Reviewer 2

This manuscript reviews 67 studies on capturing vulnerability dynamics in flood hazard research. While the topic is highly relevant and the classification of methods is useful, the manuscript requires significant methodological justification, better data visualization, and deeper synthesis before publication. So I suggest a major revision.

We want to thank the reviewers for the reviews provided. We appreciate the time this reviewer took to offer their reflection on the paper. We are glad that the reviewer finds our study relevant and timely. We addressed their feedback to sharpen the paper's scope and narrative. The main changes are the following:

- We added an additional figure and brief discussion of the geographic representation of the studies and the annual cumulative count of studies.
- We added a figure in the methods section to transparently report on the process of identifying the relevant studies.
- We extended the discussion regarding the limitations and opportunities of specific methods for the assessment of vulnerability and refined the conclusion to be more to the point.
- We streamlined terminology and checked in text citations throughout the manuscript.
- Additionally, we added 6 studies which have been suggested as relevant by an earlier reviewer of this manuscript. These studies do not change the overall narrative or key conclusions drawn and discussed in the originally reviewed draft of this manuscript, but offer more various insights into application contexts and learnings regarding dynamic vulnerability. As a result, the paper now covers 73 studies instead of 67.

Below, we have provided point-by-point responses in blue. When changes to the manuscript were made, we copied the relevant paragraphs and underlined the modified text. If references to lines are provided, they are based on the original manuscript, not the revised version, to facilitate tracking of the context in which changes were implemented.

The comments may helpful are as follows:

1. The authors are suggested to move Figure A1 from Appendix A to the main text. Add specific exclusion reasons at each step to improve methodological transparency.

R1: We thank the reviewer for their suggestion. Figure A1 in the Appendix summarizes the scoping phase process of the review, but does not represent the full review process. Therefore, instead of moving this to the main text, we decided to develop a new figure (now Figure 1), which summarizes the entire reviewing process to derive the final set of 73 studies. We furthermore extend on the methodological approach as outlined below. Additionally, we add a Figure B1 similar to A1 that captures the process of the targeted search (see below).

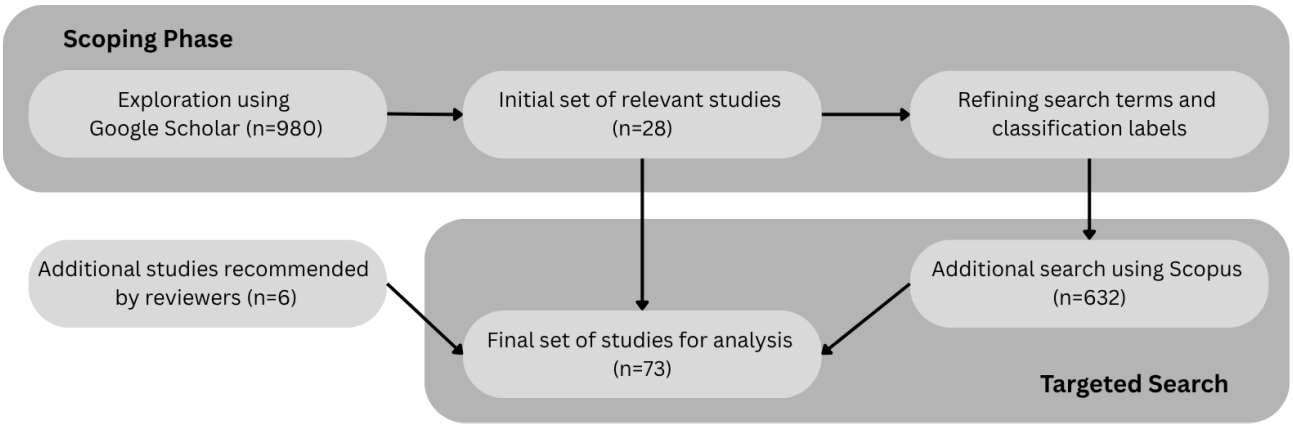

Figure 1: Methodological approach to identify relevant studies for the analysis of methods assessing vulnerability dynamics.

