Specific observations:-

1. The second sentence of the abstract confuses resilience with vulnerability, which is [almost] its opposite.

Answer: Thank you for pointing this out. We agree that the wording of this sentence could blur the distinction between vulnerability and resilience. Our intention was to refer to resilience as the capacities and system properties that influence whether disruption is absorbed, contained, or transmitted, rather than to vulnerability as susceptibility to harm. This distinction is consistent with disaster-risk terminology, in which vulnerability refers to conditions that increase susceptibility to hazard impacts, whereas resilience refers to the capacity to resist, absorb, accommodate, adapt to, and recover from them. We have therefore revised the sentence to read: "Underlying vulnerability helps explain why similar disruptions can produce different consequences, while resilience dimensions describe the capacities and system properties associated with whether disruption is absorbed, contained, or transmitted across connected systems."

2. Lines 24-31: This paragraph states things that are self-evident. It could usefully be deleted.

Answer: Thank you for this comment. We agree that the opening paragraph states general principles that are already well established in disaster-risk research and does not sufficiently advance the specific argument of this review. We will therefore remove this paragraph and begin the Introduction directly with the distinction between compound, interacting, interconnected, and cascading risks. This change makes the Introduction more focused on the conceptual problem addressed by the review and avoids unnecessary background material.

3. Lines 41-42: This was a point made by Pescaroli & Alexander (2018, Figure 2, p. 2253).

Answer: Thank you for pointing this out. We agree that this point is more directly associated with Pescaroli and Alexander (2018), particularly their discussion of escalation points and interacting dimensions of vulnerability. We will therefore add this reference alongside the existing citation and revise the sentence to make the attribution clearer. The revised text would read as: "Pescaroli & Alexander, (2018) emphasize that escalation points can emerge where multiple types and dimensions of vulnerability intersect, leading to consequences that may become more severe than the initial hazard itself."

4. Lines 32-45: This paragraph would be better if the analysis were conducted from the point of view of vulnerability rather than hazard.

Answer: Thank you for this observation. We agree that the previous wording placed too much emphasis on the hazard component of these concepts. We will therefore reframe this paragraph from the perspective of vulnerability and system conditions rather than presenting the four concepts primarily as different hazard configurations. The revised paragraph would be: "Pescaroli and Alexander (2018) show that compound risk is more closely associated with the physical hazard domain, while interacting risk considers how hazards interact with other processes and vulnerabilities. Interconnected risk gives greater attention to dependencies among human, environmental, and technological systems, through which disruption can spread from one system to another. Cascading risk places stronger emphasis on vulnerability and interdependence, particularly on the social and infrastructure nodes through which secondary emergencies can escalate and become more serious than the initial event. From this perspective, the triggering hazard is an important starting point, but it does not alone explain how a cascade develops. The development and severity of cascading consequences also depend on underlying vulnerabilities, system interdependencies, and the points at which disruption is amplified across connected systems. Sulfikkar Ahamed et al. (2023) similarly examine systemic, cascading, and compound risks through the interaction of triggering and triggered hazards, underlying vulnerabilities, and affected systems. Their review of 40 Asia-Pacific cases shows that physical, social, economic, institutional, and environmental vulnerabilities can interact and shape how complex risks develop. In this review, the initiating hazard is therefore used as the starting point for reconstructing each event pathway, while the main analytical focus is on the system failures, interdependencies, and resilience conditions that determine whether disruption remains contained or develops into a wider cascading crisis.

We have therefore reframed this paragraph from the perspective of vulnerability and system conditions rather than presenting the four concepts primarily as different hazard configurations.

5. Lines 60-61: "...the methods used to describe and map cascades remain heterogeneous." - This is a very good point, but the subject matter is heterogeneous as well!

Answer: Thank you for this clarification. We agree that methodological heterogeneity partly reflects the heterogeneity of cascading disasters themselves, which differ across hazard types, affected systems, spatial and temporal scales, and vulnerability contexts. Our intention was not to imply that methodological diversity is inherently problematic, but rather that it complicates consistent cross-case comparison. We will revise the sentence to make this distinction explicit. The revised sentence would be:

“Although the conceptual literature has become clearer, the methods used to describe and map cascades remain heterogeneous, partly reflecting the diversity of cascading processes themselves across hazards, systems, spatial and temporal scales, and vulnerability contexts. This methodological diversity is therefore not necessarily a weakness; however, it makes systematic comparison across events more difficult.

6. Line 64 and elsewhere: by territorial you mean geographical. There is a subtle difference.

Answer: Thank you for this clarification. We agree that “territorial” and “geographical” are not fully interchangeable and that our wording was imprecise. We have therefore revised the sentence to avoid conflating the two concepts. The revised sentence reads: “This perspective is relevant to natural-hazard research because it considers hazard processes together with exposed and vulnerable systems within the affected area, rather than treating hazards as isolated events.”

7. Line 81: It is not clear what 'standardized cross-case empirical coding' involves. If practical studies of actual cascades are in short supply it would be difficult to develop norms from a body of evidence.

Answer: Thank you for this comment. We agree that the phrase “standardized cross-case empirical coding” was unclear and could imply the existence of established coding norms that the literature has not yet developed. Our intention was not to suggest that such a standard already exists, but to distinguish predominantly scenario-based and case-specific approaches from comparative empirical studies that apply a common coding framework across multiple documented events. We have therefore revised the sentence to read: “These contributions moved beyond static lists of impacts and tried to reconstruct transmission pathways; however, cascades are still commonly investigated through scenarios, workshops, and systems diagrams, while comparative empirical studies using a common coding framework across multiple real-world events remain limited.”

8. Lines 90-91: "...a broad comparison across many types of real-world cascading disasters is still needed to better understand and manage cascade events." - That is exactly what the cascading disasters magnitude scale was designed to facilitate.

Answer: Thank you for this clarification. We agree that the previous sentence was too broad. The cascading-disaster magnitude scale provides an important framework for comparing the overall complexity of cascading events across cases. Our intention was not to suggest that comparative approaches are absent, but rather that there remains limited cross-case synthesis of the specific failure pathways, escalation mechanisms, and system conditions through which different types of real-world cascades develop. We have revised the sentence accordingly. The revised text would be read as:

“Existing comparative frameworks, including the cascading-disaster magnitude scale, provide an important basis for classifying the overall complexity of cascading events. However, there remains limited cross-case evidence on the specific failure pathways, escalation mechanisms, and system conditions through which different types of real-world cascades develop and spread.”

9. Line 97: The trouble with Hagen's categories is that most of them do not betoken cascading effects at all, merely interruptions in continuity of events or decisions.

