather than advocating for new scientific/academic hierarchic institutions. I was surprised when I read your argument, as it could be interpreted that you are framing this as	Around L100 we state: "While these approaches have shaped research methodology (e.g., stakeholder engagement), the paradigm of co-production recognizes that creating new knowledge in response to challenges at the nexus of natural and social processes, involves establishing new institutions with global credibility and scientific legitimacy (Miller, 2004)." In this context, 'natural' is intended to juxtaposition 'environmental' processes (e.g..,

otherwise. There is a move away from expert-led knowledge hierarchies and towards recognising lived and Indigenous knowledge as central to preparedness and recovery. Engaging more directly with this literature would strengthen the argument.	natural hazards) with 'social' processes. We have amended the text as follows: "While these approaches have shaped research methodology (e.g., stakeholder engagement), the paradigm of co-production recognizes that creating new knowledge in response to challenges at the nexus of *environmental* and social processes, involves establishing new institutions with global credibility and scientific legitimacy (Miller, 2004)." Our reference to 'new institutions' does not refer to academic hierarchical institutions, but rather 'institutions' in the broader sense, such as our own MH2O Community, comprising multi-sectorial actors as well as lived experience experts and advocacy groups. We have amended the prior text as follows: '…new institutions with global credibility, scientific legitimacy (Miller, 2004), *and representation beyond academia, including diverse communities of practice.*"
Use of "vulnerable groups" There is a substantial and growing body of evidence generated by 'populations made vulnerable' that challenges the use of the simplified term "vulnerable groups". I would strongly encourage the authors to review and revise this language, to acknowledge the agency, expertise and resistance of these populations against the 'structural vulnerabilities' they are subject to.	Within the manuscript, we refer to 'most vulnerable' groups as: "most vulnerable communities, those groups, regions and areas with the greatest multi-hazard exposures and least capacity to engage with health protection options, including poor social and physical service access and low socio-economic mobility." To this statement we have added the following: "….*and low socio-economic mobility, resulting in constrained agency.*" In the context of the manuscript narrative, we consider vulnerability related to capacity to engage with health protection, which is a major concern for some communities disproportionately exposed to natural hazards, such as coastal communities in sparsely

	serviced areas (e.g., East of England). Socio-economic *mobility* distinguishes most vulnerable communities from others typically labelled as low socio-economic status but who may not be 'disadvantaged' by this status. We feel it is important to highlight the challenges faced by communities at the intersect of disproportional hazard exposure and social/physical poor access to health services. Some groups exposed to structural vulnerabilities possess agency and expertise, supporting resistance. Others do not. We specify those with 'least capacity to engage with health protection options', referring to those without agency, who are *most* vulnerable.
Assumptions about data, synthesis and machine learning The paper engages well with the available and need for more, large-scale quantitative data synthesis and machine learning approaches, as future priorities in the Urgent Priorities. While these methods are valuable, I would caution that they may also reinforce existing epistemic inequalities if used uncritically.	We agree that misuse is a risk associated with machine learning. Currently, our manuscript reads (~L150): "The focal points represent frontiers, some fo which relate to methodological processes, like machine learning" We have amended as follows: "The focal points represent frontiers, some fo which relate to methodological processes, like the *appropriate and responsible use of* machine learning"
Although there is recognition of the need to work with communities, it remains unclear what kinds of knowledge these communities are understood to hold, and how such knowledge would be meaningfully synthesised with approaches such as machine learning. To critically move this argument forward, the 'how' feels underdeveloped - Is this synthesis the priority, or are/what other forms of knowledge production are equally valued? The paper would benefit from greater clarity and specificity on how space for different forms of knowledge will be ensured. At present, this section feels quite vague and requires more substance to be convincing.	We agree these nuances are critically important, though unfortunately outside the scope and length of the paper. Types of knowledges and how these would be engaged with will look different depending on the specific MH2O pathway under examination and the 'who' involved. We have amended our statement in 'Closing remarks' to include: "It is likely that MH_2O pathways will vary over shorter and longer timeframes, across *heterogeneous* urban, rural and coastal landscapes, and between as well as within *diverse communities with critical environment and health knowledges. Beyond traditional*

	scientific evidence generation, MH_2O pathway development must engage lived experience, including local and indigenous understandings of place-and-space-based resilience, positioning community and decolonial forms of knowledge production alongside formal institutional systems.."
Line 117: "fo" should be corrected to "for"	Thank you.