- L.119-135: "The review process followed two main steps. First, an initial scoping phase combined exploratory Google Scholar searches with inputs from co-authors (see Appendix A for details). In this first step, we identified and analyzed 28 relevant articles. This stage allowed us to refine search terms for the semi-systematic review. It also allowed us to develop and refine the classification categories for the content analysis. In the second step, we conducted targeted searches in the Scopus database (July 2025) using queries that combined methodological terms (e.g., curve-based, simulation, indicator-based, qualitative, or statistical approaches) with flood-related keywords (e.g., flood, flood risk), vulnerability-related concepts (e.g., vulnerability, resilience, adaptive capacity), and temporal or dynamic aspects (e.g., longitudinal, recovery, adaptation). The queries are listed in Appendix B. Each query returned approximately 100 studies, totaling 628 articles. These studies were then screened for relevance by co-authors with expertise in the respective methods. We included only peer-reviewed, English-language studies and removed duplicates (n=73). The remaining articles (n=555) were then filtered for relevance to capture vulnerability dynamics based on the title and abstract. Articles were excluded if the abstract did not mention any aspects relevant to any of vulnerability dynamics types, if they framed vulnerability as a convolution of exposure and vulnerability, or if they focused on other hazards and did not make reference to flooding as the relevant context for the vulnerability dynamics. The remaining studies (n=229) were then reviewed more closely considering the full text to obtain clarity regarding the same exclusion criteria. When eligibility was unclear, a second reviewer assessed the study, and inclusion decisions were made collectively. This happened in 26 cases. This targeted search returned 39 studies. Additionally, reviewers of an earlier version of the manuscript had recommended additional studies to include (n=6) which were taken into account as well. The final set of 73 relevant publications, including the 28 studies identified in the scoping phase, was reviewed in detail by at least one co-author, following the categories shown in Table 1. Some categories followed existing typologies (e.g., physical and social vulnerability sub-dimensions summarized in Table 2), while others were adapted from the literature. Reviewers were asked to provide a free-text elaboration for some of the categories, regarding the key findings of the study, and the limitations mentioned. The definitions for each of the adapted categories are described in the next sections."

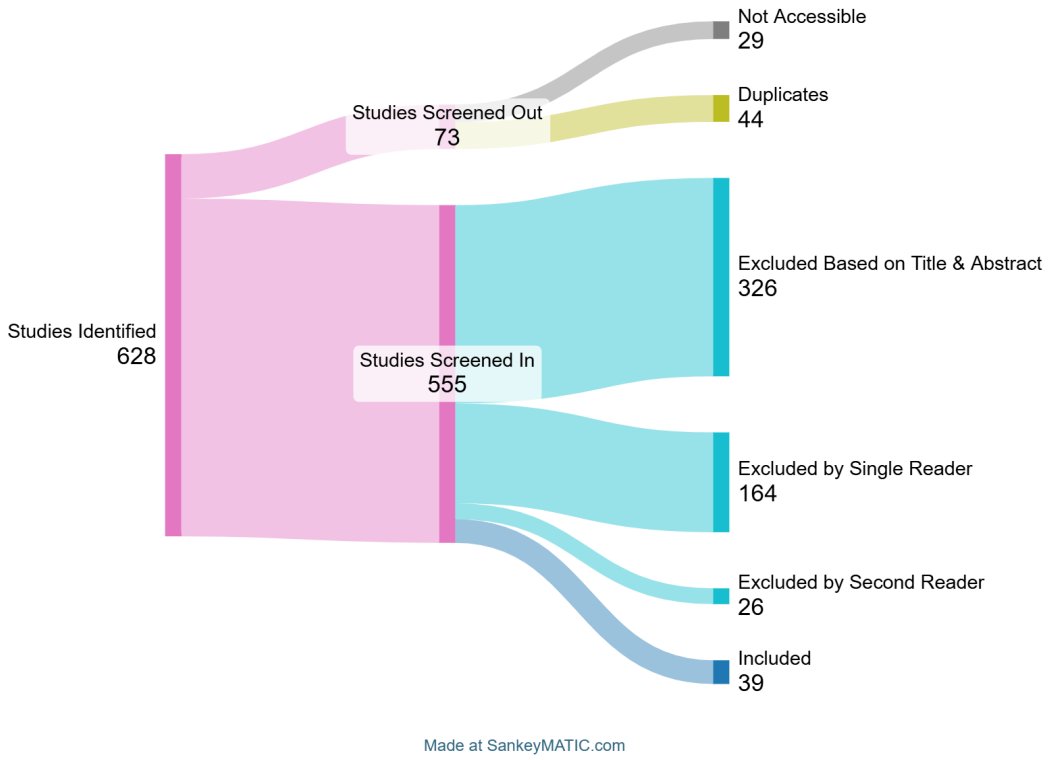

Fig. B1: Summary of the literature review and number of publications included in this analysis as part of the targeted search.