Answer: Thank you for this observation. We agree that Hagen et al. (2015) use a broad interpretation of “triggers of cascading effects.” Their categories include disruptions of information, organisational, supply, and regulatory relations as well as pre-disaster conditions, and several of these represent interruptions in operational continuity or decision-making rather than cascading effects in the stricter sense of a secondary disruption generating further consequences. Our intention was to use this study as an example of the governance/crisis-management perspective rather than to adopt its categories as a definition of cascading effects. We have revised the paragraph to make this distinction explicit and to note that this example itself illustrates variation in how the literature conceptualises the conditions that trigger or amplify cascades. The revised text would be:

“By contrast, governance-oriented and crisis-management studies often focus on operational conditions that may enable or amplify cascade development. Drawing on six crisis case studies, Hagen et al. (2015) categorized disruptions in information, organization, supply, legal and regulatory relations, disturbance relations, and pre-disaster conditions as triggers of cascading effects. Several of these categories describe interruptions in operational continuity or decision-making rather than cascading effects in themselves, illustrating the broader way in which the term has sometimes been applied in crisis-management research. A mixed-method approach with local stakeholders was also used to examine awareness of cascading risk and found a gap between awareness and its integration into policy and practice (Pescaroli, 2018). Together, these studies highlight the importance of coordination, information flow, preparedness, and operational resilience, but also show that the boundary between conditions that enable a cascade and the cascading effects themselves is not always clearly defined.”

10. Line 106: I recommend you read Ken Hewitt's 1983 book, which established the primacy of vulnerability over hazard long before Kelman dealt with it. This was the so-called 'radical critique'. It still has plenty of lessons for the present day.

Answer: Thank you for this important historical reference. We agree that the vulnerability-centered critique predates the more recent literature cited in the manuscript. Hewitt's (1983) critique of the dominant hazard-centered interpretation of disasters provides an important foundation for later vulnerability-oriented disaster research. We have therefore added Hewitt (1983) to this discussion and revised the paragraph to acknowledge the earlier development of this perspective before discussing more recent applications by Duvat et al. (2021) and Kelman (2018). The revised sentences would be:

"Another explanation centers on long-term vulnerability, dependency, and social inequality. Hewitt (1983), in what became known as the radical critique of the dominant hazard-centered view, argued that disasters should not be explained primarily through extremes in physical processes, but through the social conditions that shape who is exposed, vulnerable, and able to cope. Later studies developed this argument further by showing how historical political-institutional dynamics, unsustainable development, weak local institutions, population mistrust in public authorities, social inequalities, and environmental degradation can accumulate over time and amplify disaster impacts (Duvat et al., 2021). Kelman (2018) pushes this critique further by arguing that the root causes of disasters are vulnerabilities, that these vulnerabilities are long-term and multi-causal, and that attempts to identify neat causal chains can obscure the deeper social processes through which disasters emerge."

11. Lines 111-113: Resilience cannot be applied if vulnerability is not understood first.

Answer: Thank you for this clarification. We agree that vulnerability should provide the conceptual starting point and that resilience should not be presented as an alternative to vulnerability. We have revised this passage to make the sequence explicit. Vulnerability is now described as explaining the underlying conditions that shape susceptibility to cascading consequences, while resilience dimensions are used subsequently as a complementary lens to examine the capacities and system properties that influence whether disruption is absorbed, contained, adapted to, or propagated. The revised paragraph would be:

"These arguments are a necessary correction to narrow hazard-chain thinking and establish "vulnerability" as a necessary starting point for understanding why disaster impacts develop unevenly and why some people, infrastructures, and systems are more susceptible to cascading consequence. "Resilience" is therefore not treated here as an alternative to vulnerability. Rather, once the underlying vulnerabilities and dependencies are recognized, resilience dimensions provide a complementary way to examine the capacities and system properties that influence whether disruption is absorbed, contained, adapted to, or transmitted across connected systems. Failure mechanisms represent the observable breakdowns that occur during an event, such as loss of access, service interruption, or failure of monitoring and control, while vulnerability helps explain the conditions that make such breakdowns consequential. Resilience dimensions then help examine whether sufficient redundancy, substitutability, institutional capacity, and other system capacities are available to prevent those failures from spreading further. Comparable applied resilience studies have used resilience attributes to explain differences in post-earthquake urban recovery, to frame management metrics, and to diagnose built-environment weaknesses before disruption occurs (Al-Humaiqani & Al-Ghamdi, 2024; Allan & Bryant, 2014; Kerner & Thomas, 2014). This framing is especially important for cascading disasters, which are rarely explained by a single hazard or a single damaged component. Therefore, vulnerability can provide the conceptual basis for understanding susceptibility to cascading effects, while resilience dimensions are used as a complementary analytical lens for examining the system capacities associated with whether observed failures remain localized or propagate across systems. This makes it possible to move beyond merely describing what failed and to examine the conditions and capacities that shaped how those failures developed into wider cascading consequences."

12. Lines 117-118: "...resilience dimensions are therefore used as an analytical bridge between observable failure mechanisms and the deeper system weaknesses that allowed those failures to propagate" - This is a thoroughly muddled statement.

Answer: Thank you for pointing this out. We agree that the previous sentence compressed vulnerability, observable failure mechanisms, and resilience capacities into a single statement and therefore made their respective analytical roles unclear. We have removed this sentence and now distinguish them explicitly: vulnerability refers to the underlying conditions that shape susceptibility to harm; failure mechanisms represent the observable breakdowns occurring during an event; and resilience dimensions are used to examine the capacities and system properties associated with whether those failures remain localized or propagate across connected systems.

According to the comments (11 and 12), the text would be revised as follow: "These arguments are a necessary correction to narrow hazard-chain thinking and establish "vulnerability" as a necessary starting point for understanding why disaster impacts develop unevenly and why some people, infrastructures, and systems are more susceptible to cascading consequence. "Resilience" is therefore not treated here as an alternative to vulnerability. Rather, once the underlying vulnerabilities and dependencies are recognized, resilience dimensions provide a complementary way to examine the capacities and system properties that influence whether disruption is absorbed, contained, adapted to, or transmitted across connected systems. Failure mechanisms represent the observable breakdowns that occur during an event, such as loss of access, service interruption, or failure of monitoring and control, while vulnerability helps explain the conditions that make such breakdowns consequential. Resilience dimensions then help examine whether sufficient redundancy, substitutability, institutional capacity, and other system capacities are available to prevent those failures from spreading further. Comparable applied resilience studies have used resilience attributes to explain differences in post-earthquake urban recovery, to frame management metrics, and to diagnose built-environment weaknesses before disruption occurs (Al-Humaiqani & Al-Ghamdi, 2024; Allan & Bryant, 2014; Kerner & Thomas, 2014). This framing is especially important for cascading disasters, which are rarely explained by a single hazard or a single damaged component. Therefore, vulnerability can provide the conceptual basis for understanding susceptibility to cascading effects, while resilience dimensions are used as a complementary analytical lens for examining the system capacities associated with whether observed failures remain localized or propagate across systems. This makes it possible to move beyond merely describing what failed and to examine the conditions and capacities that shaped how those failures developed into wider cascading consequences."

