

## RESPONSE TO THE REVIEWERS

egusphere-2025-4062

Reviewer 2 comment	Response
<p>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 NHSS readers.</p>	<p>Thank you for the very encouraging feedback.</p>
<p>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 more robust and more clearly situated within interdisciplinary hazard research.</p>	<p>Thank you for this observation. We have addressed specific comments (below) on this point.</p>
<p><b>Use of the term "amenable health condition"</b></p> <p>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.</p>	<p>Thank you, we agree our terminology could be clearer. We have replaced 'manageable' with 'underlying' health conditions.</p>
<p><b>Compounding, co-occurring and cascading impacts</b></p> <p>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</p>	<p>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</p>

<p>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.</p>	<p>pathways is beyond the scope of the perspectives piece. However, we have added text to clarify that our focus is inclusive:</p> <p>‘Thus, understanding transitions between single and multiple hazards, the multi-risks resulting from compound and consecutive <i>or cascading</i> multi-hazards, and specifically MH2Os’ is central to climate adaptation.’ (L40-45). We have also added reference to <i>cascading</i> as well as co-occurring/cumulative and interrelated hazards to the ‘Closing remarks’ and ‘Introduction’ to make clear that the focus is holistic.</p>
<p><b>Hazard inclusion criteria</b></p> <p>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 respiratory conditions such as asthma. Please explain the rationale for excluding these hazards, especially given the stated interest in multi-hazard pathways.</p>	<p>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).</p>
<p>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.</p>	<p>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.</p> <p>Geological hazards are mentioned throughout, including earthquakes and landslides.</p>
<p><b>Participation and knowledge production</b></p> <p>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.</p>	<p>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’:</p>

	<p>“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, <i>including the impact of natural hazards on the health and wellbeing of societies, decolonial (Lenette, 2022) and social-ecological justice narratives (Forsythe, 2008).</i>”</p>
<p>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 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.</p>	<p>Around L100 we state:</p> <p>“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).”</p> <p>In this context, ‘natural’ is intended to juxtaposition ‘environmental’ processes (e.g., natural hazards) with ‘social’ processes. We have amended the text as follows:</p> <p>“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 <i>environmental</i> and social processes, involves establishing new institutions with global credibility and scientific legitimacy (Miller, 2004).”</p> <p>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:</p> <p>‘...new institutions with global credibility, scientific legitimacy (Miller, 2004), <i>and representation beyond academia, including diverse communities of practice.</i>”</p>

<p><b>Use of “vulnerable groups”</b></p> <p>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.</p>	<p>Within the manuscript, we refer to ‘most vulnerable’ groups as:</p> <p>“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.”</p> <p>To this statement we have added the following:</p> <p><i>“....and low socio-economic mobility, resulting in constrained agency.”</i></p> <p>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 <i>mobility</i> 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 <i>most</i> vulnerable.</p>
<p><b>Assumptions about data, synthesis and machine learning</b></p> <p>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.</p>	<p>We agree that misuse is a risk associated with machine learning.</p> <p>Currently, our manuscript reads (~L150):</p> <p>“The focal points represent frontiers, some of which relate to methodological processes, like machine learning”</p> <p>We have amended as follows:</p>

	<p>“The focal points represent frontiers, some of which relate to methodological processes, like the <i>appropriate and responsible use of machine learning</i>”</p>
<p>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.</p>	<p>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 MH<sub>2</sub>O pathway under examination and the ‘who’ involved.</p> <p>We have amended our statement in ‘Closing remarks’ to include:</p> <p>“It is likely that MH<sub>2</sub>O pathways will vary over shorter and longer timeframes, across <i>heterogeneous</i> urban, rural and coastal landscapes, and between as well as within <i>diverse communities with critical environment and health knowledges. Beyond traditional scientific evidence generation, MH<sub>2</sub>O 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.</i>”</p>
<p>Line 117: “fo” should be corrected to “for”</p>	<p>Thank you.</p>