2. The paper lacks an analysis of where and when these studies were conducted in Results section. Add charts showing publication years and geographic locations to address potential regional biases.

R2: We thank the reviewer for this suggestion. We agree that a figure to show geographic representation is an important addition and we added the following figure and accompanying text. The figure also presents information on the temporal development of the number of studies.

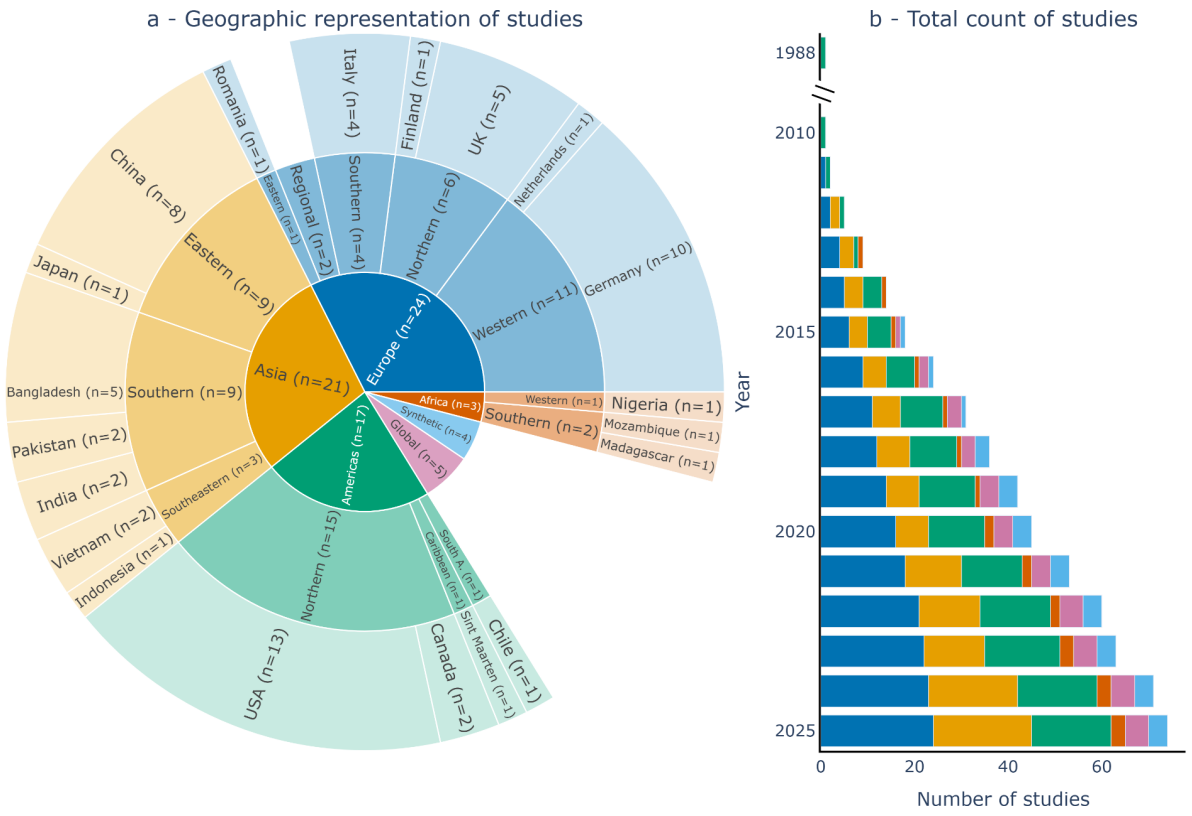

Figure 2 (new): a: Geographic distribution of studies included in the review. Studies are grouped by continent, regions (following the United Nations geoscheme) and country. Some studies were not limited to one specific continent or country and were thus applied on a global or regional scale. A few studies also made use of synthetic cases not rooted in a specific geographic context. b: Total cumulated number of studies on dynamic vulnerability published across years, colored by continent.