13. As the cascading disasters magnitude scale shows, not all cascading effects involve escalation. Rather than assuming that it occurs, it would be better to analyse why it does in the cases where it can readily be identified.

Answer: Thank you for this important distinction. We agree that not all cascading effects necessarily involve escalation. In this review, however, the analytical scope was deliberately restricted to cases classified as M3–M5 on Alexander's cascading-disaster magnitude scale. Under this operationalisation, retained cases contained at least one identifiable escalation point, whereas M0–M2 cases were excluded from the final event pool. We will clarify this scope to avoid implying that escalation is an inherent feature of all cascading effects. The analysis therefore asks why escalation occurred in the retained cases and which failure mechanisms and system conditions were associated with that escalation, rather than assuming that all cascading effects necessarily escalate. This clarifications have been presented in Methods section, part d) Data extraction and synthesis.

14. Line 131 et seq.: It beats me as to why PRISMA is conjured up so often in the social sciences when it was specifically designed to evaluate medical research. Full use of the PRISMA methodology involves looking for weaknesses in empirical studies that might

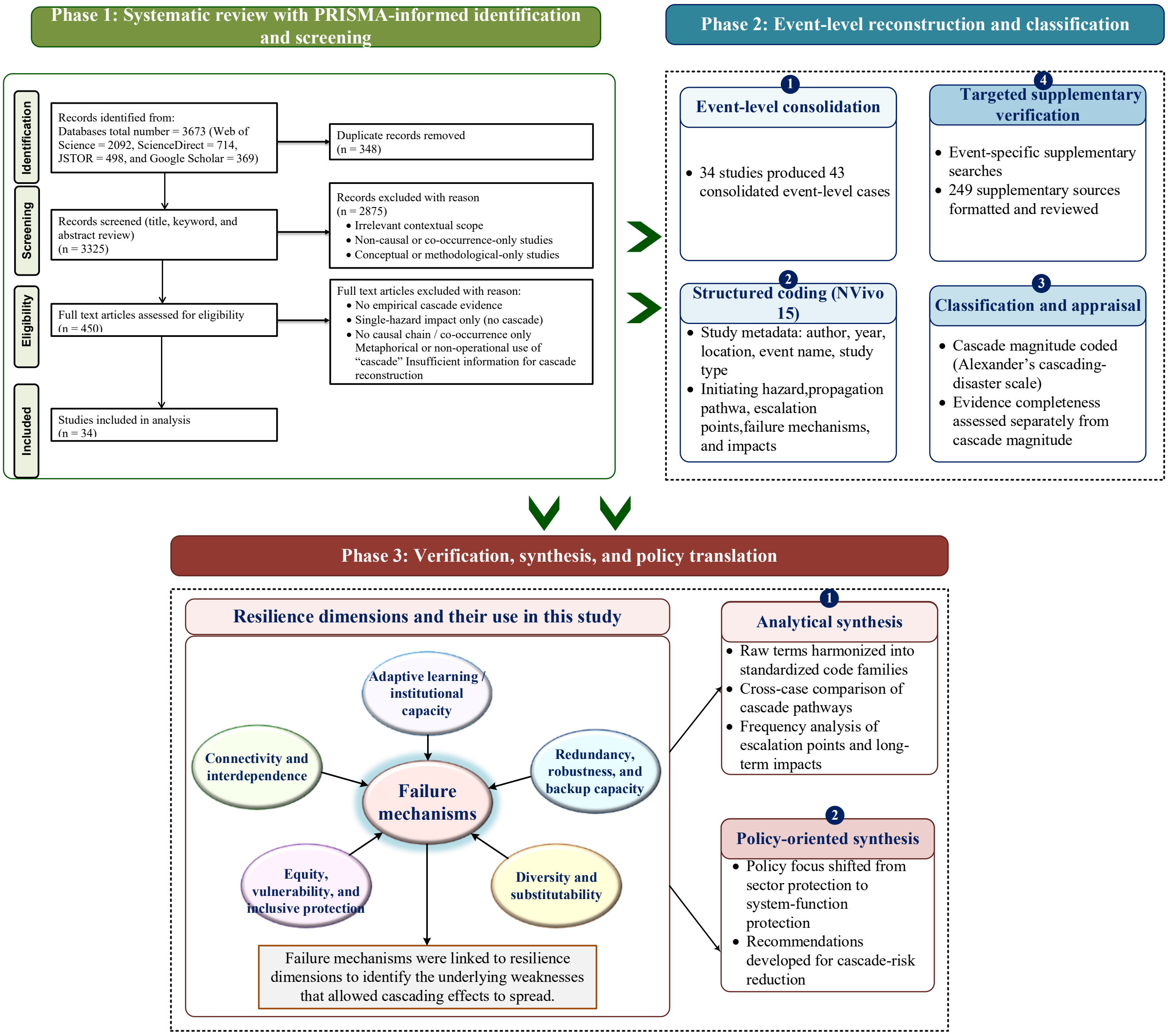
bias results and lead to unwanted outcomes in patients. In fact, this paper does not use PRISMA as described by its originators in their 2020 article in the Annals of Surgery. Hence, the description of methodology is misleading.

Answer: Thank you for raising this methodological point. We agree that the previous wording could imply a broader use of PRISMA than was intended. PRISMA 2020 was developed primarily for systematic reviews of health interventions; however, the PRISMA 2020 authors also state that many checklist items are applicable to reviews with other objectives and to non-health fields. PRISMA is also explicitly presented as a reporting guideline rather than a methodology for conducting or appraising systematic reviews. In this study, we used the applicable PRISMA elements to structure and transparently report literature identification, screening, eligibility assessment, and study selection; we did not intend to claim that the complete clinical evidence-evaluation framework was applied. We have therefore revised the Methods to describe the study as a systematic review with PRISMA-informed identification and screening, and we clarify that the subsequent synthesis was event-level and mechanism-focused. Evidence completeness was assessed separately to determine whether the available sources were sufficient to reconstruct each event's initiating event, propagation sequence, escalation points, and impact pathways. The revised text would be:

"This study employed a systematic review design, with the identification, screening, eligibility assessment, and reporting of study selection informed by PRISMA 2020. PRISMA was used as a framework for transparent literature identification and selection rather than as a clinical evidence-grading protocol. Because the objective was to reconstruct and compare event-level cascade mechanisms rather than to estimate intervention effects, evidence was assessed in terms of its adequacy for reconstructing the initiating event, propagation sequence, escalation points, and impact pathways. Figure 1 presents the framework that summarizes the study workflow from PRISMA-informed identification and screening to event-level coding, cross-case synthesis, and risk-reduction interpretation."