- L.207: "We identified 73 relevant studies that explicitly consider dynamic vulnerability, the majority of which (98%) have been published since 2010 (Figure 2b). Study geographies are concentrated in a few, scattered countries. In particular, a large fraction (42%) of studies are focused on cases in the United States of America, Germany and China. As summarized in Figure 2a, our search did not return any studies in many geographical regions, such as Northern, Middle and Eastern Africa, or Central and Western Asia, Central America, or the continent of Oceania. Over the years, both the increase in studies as well as the relative distribution across the continents remained relatively similar (Figure 2b)."

3. Lines 93-96: Vulnerability and exposure are often conflated in empirical studies. Include a conceptual diagram clearly delineating vulnerability, exposure, and hazard dynamics in this paper's specific context.

R3: We agree with the reviewer that vulnerability and exposure are often conflated in empirical studies and we therefore include a detailed section on the theoretical perspectives on vulnerability and the approach used to define vulnerability herein (lines 78-105). Rather than recreating conceptual figures of risk, as there are already numerous in the literature, we have referred to readers to figures in other existing papers that highlight these core concepts (e.g., Simpson et al. 2022). The updated text reads as follows:

- L. 87: "To provide conceptual clarity, the United Nations Office for Disaster Risk Reduction (UNDRR) and the Intergovernmental Panel on Climate Change (IPCC) offer widely recognized definitions that

help anchor vulnerability within disaster and climate risk frameworks (for visual conceptualizations see e.g. Simpson et al., 2021).

Simpson, Nicholas P.; Mach, Katharine J.; Constable, Andrew; Hess, Jeremy; Hogarth, Ryan; Howden, Mark et al. (2021): A framework for complex climate change risk assessment. In One Earth 4 (4), pp. 489–501. DOI: 10.1016/j.oneear.2021.03.005.

4. Tables 1 and 2 rely heavily on the sub-dimensions from Stolte et al. (2024). Discuss whether this specific framework perfectly fits all 67 reviewed papers or if any critical sub-dimensions had to be forced into ill-fitting categories.

R4: In this paper we used the framework from Stolte et al. (2024) as it offers a clear set of sub-dimensions and respective definitions. As such, while many studies donot explicitly define or clarify which vulnerability (sub-)dimensions are used, the framework offered helpful guidance in making the diverse studies comparable. The definitions by Stolte et al. (2024) were especially helpful as they could be compared against what and how the data sources and aspects of vulnerability were described in the studies. However, we acknowledge that putting things into boxes always introduces biases. We made the following adjustment as part of the discussion section:

- L.446: " The choice of search terms, drawn primarily from the disaster risk research community, together with the applied definition of vulnerability and the focus on flood-related studies, may have introduced bias. Similarly, many studies did not clearly define which vulnerability (sub-)dimensions they were addressing and our application and categorization of these vulnerability sub-dimensions following a specific framework could have also introduced some bias to our analysis. Furthermore, some aspects of vulnerability could fit multiple sub-dimensions. We tried to minimize these biases by comparing and matching the definitions of the (sub-)dimensions by Stolte et al. (2024) and the authors' original categories and descriptions to the extent possible.

5. The heatmap in Figure 2 is overly dense and difficult to read. Split this figure or use network/chord diagrams to better illustrate the connections between methods, foci, and data sources.

R5: We agree with the reviewer that Figure 2 is quite dense. However, we experimented with other visualizations during the writing process and did not find alternative visualizations that allowed us to offer comparable information equally clearly. Specifically, when trying to visually display this information in a chord diagram, it was difficult to distinguish the chord thicknesses at the scale of the figure. In the end, we decided that the heatmap provided the best visualization of the different relationships and frequencies, easily distinguishable by color and annotation.

6. Lines 506-509: The Discussion rightly notes that most studies focus on correlation rather than causal mechanisms. Propose a conceptual framework or a set of guidelines for researchers to move toward causal inference.

R6: We thank the reviewer for this suggestion. We believe that it is out of the scope of this study to introduce a set of guidelines for the causal inference in the discussion. We offer and refer to various good practices, e.g., the potential of agent-based modeling or qualitative analysis methods, that can uncover or incorporate such casual relationships. Given the relative paucity of studies, we did not think it was

appropriate to come up with a complete set of guidelines. Therefore, we refined our discussion section to suggest this as future work:

- L.506 - 512: "Another insight is that despite the diversity of methods and data sources, few studies explicitly identified causal pathways for changes in vulnerability. Most quantitative work focused on correlations, which provide associations but not mechanisms. Exceptions included mechanistic curve-based models of infrastructure or crop sensitivity, as well as specific dynamic simulation models. Qualitative approaches, such as the advanced impact chains developed by Albulescu and Armas, (2024) or expert elicitation by Whytlaw et al. (2021), offer more profound insight into process-level causality. A way forward may lie in metaanalyses of correlation studies to extract generalizable trends, analogous to how some depth–damage curves are developed for different infrastructure, thereby bridging qualitative process mapping with quantitative model calibration. Future studies should also work on developing a framework or general set of guidelines to help researchers move towards causal inference. Developing such a framework would require a separate in depth analysis of literature and approaches on the topic."

7. The Conclusion recommends combining methods, such as linking statistical trends to simulation models. Provide 1-2 concrete examples or hypothetical scenarios demonstrating how this works in practice.

R7: We thank the reviewer for this suggestion and made the two examples more concrete. These are integrated in a broader revision of the discussion based on the comments by both reviewers which are added in response to the comment

- L. 542: Looking ahead, three priorities stand out. Methodologically, the field would benefit from closer attention to 1) develop and test methods that allow the identification of causal pathways for vulnerability dynamics , 2) combining the strengths of different methods and 3) from learning across risk disciplines that study dynamic system responses, which may offer transferable concepts and tools. By combining methods, statistical methods could for example be used to extract recovery patterns for a specific case study or even across contexts to deduce more accurate behavioral rules for agents in simulation models. Similarly, qualitative forensic analysis might offer additional insights, e.g. regarding installed risk mitigation measures and their effects, allowing to modify or expand the set of damage curves applied in a certain context.

8. Section 4.1 highlights the lack of calibration data for curve-based approaches. Discuss how emerging global disaster loss databases or crowdsourcing could address this gap

R8: We added a short reflection on global disaster loss databases and crowdsourcing:

- L. 250: "Commonly, these studies acknowledge the lack of calibration and validation data for the flood impact models. A short-term solution to overcome this lack of calibration data could be the use of alternative data sources such as crowdsourcing (Ponukumati & Regonda, 2025; Assumpcao et al. 2018). Another promising development is that global and regional flood impact datasets are getting created or updated using new sources of information offering a wider temporal coverage or spatial detail (e.g. Veigel et al., 2025; Bruijn et al. 2019 or Paprotny et al. 2024). "

Bruijn, Jens A. de; Moel, Hans de; Jongman, Brenden; Ruiter, Marleen C. de; Wagemaker, Jurjen; Aerts, Jeroen C. J. H. (2019): A global database of historic and real-time flood events based on social media. In Scientific data 6 (1), p. 311. DOI: 10.1038/s41597-019-0326-9.

Paprotny, Dominik; Terefenko, Paweł; Śledziowski, Jakub (2024): HANZE v2.1: an improved database of flood impacts in Europe from 1870 to 2020. In Earth Syst. Sci. Data 16 (11), pp. 5145–5170. DOI: 10.5194/essd-16-5145-2024.

Veigel, Nadja; Kreibich, Heidi; Bruijn, Jens A. de; Aerts, Jeroen C. J. H.; Cominola, Andrea (2025): Content analysis of multi-annual time series of flood-related Twitter (X) data. In Nat. Hazards Earth Syst. Sci. 25 (2), pp. 879–891. DOI: 10.5194/nhess-25-879-2025.

9. Section 4.2 notes data scarcity for parameterizing Agent-Based Models. Briefly explore using behavioral economics surveys or social media data to build more objective agent rules.

R9: We added a short reflection on the potential of surveys and social media data:

- L.298: "Across ABM studies, a recurring limitation is the lack of empirical data for parameterizing agent behavior, and a focus on select dynamics, which constrains model realism (e.g., Abebe et al., 2019; Ciullo et al., 2017; Haer et al., 2019). Text-mining of social media or newspapers can uncover direct and indirect impact patterns related to flood events (e.g. Bruijn et al., 2019; de Brito et al. 2025) which can be used to improve the parametrization of simulation models. Similarly, ABMs are a widely used method across application contexts. Insights from behavioral economic studies in the context of financial impacts from floods could provide additional ideas for model parameterization, for example by means of micro-experiments or the use of evolutionary algorithms to match model outputs with observations (Axtell et al. 2025; Taberna et al. 2020)."