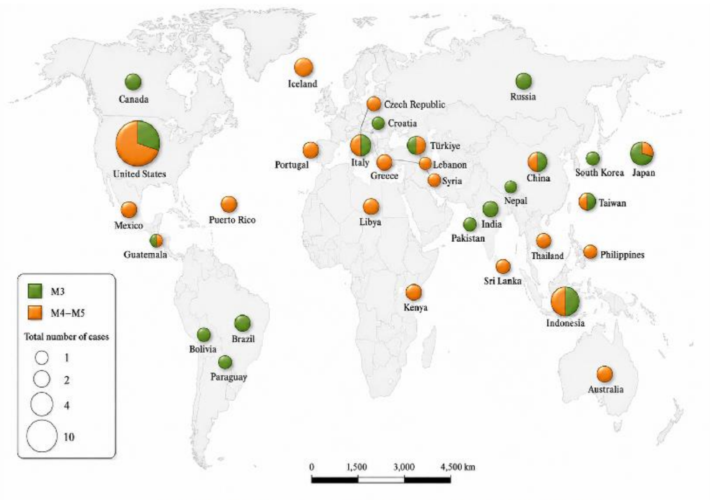
15. Figure 1 needs improvements in legibility.

Answer: Thank you for this comment. We agree that the previous version of Figure 1 was visually dense and that several labels became difficult to read at manuscript scale. We have revised the figure by increasing font sizes and simplifying the text within the boxes.

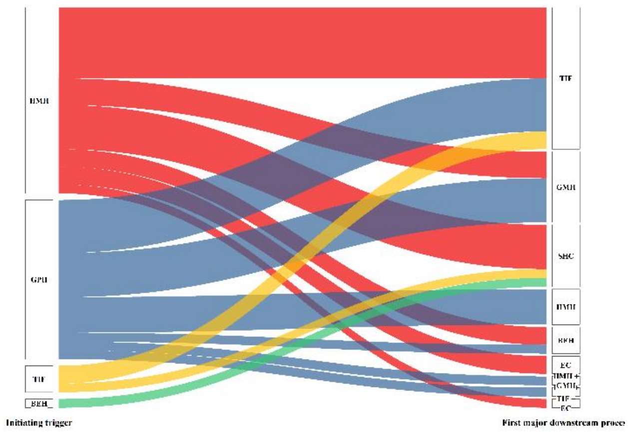


16. Figure 2a refers only to the cases extracted from the literature and is not a portrait of cascading disasters worldwide. It is difficult to see what point can be made from it.

Answer: Thank you for this comment. We agree that the previous presentation could be interpreted as a global portrait of cascading disasters, which was not our intention. Figure 2a shows only the geographic distribution of the cases included in the review and is therefore a representation of the reviewed evidence base rather than of the worldwide occurrence of cascading disasters. We have revised the panel title and accompanying text to make this distinction explicit and to emphasize that the observed geographic concentration may reflect differences in documentation, research visibility, and study availability.



a) Geographic distribution of cascading-disaster cases by country and cascade magnitude



b) Initial cascade transitions from initiating triggers to first major downstream processes or system disruptions
HMH = Hydro-meteorological hazards; GPH = Geophysical hazards;
GMH = Geomorphological hazards; TIF = Technological/infrastructure failures;
BEH = Biological/ecological hazards; SHC = Social/humanitarian crises;
EC = Environmental contamination.

c) Cases included in each mechanistic cascade pathway

Initiating trigger	First major downstream process	Events
HMH	TIF	Uri 2021; Katrina 2005; Lekima 2019; Otis 2023; Sandy 2012; Central Italy snow 2017; China ice storm 2008; Storm Daniel 2023
GPH	TIF	San Fernando 1971; Eyjafjallajökull 2010; Marmara 1999; Gorkha 2015; Hengchun 2006; Sea of Japan 1983
GPH	GMH	Central Italy landslide 2016–17; Unzen/Mayuyama 1792; Alaska 1964; Pinatubo–Yunya 1991; Fuego–Agua 1717
HMH	SHC	Puerto Rico 2016–20; Amphan 2020; TC Harold 2020; Tornado COVID 2020; Makassar 2019
GPH	HMH	Indian Ocean tsunami 2004; Okushiri 1993; Anak Krakatau 2018; Türkiye–Syria 2023
HMH	GMH	Morakot 2009; Agatha–Pacaya 2010; Madeira 2010
HMH	BEH	Kenya floods–cholera 2020; Pantanal wildfires 2020
HMH	EC	Prague flood Natech 2002; Black Summer 2019–20
TIF	TIF	Baltimore tunnel 2001; North America blackout 2003
BEH	SHC	Desert locust Pakistan 2019–20
GPH	BEH	Zagreb earthquake 2020
GPH	HMH + GMH	Palu 2018
GPH	HMH + TIF	Tōhoku 2011
HMH	TIF + EC	Harvey 2017
TIF	SHC	Beirut port 2020

Figure 2: (a) Geographic distribution of cascading-disaster cases included in this review; (b) initial transitions from initiating triggers to first major downstream processes or system disruptions; (c) tabular summary of cases represented in each transition category

17. Regarding Figure 2b, my understanding was that the author wanted to get away from a hazard-based interpretation of cascading disasters, and yet here the cascade seems to be from one type of hazard to another.

Answer: Thank you for this observation. We agree that the previous labelling and presentation of Figure 2b could give the impression that cascading disasters were being interpreted primarily as transitions from one hazard type to another. This was not the intended role of the figure. The analysis represents only the initial transition in each reconstructed event, from the initiating trigger to the first major downstream process. Importantly, these downstream transitions include not only secondary physical hazards but also technological/infrastructure failures, social and humanitarian crises, and environmental contamination. We have therefore revised the terminology in Figure 2.b from “initiating hazard” and “transformed hazard” to “initiating trigger” and “first major downstream process,” and revised the accompanying text to clarify that this is a descriptive entry-stage analysis rather than a hazard-based explanation of cascade development. The subsequent analyses focus on escalation points, system failures, vulnerability-related conditions, and resilience capacities that explain how these initial disruptions developed into wider cascading consequences. The revised text will be read as:

"Figure 2.b provides a descriptive overview of the initial transition identified in each reconstructed cascade, from the initiating trigger to the first major downstream process or system disruption. Hydro-meteorological and geophysical hazards dominated the initiating stage of the reviewed cases, while the first major downstream transitions included secondary physical hazards as well as technological and infrastructure failures, social and humanitarian crises, and environmental contamination. Among moderate cascade cases, hydro-meteorological hazards were the most frequent initiating trigger (11 of 19 cases), followed by geophysical hazards (6 cases). Among high-complexity cases, geophysical triggers were the most frequent (12 of 24 cases), followed by hydro-meteorological triggers (10 cases). These differences describe the composition and initial transition patterns of the reviewed cases and should not be interpreted as evidence that particular hazard types inherently produce more severe cascades. The subsequent analyses therefore examine the escalation points, system failures, vulnerability-related conditions, and resilience capacities through which these initial disruptions developed into wider cascading consequences."

18. Figure 2c is a table.

Answer: Thank you for pointing this out. We agree that panel 2c is tabular in format. We have retained it within the composite Figure 2 because it directly supports the interpretation of panels 2a and 2b by identifying the cases represented in each cascade-transition category. We have revised the figure caption for further clarification.