Axtell, Robert L.; Farmer, J. Doyne (2025): Agent-Based Modeling in Economics and Finance: Past, Present, and Future. In Journal of Economic Literature 63 (1), pp. 197–287. DOI: 10.1257/jel.20221319.

Brito, Mariana Madruga de; Sodoge, Jan; Kreibich, Heidi; Kuhlicke, Christian (2025): Comprehensive Assessment of Flood Socioeconomic Impacts Through Text-Mining. In Water Resources Research 61 (1), Article e2024WR037813. DOI: 10.1029/2024WR037813.

Taberna, A.; Filatova, T.; Roy, D.; Noll, B. (2020): Tracing resilience, social dynamics and behavioral change: a review of agent-based flood risk models. In 2663-3027. Available online at https://opus.lib.uts.edu.au/handle/10453/146588.

10. Standardize terms like "vulnerability change," "vulnerability shifts," and "dynamic vulnerability" early in the introduction to avoid confusion.

R10: We thank the reviewer for the suggestion to streamline the used terminology. We decided to strictly use the term vulnerability dynamic(s) or dynamic vulnerability and get rid of terms like vulnerability change.

11. Section 6 is too narrative. Add 3-5 concise bullet points highlighting the "Key Takeaways" for practitioners.

R11: We revised the conclusion to make it more direct:

- L. 530-549: "This review provides the first methodological comparison of approaches used to capture vulnerability dynamics in the context of flood risk - an aspect that previous reviews have addressed only implicitly or in passing. We compared how common assessment methods have been used or adapted, with an explicit focus on the types of dynamics they are able to capture. This offers researchers a basis for identifying promising methods for the assessment and can serve as a starting point to continue discussions on opportunities and limitations for the application of specific approaches.

  Across the 73 studies analyzed, we identified five main methodological approaches: curve-based, dynamic simulation, indicator-based, qualitative, and statistical, each with distinct strengths and limitations. Event-related dynamics dominate the field, with underlying and complexity-related changes receiving less attention. Social vulnerability dimensions such as economic, cultural/behavioural, and governance aspects are commonly included, while the physical dimension is often reduced to urban assets and critical infrastructure. Most methods draw on a combination of data sources, although remote sensing and workshop-derived inputs appear to be relatively uncommon.

  Looking ahead, three priorities stand out. Methodologically, the field would benefit from closer attention to 1) develop and test methods that allow the identification of causal pathways for vulnerability dynamics , 2) combining the strengths of different methods and 3) from learning across risk disciplines that study dynamic system responses, which may offer transferable concepts and tools. By combining methods, statistical methods could for example be used to extract recovery patterns for a specific case study or even across contexts to deduce more accurate behavioral rules for agents in simulation models. Similarly, qualitative forensic analysis might offer additional insights, e.g. regarding installed risk mitigation measures and their effects, allowing to modify or expand the set of damage curves applied in a certain context. Furthermore, learning from other risk disciplines or research fields that investigate dynamic responses within a system may offer valuable insights to further advance research on vulnerability dynamics in the context of flood risk.

  As the field develops, applying these approaches across various hazards, integrating different methods, paying closer attention to causal pathways, and conducting meta-analyses of findings regarding changes in vulnerability may improve both the understanding of vulnerability dynamics and the ability to manage and predict them."

12. Ensure all references and in-text citations strictly adhere to the journal's formatting guidelines

R12: We carefully checked that in-text citations adhere to the formatting guidelines.

Additional revision: During a review process of an earlier version of this manuscript (https://egusphere.copernicus.org/preprints/2025/egusphere-2025-850/), the reviewers had suggested a set of six studies that are also relevant. They all apply statistical methods regarding (sub-)dimensions of vulnerability and reflect a similar pattern across methods, data, vulnerability focus, and type of dynamics. We decided to include these 6 studies summarized below for sake of completeness and added diversity in terms methods used, purpose of the analysis and the learnings:

- Bubeck, P., Berghäuser, L., Hudson, P., & Thieken, A. H. (2020). Using panel data to understand the dynamics of human behavior in response to flooding. Risk Analysis, 40(11), 2340-2359.

- Bubeck, P., Botzen, W. J., Kreibich, H., & Aerts, J. C. (2013). Detailed insights into the influence of flood-coping appraisals on mitigation behaviour. Global environmental change, 23(5), 1327-1338.
- Gallagher, J. (2014). Learning about an infrequent event: Evidence from flood insurance take-up in the United States. American Economic Journal: Applied Economics, 206-233
- Kousky, C. (2017). Disasters as learning experiences or disasters as policy opportunities? Examining flood insurance purchases after hurricanes. Risk analysis, 37(3), 517-530
- Deryugina, Tatyana, Laura Kawano, and Steven Levitt. 2018. "The Economic Impact of Hurricane Katrina on Its Victims: Evidence from Individual Tax Returns." American Economic Journal: Applied Economics 10 (2): 202–33.
- Davlasheridze, Meri, Karen Fisher-Vanden, and H. Allen Klaiber. "The effects of adaptation measures on hurricane induced property losses: Which FEMA investments have the highest returns?." Journal of Environmental Economics and Management 81 (2017): 93- 114.

In the initial submission version we had not included these six studies. As such we made minor modifications throughout the manuscript (e.g. updating the number of studies considered), and particularly made the following adjustments:

- L.207-l.224: “We identified 73 relevant studies that explicitly consider dynamic vulnerability in their assessments. Figure 2 summarises the distribution of methodological approaches, conceptual foci, types of dynamics, physical and social vulnerability categories, and data sources considered. Overall, the main methodological approaches are relatively evenly represented. Most studies (n = 49) address vulnerability dynamics as the outcome of a flood event. A smaller subset (n = 19) applies dynamic vulnerability in multiple ways, for example, treating it both as a precondition to hazard impact and as an outcome of the event. Across the sample, there is a modest bias toward event-related dynamics (n = 38), while complexity-related dynamics are least represented (n = 13).

  In terms of vulnerability dimensions, several recur across multiple studies. Economic factors and cultural/behavioural aspects are most often considered, alongside awareness and information, demographic characteristics, and governance or institutional features. Most studies address multiple aspects of social vulnerability, while physical vulnerability dimensions are more narrowly represented. Here, there is a clear bias toward exposed urban assets (n = 41) and critical infrastructure (n = 23), which are often the sole physical characteristics analysed. [...]”

- Section 4.5 (l.370 - l.415): “Eighteen studies employ statistical approaches, which differ mainly in whether they analyse vulnerability as an outcome of events or as a precondition influencing outcomes. As shown in Figure 2, no study conceptualizes vulnerability as a factor in their analysis. In our sample set, we do not find any studies that investigate vulnerability dynamics due to the complexity of interacting processes. Instead, most studies employ an event-related assessment approach, utilizing various data sources and focusing on different vulnerability components. A key distinguishing element is whether they approached vulnerability solely as an outcome or as both a precondition and an outcome.

  The first group primarily applies an outcome-focused approach (Bubeck et al., 2012, 2013, 2020; Deryugina et al., 2018; Gallagher, 2014; Gallagher and Hartley, 2017; Kienzler et al., 2015; Köhler et al., 2023; Kousky, 2016; Phifer et al., 1988). Bubeck et al. (2012, 2013, 2020), Kienzler et al. (2015) and Köhler et al. (2023) investigate explicit correlations between past flood experiences and future flood preparedness or mitigation efforts, while Phifer et al. (1988) investigate relations to the health in the elderly. Gallagher (2014) and Kousky (2016) investigate the temporal evolution of insurance take-up following flood events while Deryugina et al. (2018) and Gallagher and Hartley (2017) investigate tax return patterns and debt patterns (regarding loans and credit cards) respectively in the recovery process from flood events.

Some studies rely primarily on interview data and apply descriptive statistical approaches in their analysis (Bubeck et al., 2012, 2013, 2020; Köhler et al., 2023; Phifer et al., 1988). Gallagher and Hartley (2017) and Deryugina et al. (2018) use a difference-in-difference approach comparing census blocks that were affected by the flood with those that were not, using modeled flood data and census information, along with field monitoring data regarding the debt development. Kousky (2016) and Gallagher (2014) use panel data from insurance claims for their analysis.