19. Line 262 et seq.: In this paragraph there is a great confusion between causes and effects. Although in cascading disasters an effect can become a cause, to achieve a reasonable level of explanation there needs to be much better separation between the two.

Answer: Thank you for pointing this out. We agree that the previous paragraph grouped secondary hazards, system failures, and downstream social consequences too loosely under the term "transformed hazards," which blurred the distinction between causes and effects. We have revised the terminology and interpretation to separate: (1) secondary physical processes that act as new causes, (2) technological or infrastructure failures that may function as escalation mechanisms, and (3) downstream social and humanitarian consequences. We also clarify that an effect was treated as a new cause only when the reconstructed event sequence showed that it generated further cascading consequences. Figure 2 and the accompanying text have been revised accordingly to describe the "first major downstream process or system disruption" rather than a generic transformed-hazard category. The revised text would be as follows:

“Across both cascade magnitude groups, technological and infrastructure failures were the most common first major downstream disruptions (8 and 10 cases in moderate- and high-complexity cascade cases, respectively). This finding indicates that disruption of lifeline and built-system, in several events, subsequently became escalation points that generated further consequences across dependent services. Secondary physical processes were also prominent, particularly in high-complexity cases, and included landslides, liquefaction, debris flows, lahars, tsunami-related processes, and slope failures. These processes are treated here as secondary causes when they generated additional damage or system disruption. By contrast, displacement, shelter disruption, livelihood stress, and humanitarian-response are treated as downstream social and humanitarian consequences rather than as hazards in themselves, unless the evidence showed that they subsequently generated further cascading effects. This distinction is important because, in a cascading disaster, an effect can become a new cause, but its role depends on its position in the event sequence.

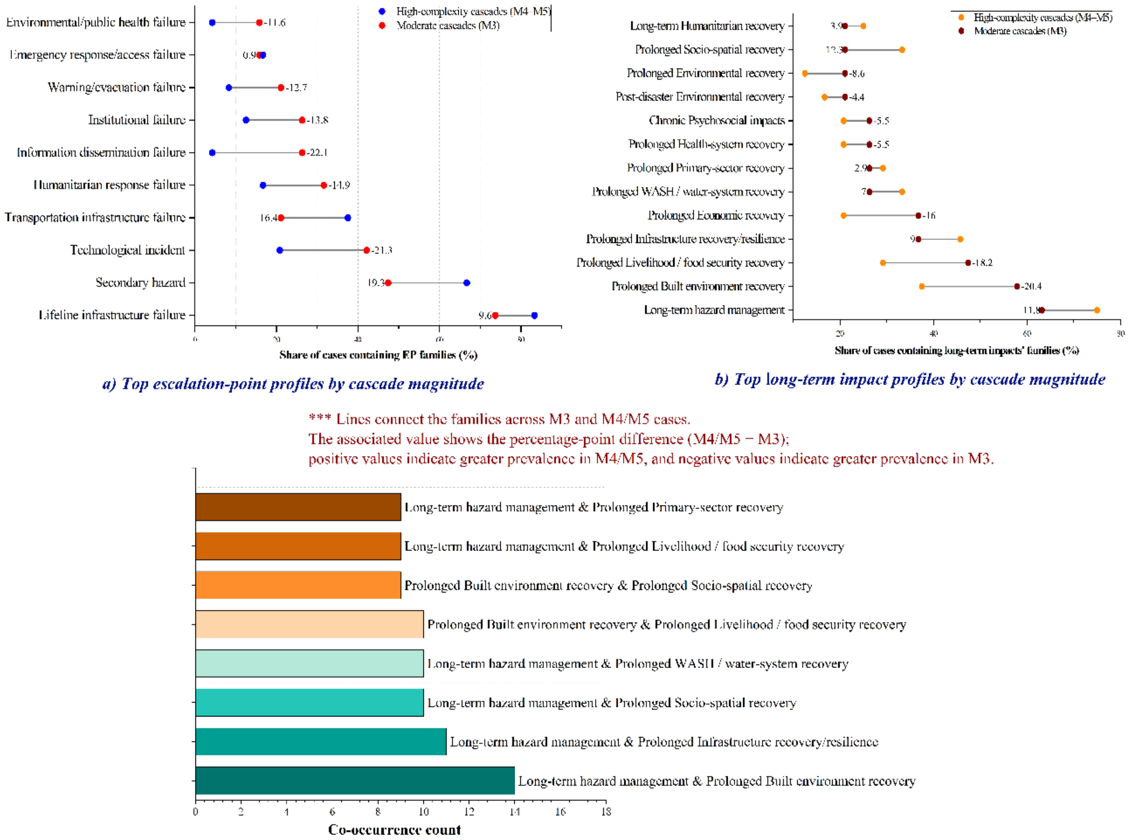
….

To examine propagation structure more directly, path depth was calculated from the ordered event sequences as the number of directed transitions within each documented pathway. At the event level, the maximum documented path depth averaged 6.58 transitions in high-complexity cases (M4–M5; median = 6, $n = 24$, $SD = 2.57$, range = 3–13), compared with 5.63 transitions in moderate cases (M3; median = 5, $n = 19$, $SD = 1.95$, range = 3–10). The Kruskal–Wallis test did not indicate a statistically significant difference between the groups ($H = 1.53$, $p = 0.216$). Mean path depth showed a similar pattern (3.65 versus 3.01 transitions; $H = 2.30$, $p = 0.129$). These results do not support treating higher cascade magnitude as a simple proxy for longer propagation sequences. Cascade complexity also depends on the configuration of causes, multiple chains, and escalation points rather than sequence length alone.”

20. I have struggled unsuccessfully to understand Figure 3. It does not have a clear message. It also seems to be critically dependent on a limited data set. It may well be that the results would be broadly similar if the data set were very much larger, but that is difficult to argue without more evidence. The figure also needs serious improvements in legibility.

Answer: Thank you for this comment. We agree that the previous version of Figure 3 combined several descriptive analyses and did not communicate their central message clearly enough. We also agree that the 43-case literature-derived database, particularly when divided into M3 and M4–M5 groups, does not support generalization of the observed percentage differences to the wider population of cascading disasters. Our intention was to describe patterns within the reviewed cases rather than to infer population-level relationships.

We have therefore revised Figure 3 and the accompanying text in two ways. First, the figure has been simplified to emphasize the most frequent escalation-point and long-term-impact families, with larger labels and clearer indication of the number of cases in each magnitude group.



a) Top escalation-point profiles by cascade magnitude

b) Top long-term impact profiles by cascade magnitude

c) Top major co-occurring pairs of long-term impact categories, ranked by number of events in which both categories appear together

Figure 3: Escalation-point and long-term impact profiles

Second, the text has been revised to emphasize the main within-sample finding: escalation in the reviewed cases was commonly associated with lifeline failures and secondary hazards, while long-term consequences frequently involved continuing hazard management and overlapping infrastructure, built-environment, water-system, and displacement/resettlement and migration-related recovery burdens. We have also added an explicit caution that these patterns reflect the reviewed evidence base and should not be interpreted as estimates of cascading-disaster patterns worldwide.

The revised text would be: “The long-term impact analysis (Figure 3.b) shows that persistent recovery burdens were common across the reviewed cases. Long-term hazard management was one of the most frequent categories in both magnitude groups, occurring in 12 moderate- and 18 high-complexity cases. This category refers to the ongoing management of unresolved or recurring hazard conditions, such as post-disaster slope instability, flood risk, contamination risk, dam or reservoir concerns, recurrent disease risk, and ongoing monitoring and preparedness demands. Within the reviewed sample, its frequent occurrence shows that unresolved hazard conditions often remained part of the recovery process after the immediate emergency had ended. Infrastructure, built-environment, water-system, displacement/resettlement and migration-related, livelihood, and economic recovery also appeared repeatedly. The magnitude-group differences are relatively small and uneven across categories and are therefore treated as exploratory rather than as evidence of systematic differences between moderate- and high-complexity cascades.

The co-occurrence structure (Figure 3.c) further shows that long-term impact categories frequently appeared together. The most recurrent combinations involved long-term hazard management with built-environment, infrastructure, displacement/resettlement and migration-related recovery, WASH/water-system, primary-sector, and livelihood/food-security recovery, while built-environment recovery also frequently co-occurred with displacement/resettlement and migration-related recovery and livelihood/food-security recovery. These combinations identify the recovery burdens that most often appeared together within the reviewed cases and can be interpreted alongside the escalation profiles shown in Figure 3.a."

21. Lines 293-294: "...ongoing hazard exposure, reconstruction, infrastructure restoration, and spatial recovery often combined to form a recovery burden." - Yes, but this is hardly novel. We have known it for many decades.

Answer: Thank you for this comment. We agree that the general observation that recovery burdens overlap across sectors is well established and should not be presented as a novel finding. We have therefore revised the interpretation to focus on the specific contribution of the co-occurrence analysis: identifying which long-term impact categories most frequently appeared together within the reviewed cases. We also interpret these recurring combinations alongside the escalation profiles identified earlier in the analysis, without implying a direct causal relationship between individual escalation points and particular recovery outcomes. The revised sentences read:

"The co-occurrence structure (Figure 3.c) further shows that long-term impact categories frequently appeared together. The most recurrent combinations involved long-term hazard management with built-environment, infrastructure, displacement/resettlement and migration-related recovery, WASH/water-system, primary-sector, and livelihood/food-security recovery, while built-environment recovery also frequently co-occurred with displacement/resettlement and migration-related recovery and livelihood/food-security recovery. These combinations identify the recovery burdens that most often appeared together within the reviewed cases and can be interpreted alongside the escalation profiles shown in Figure 3.a."

22. Lines 296-297: "Prolonged infrastructure recovery/resilience was observed in 45.8% of high-complexity cascades" - Complex cascades are probably inevitable in large disasters, which, by virtue of their size, take longer and require more resources to remedy.

Answer: Thank you for this important point. We agree that the observed difference in prolonged infrastructure recovery should not be interpreted as an independent effect of cascade complexity. Larger disasters may both generate more complex cascades and require longer and more resource-intensive recovery, creating an important confounding effect. We have therefore revised the paragraph to present the magnitude-group differences as descriptive associations only and to state explicitly that the present dataset cannot separate the effect of cascade complexity from the overall scale and severity of the disaster. The revised text would be read as:

"The magnitude-group differences are relatively small and uneven across categories and are therefore treated as exploratory rather than as evidence of systematic differences between moderate- and high-complexity cascades."

23. Line 301, and elsewhere: The term 'spatial recovery needs' crops up at intervals in this paper. What does it mean? Cascading disasters produce panarchy, which occurs at several spatial scales simultaneously.

Answer: Thank you for this clarification. We agree that the term "spatial recovery" was ambiguous, particularly because cascading processes can occur simultaneously across multiple spatial scales. In our coding, this category was not intended to represent a particular geographical scale. It referred specifically to continuing displacement, relocation, resettlement, migration pressure, and related recovery burdens affecting displaced populations and settlements. We have therefore removed the phrase "spatial recovery needs" and replaced the broader "socio-spatial recovery" terminology with the more explicit term "displacement/resettlement and migration-related recovery." The corresponding coding definition in Appendix D has also been clarified.

24. Line 317: "failure mechanisms capture the functional pathways of failure" - this is a self-referencing statement.

Answer: Thank you for pointing this out. We agree that the previous wording was circular because it defined failure mechanisms in terms of "pathways of failure." We have revised the sentence to define failure mechanisms operationally as observable functional breakdowns through which disruption propagates. The revised text reads:

"In this study, failure mechanisms refer to observable functional breakdowns through which disruption propagates, such as loss of hazard control, access disruption, and lifeline interruption. Therefore, the analysis first identifies which system functions were most frequently disrupted and then examines the resilience dimensions associated with whether these disruptions remained contained or propagated across systems."

25. Line 396: "Closely related to lifeline failure, road and transportation network failure" - roads and other transportation corridors are lifelines!

Answer: Thank you for pointing this out. We agree that transportation systems, including roads, railways, ports, and airports, are conventionally considered part of lifeline infrastructure. Our previous wording could therefore incorrectly suggest that transportation failure is conceptually separate from lifeline failure. In the present analysis, transport, mobility, and physical-access failure was retained as a distinct analytical subfamily because of its specific role in constraining evacuation, emergency access, logistics, rescue, and the movement of people and resources, while remaining part of the broader lifeline-infrastructure domain. We have revised the paragraph to make this hierarchy explicit and have also separated communication-system failure from transportation failure in the description. The revised text reads:

"Within the broader category of lifeline infrastructure, transport, mobility, and physical-access failure was another major stage at which disaster cases cascaded. Transportation was examined separately in the present analysis because of its specific role in maintaining evacuation, emergency access, logistics, and movement of people and resources. In many cases, the disaster cascaded not only because infrastructure was physically damaged, but also because damaged roads, bridges, railways, airports, ports, evacuation routes, and logistics channels prevented response systems from functioning at the required speed and scale. The dataset repeatedly links transport and mobility disruption with access isolation, emergency response delays, supply chain and logistics disruption, humanitarian aid system strain, health system disruption, shelter disruption, and prolonged repair operations. Communication and information systems, themselves another critical lifeline function, also shape whether transport and access disruption develops into a wider cascade. Recent reviews on social media in disasters triggered by natural hazards show that disaster-management information increasingly depends on data collection, actionable information extraction, relevance filtering, and decision-support capacity (Gopal et al., 2026). This supports the present study's finding that communication failure should not be treated as a secondary inconvenience but as part of the operational backbone of emergency response and cascade containment. This pattern was visible in the 2004 Indian Ocean tsunami, where damaged transport and communication systems isolated affected communities and delayed aid delivery; in Hurricane Katrina, United States, 2005, where flooded transport corridors, communication breakdown, shelter failure, and emergency-management strain contributed to the development of a prolonged humanitarian crisis; and in Hurricane Otis, Mexico, 2023, and the Türkiye–Syria earthquake, 2023, where access-route and communication-network failure weakened the operational backbone of emergency response and allowed secondary impacts to spread into health, shelter, food security, public order, and recovery systems."