Phifer et al. (1988) find that flood vulnerability extends beyond immediate damage, as health effects persist over time, particularly among those who experience both personal and community-wide destruction. Similarly, Köhler et al. (2023) identify a paradox where individuals with more flood experience tend to take more precautionary measures but simultaneously feel less resilient. These findings underscore the role of psychological and social dynamics in vulnerability.

While Bubeck et al. (2012) demonstrate that flood events trigger accelerated mitigation efforts and preparedness improvements, Kienzler et al. (2015) show that these improvements are inconsistent across cases. Bubeck et al. (2020) find empirical evidence for - amongst other things - a decline in perceived flood risk and risk mitigation intentions with a weak to medium effect 18 months after a flood event. Bubeck et al. (2013) dive deeper into the specific factors, such as ways to cope with flood impacts, that shape the recovery processes and find that a postponement attitude tends to have a significant negative effect on the installment of risk mitigation measures, while socioeconomic aspects seem to play less of a role. Gallagher (2014) finds that insurance uptake increases after flood events, while Kousky (2016) concludes that insurance uptake increased directly after flood events, died down after about three years, and that insurance uptake is also correlated with governmental disaster relief grants. Gallagher and Hartley (2017) find that the debt decreased after an event in correlation with the payout of flood insurance money used to pay back loans instead of rebuilding. They hypothesize on possible reasons, both a demand-driven process (paying off loans and moving) and a lender-driven process (required to pay off mortgages on houses where house value was used as collateral). Finally, Deryugina et al. (2018) find various patterns including temporarily increased unemployment, relocation, increased marriage probabilities and withdrawals from retirement accounts in the aftermath of flood impacts.

Similar to studies employing other methodological approaches, multiple studies acknowledge the challenges associated with input data completeness, accuracy and aggregation level (e.g., Bubeck et al. 2020; Gallager, 2014; Gallagher and Hartley, 2017; Köhler et al., 2023). Bubeck et al. (2012) note some specific challenges relating to dynamic vulnerability with regards to the timing of flood events considered, which is not resolved in enough detail to derive conclusions about overlapping processes of recovery and risk reduction/mitigation efforts. Deryugina et al. (2018) note that for the difference-in-difference method it is particularly challenging to find a credible comparison group that can serve as the benchmark and counterfactual to the flood impacted area. They also note that especially urban areas in the surrounding region might also be affected by cascading effects on the labor market, which makes unimpacted cities in the vicinity less suitable.

Studies combining precondition–outcome perspectives include Atiqul Haq et al. (2024), Biswas et al. (2024), Dalvasheridze et al. (2017), Jamshed et al. (2021), Jiang et al. (2023), Houston et al. (2021) and Salvucci and Santos (2020). These studies examine how flood exposure affects broader vulnerability characteristics, including fertility, birth weight, mobility, and consumption. They also investigate which vulnerability sub-dimensions are correlated with the changes. For example, Biswas et al. (2024) investigate which socioeconomic factors are generally correlated more strongly with low birth weights in combination with potential flood exposure. Dalvasheridze et al. (2017), use data on ex-ante long-term mitigation investments and ex-post spendings on recovery and clean-up, as well as building damages, to investigate the damage reduction effects. They find that ex-ante investments primarily reduce the probability of damage, while ex-post investments mainly

result in loss reduction. Jamshed et al. (2021) investigate how the mobility patterns between rural and urban settlements vary depending on factors including the age of the household head and economic situation, and Jiang et al. (2023) explore how recovery patterns in terms of credit use are affected by the wealth of the impacted household (Contreras and Torres-Machi, 2025, do the same for travel characteristics). They use various data sources for their analysis and apply several different methods of inference analysis including bivariate, multivariate or multinomial regression analysis (e.g., Atiqul Haq et al., 2024; Biswas et al., 2024; Jamshed et al., 2021), Autoregressive Integrated Moving Average model for time-series data (e.g., Atiqul Haq et al., 2024) and Moran's I statistics for spatial correlation analysis (e.g., Biswas et al., 2024), difference-in-difference to compare changes in affected regions in comparison to unaffected places (Salvucci and Tarp, 2021), and descriptive statistics (Jamshed et al., 2021; Jiang et al., 2023; Houston et al., 2021). Biswas et al. (2024) note that a key limitation in the inability to establish causality is due to input/measurement data constraints. [...]"