26. Lines 455-457: "The central policy recommendation of this review is that cascade-risk reduction should not be organized solely around sectors, but around the system functions that prevent disruption from spreading across sectors." - That is a very valid point, but it needs to be illustrated with proper examples (which it isn't).

Answer:

Thank you for this comment. We agree that this recommendation required more concrete illustration. We have therefore expanded the text to explain more clearly how a function-based approach differs from sector-based planning and added examples from Winter Storm Uri, the 2004 Indian Ocean tsunami, and the 2011 Tōhoku–Fukushima disaster. These cases illustrate how continuity functions such as power, access, communication, and hazard control operate across multiple sectors and how failure of one function can propagate through several dependent systems. The revised text read as:

"The central policy recommendation of this review is that cascade-risk reduction should not be organized solely around sectors, but around the system functions that prevent disruption from spreading across sectors. A sector-based approach may protect electricity, water, transport, health, and emergency management separately, whereas a function-based approach asks which continuity functions must remain operational across these sectors and which dependencies could allow one failure to disable several others. In practice, this means protecting functions such as power continuity, emergency access, communication, monitoring and control, and backup service provision across organizational boundaries. For example, the 2021 Winter Storm Uri showed how electricity failure affected heating, water, healthcare, fuel, and transport simultaneously; the 2004 Indian Ocean tsunami showed how transport and communication failure isolated communities and delayed aid; and the 2011 Tōhoku–Fukushima disaster showed how failure of hazard-control and safety functions allowed disruption to extend into contamination, evacuation, infrastructure, and long-term recovery. [HB34.1]Disaster risk reduction, therefore, cannot focus solely on the triggering hazard or on protecting individual assets. It must also identify which failures in lifeline services, access networks, monitoring systems, emergency coordination, and social protection are likely to convert a hazard into a public-health, humanitarian, logistical, or long-term recovery crisis."

27. Line 486: "recovery planning should not assume that risk disappears once the triggering hazard has ended" - who says it does? The whole principle of the very popular slogan 'build back better' is predicated on assumptions of continuing hazard or threat.

Answer: Thank you for this comment. We agree that the original wording was too broad. The principle that risk continues beyond the immediate event is already well established in the Build Back Better approach and in contemporary recovery policy. Our intention was instead to highlight the implementation gap that can arise in practice, particularly where residual, recurrent, or evolving risks remain during recovery. We have therefore revised the sentence to acknowledge the established Build Back Better principle and to emphasize the need to operationalize continuing-risk management during recovery. We have also added a footnote with concrete examples from Hurricane Harvey in Texas (2017), the Indian Ocean earthquake and tsunami in Banda Aceh, Indonesia (2004), and post-tsunami reconstruction in Sri Lanka (2004 onward), where studies have documented gaps between risk-reduction principles and recovery implementation. The revised text read as:

"Fourth, recovery planning should explicitly account for residual, recurrent, and evolving risks after the triggering hazard has ended. Although this principle is well established in the Build Back Better approach, its implementation can remain uneven in practice."

Overall evaluation:-

1. Although the methodology is unusual, most of the observations and conclusions in this paper are not novel. The paper does not adequately bring out which of its findings are innovative, and there are some.

Answer: Thank you for this important observation. We agree that several individual findings discussed in the manuscript, including the importance of vulnerability, interdependence, infrastructure continuity, and prolonged recovery, are well established and should not be presented as novel in themselves. The previous version did not distinguish these established observations clearly enough from the specific contribution of the present review. We have therefore revised the Abstract, the end of the Introduction, and the opening of the Discussion to state the contribution more explicitly. The innovative element lies in the common event-level comparison across hazard types: separating initial transitions, escalation points, and downstream consequences; examining whether cascade magnitude is simply a proxy for propagation depth; identifying recurrent functional interfaces through which disruption crosses sectors; and using these patterns to develop the continuity-function framework.

2. As interactions among different kinds of vulnerability are the main source of escalation in cascading disasters, this paper needs more emphasis on vulnerability, as this is the main explanatory variable. The paper tends to use resilience as a surrogate for vulnerability, which is confusing and perhaps misleading.

Answer: Thank you for this important clarification. We agree that vulnerability should remain the primary explanatory concept and that resilience should not function as a surrogate for vulnerability. The revised Introduction distinguished the two concepts. We have strengthened this distinction across the Abstract, Methods, and Discussion. Vulnerability is now explicitly treated as the underlying susceptibility through which contextual conditions shape the consequences of disruption, whereas resilience dimensions are used only as a complementary capacity-side lens describing the ability to absorb, contain, adapt to, or recover from disruption. We also state explicitly that the review did not construct a standardized quantitative vulnerability index and therefore does not estimate an independent statistical effect of vulnerability on cascade magnitude.

3. One major problem is that the consequences of disaster are critically dependent on the context in which it occurs. We can define 'context' as the social, economic, cultural, psychological and environmental milieu that surrounds disaster risk and to some degree interacts with it. If necessary, we can disaggregate different types of context. However, overall, context should be considered as the sum of elements that have no direct causal relationship with disaster but, paradoxically, are (or should be) essential to any attempt to explain it. For example, how serious is the failure of electricity supply to the 900 million people in the world who have no access to electricity, or the 1.8 billion whose access is limited? There are many other examples. This suggests that a scenario-based approach to cascades is still very much needed.

Answer: Thank you for this important observation. We agree that the consequences of a functional failure cannot be interpreted independently of the context in which it occurs. We have therefore introduced a clearer distinction between propagation mechanisms and contextual conditions. Context is now defined as the social, economic, cultural, psychological, institutional, and environmental conditions that shape the significance of disruption without necessarily appearing as direct causal steps in the cascade. We have also clarified that the present cross-case analysis does not replace scenario-based analysis. Rather, the event-level synthesis identifies recurrent escalation interfaces that can be used to structure context-specific scenarios in which service access, governance, investment, power relations, inequality, and environmental conditions are explicitly considered.

4. The sort of macroscopic analysis given in this paper does not identify cascades, but merely causes and effects. There is little actual analysis of the propagation of cascades through chains and networks, yet the most useful thing that could be done is to find unusual and unexpected consequences and explain them in terms of cascading disaster.

Answer: Thank you for this important criticism. We agree that the previous presentation emphasized aggregated cause, effect, and failure categories to such an extent that the underlying propagation sequences were not sufficiently visible. The event-level coding did reconstruct ordered propagation pathways, but the manuscript did not demonstrate this clearly enough. We have therefore strengthened the Methods to explain how each cascade was reconstructed as a sequence of causally supported transitions, including branches and points at which an effect became a new cause. The frequency analyses are now explicitly presented as a cross-case synthesis of these reconstructed pathways rather than as a substitute for cascade analysis. We have also added representative reconstructed pathways to the Results (please see table and following text below), highlighting less intuitive cross-system transitions, and provide the event-level propagation sequences in a supplementary appendix.

"To make the event-level propagation structure more visible, Table 1 presents selected reconstructed pathways from the coded database. The examples are illustrative rather than representative and were selected to show different forms of cross-system propagation, including lifeline interdependence, secondary-hazard escalation, public-health interaction, transboundary transport disruption, and communication-system failure. Each sequence reproduces a documented ordered pathway from the database; no additional causal links were inferred.

Table 1. Illustrative reconstructed propagation pathways across contrasting cascading events

Event (M-level)	Propagation structure	Illustrative ordered propagation sequence	Major coded escalation point(s)	Analytical significance
2021 Winter Storm Uri and COVID-19 Cascade, USA (M4)	11 paths; max depth 7	Power system failure → Infrastructure interdependency feedback loop → Water and sanitation system disruption → Pandemic-response constraint → Public-health operation disruption → Supply-chain and logistics disruption	Power system failure (Lifeline infrastructure failure; 82% of paths); Infrastructure interdependency feedback loop (Lifeline infrastructure failure; 46% of paths); Water and sanitation system disruption (Lifeline infrastructure failure; 36% of paths)	Shows how a power-system failure crossed into water, public-health, and supply-chain functions during an overlapping pandemic emergency.
2011 Tōhoku Earthquake–Tsunami–Fukushima Triple Disaster, Japan (M4)	12 paths; max depth 10	Tsunami generation and coastal inundation → Nuclear accident / radiological contamination → Transport and mobility disruption → Power system failure → Industrial / chemical facility disruption → Trade /	Tsunami generation and coastal inundation (Secondary hazard; 75% of paths); Nuclear accident / radiological contamination (Technological incident; 42% of paths); Power system failure	Shows a secondary physical hazard crossing into nuclear safety, energy, industrial, trade, and transnational systems.

		production-network disruption → Cross-border / global travel disruption	(Lifeline infrastructure failure; 42% of paths)	
2004 Indian Ocean Earthquake and Tsunami Humanitarian Cascade (M4)	11 paths; max depth 8	Tsunami generation and coastal inundation → Communication and information-system disruption → Monitoring / control-system failure → Access isolation and emergency-response delay → Emergency management / response-operation strain → Humanitarian relief and aid-system strain → Governance and coordination breakdown → Cross-border / global travel disruption → Supply-chain and logistics disruption	Tsunami generation and coastal inundation (Secondary hazard; 91% of paths); Humanitarian relief and aid-system strain (Humanitarian response failure; 27% of paths); Warning and evacuation-communication failure (Warning/evacuation failure; 9% of paths)	Shows how communication, monitoring, access, and response failures converted physical impacts into humanitarian and logistics escalation.
2020 Flooding–COVID-19–Cholera Cascade, Kenya (M4)	6 paths; max depth 8	Urban / fluvial / pluvial inundation → Displacement and migration pathway → Critical facility / public-building failure → Education-service disruption → Water and sanitation system disruption → Food-security and livelihood disruption → Shelter and evacuation disruption → Pandemic-response constraint → Disease transmission / outbreak pathway	Disease transmission / outbreak pathway (Public health infrastructure failure; 50% of paths); Displacement and migration pathway (Socio-spatial/humanitarian failure; 50% of paths); Water and sanitation system disruption (Lifeline infrastructure failure; 33% of paths)	Shows flooding interacting with displacement, WASH disruption, shelter pressure, and pandemic-response constraints to produce a disease cascade.
2010 Eyjafjallajökull Volcanic Ash Aviation Cascade, Iceland–Europe (M5)	6 paths; max depth 9	Volcanic ash / tephra disruption → Environmental contamination / pollution pathway → Transport and mobility disruption → Cross-border / global travel disruption → Aviation-system closure → Governance and coordination breakdown → Economic and business interruption → Trade / production-network disruption → Policy / regulatory learning pathway → Repair / restoration operation strain	Aviation-system closure (Transportation infrastructure failure; 100% of paths)	Shows how a geographically localized volcanic event propagated through aviation closure into cross-border governance, business, and trade disruption.
2006 Hengchun Earthquake Submarine Cable Communication Cascade, Taiwan / East and Southeast Asia (M3)	5 paths; max depth 3	Communication and information-system disruption → Cross-border / global travel disruption → Economic and business interruption	Communication and information-system disruption (Information dissemination failure; 40% of paths)	Shows a less obvious cross-system pathway in which communication failure propagated into regional travel and economic disruption.
2009 Typhoon Morakot Flood–Landslide–Water-System Cascade, Taiwan (M3)	6 paths; max depth 10	Urban / fluvial / pluvial inundation → Landslide / slope-failure propagation → Transport and mobility disruption → Housing and building damage → Power system failure → Infrastructure interdependency feedback loop → Water and sanitation system disruption → Access isolation and emergency-response delay → Emergency management / response-operation strain → Shelter and evacuation disruption → Supply-chain and logistics disruption	Dam / reservoir failure or failure-risk pathway (Flood-control infrastructure failure; 83% of paths); Landslide / slope-failure propagation (Secondary hazard; 67% of paths); Water and sanitation system disruption (Lifeline infrastructure failure; 50% of paths)	Shows how flooding and slope failure propagated through transport, power, water, emergency access, shelter, and supply-chain systems.

Note: Path count is the number of distinct standardized propagation paths recorded for the event. Maximum path depth is the maximum number of directed transitions in any documented path. Escalation-point shares refer to the proportion of that event's documented paths containing the coded escalation point.”

5. Hence, I think that this paper is a brave attempt to advance our understanding of cascading disasters, but it is methodologically flawed. For example, as noted above, cascades of high complexity prolong the recovery of infrastructure - but what about the size of the disaster and the context of investment, political priorities, power relations and all the rest?

Answer: Thank you for this important criticism. We agree that the previous manuscript allowed some descriptive differences between cascade-magnitude groups to be interpreted more causally than the study design supports. Overall disaster size, baseline vulnerability, service access, investment, governance capacity, political priorities, power relations, and other contextual conditions may influence both cascade development and recovery burden. These factors were not independently controlled in this review. We have therefore not attempted to infer their effects retrospectively. Instead, we have revised the manuscript to restrict the magnitude-group comparisons to descriptive patterns, removed causal interpretation of the recovery differences, and added an explicit methodological limitation concerning these potential confounders. We have also strengthened the treatment of vulnerability and context and clarified that the continuity-function framework is intended as a diagnostic structure for context-specific analysis rather than as a causal or predictive model.