

Reviewer Report

Manuscript: *Spatiotemporal reorganization of global earthquake impacts within coupled human–Earth systems*

The manuscript addresses a relevant and timely topic for *Natural Hazards and Earth System Sciences*: the spatiotemporal evolution of global earthquake impacts within coupled human–Earth systems. The study is valuable in its attempt to integrate global disaster records, spatial analysis, centroid trajectories, standard deviation ellipses, and Geographical Detector modeling. The database has potential to support a global-scale contribution, and the topic is clearly aligned with the scope of the journal. However, the manuscript requires substantial revision before it can be considered for publication. In its current form, the study presents important conceptual, methodological, and interpretative limitations that weaken the robustness of the conclusions. In particular, the analysis tends to overinterpret EM-DAT disaster records as indicators of global seismic occurrence, applies spatial metrics without sufficient uncertainty assessment, uses temporally inconsistent explanatory variables, and does not adequately normalize fatalities or economic losses. Therefore, I recommend Major Revision. If the authors are unable to address these issues comprehensively, the manuscript should not be accepted in its present form.

observations

1. The statement that earthquake frequency increased should be corrected. The manuscript should refer to an increase in earthquake disaster events recorded in EM-DAT, unless this result is validated using instrumental seismic catalogs.
2. The conceptual distinction among seismic hazard, seismicity, exposure, vulnerability, disaster impact, and risk must be clearly defined.
3. EM-DAT records should not be interpreted as a complete representation of global earthquake occurrence.
4. The inclusion of earthquake events with magnitudes as low as 3.0 must be justified.
5. The magnitude distribution of the database should be reported.
6. Sensitivity analyses should be conducted using magnitude thresholds such as $M_w \geq 5$, $M_w \geq 6$, and $M_w \geq 7$.
7. Physical seismic intensity variables should be incorporated into the analysis.
8. Magnitude, PGA, macroseismic intensity, depth, or ground-motion severity should be considered as explanatory variables.
9. Focal depth should be included in the analysis.
10. Tectonic regime should be incorporated as an explanatory factor.
11. Shallow crustal, subduction, intraplate, and megathrust earthquakes should be distinguished.
12. Earthquake-only events should be separated from earthquake–tsunami compound events.
13. The 2004 Sumatra and 2011 Tohoku events should be treated separately or tested for influence.
14. Sensitivity analyses excluding major catastrophic events should be included.

15. The influence of Sumatra 2004, Wenchuan 2008, Haiti 2010, Tohoku 2011, and Türkiye–Syria 2023 should be explicitly assessed.
16. Fatalities should be normalized by national population, exposed population, or population located in seismic hazard zones.
17. Economic losses should be normalized by GDP, exposed capital stock, or national economic capacity.
18. The analysis should not rely only on cumulative fatalities as the dependent variable.
19. Alternative dependent variables should be included, such as fatalities per event, fatalities per million inhabitants, mortality rate, and economic losses as a percentage of GDP.
20. The use of 2021 explanatory variables to explain cumulative fatalities over 1980–2024 should be reconsidered.
21. The Geographical Detector analysis should be recalculated using period-specific or event-year explanatory variables.
22. Alternatively, the Geographical Detector analysis should be restricted to a recent period consistent with the explanatory datasets.
23. The discretization procedure for continuous variables in the Geographical Detector model must be reported.
24. The number of strata used for each explanatory variable should be specified.
25. Sensitivity analysis should be conducted for different discretization methods.
26. Statistical significance of q-values should be reported using permutation tests.
27. The final number of countries included in the Geographical Detector analysis should be reported.
28. The treatment of countries with missing socioeconomic, governance, environmental, or health data should be clarified.
29. The treatment of zero values in fatalities, losses, affected population, and GDP-related indicators should be explained.
30. The manuscript should clarify whether logarithmic transformations were applied.
31. Logarithmic scales should be used for highly skewed variables.
32. Causal terms such as “drivers”, “influence”, “shape”, and “mechanisms” should be avoided unless supported by a causal research design.
33. Causal language should be replaced by more appropriate terms such as “associated factors”, “spatial covariates”, or “statistical associations”.
34. The expression “earthquake disaster centroid” should be reconsidered.
35. Centroid results should be defined as statistical centroids of reported impacts, not physical centroids of disasters.
36. Centroid shifts should not be interpreted as migration of seismicity or migration of disaster processes.
37. Uncertainty estimates should be added for centroid locations.
38. Bootstrap confidence intervals should be provided for centroid trajectories.
39. The sensitivity of centroid shifts to extreme events should be tested.
40. The centroid distance calculation should be revised.

41. A planar constant C is not sufficient for global geographic distances unless properly justified.
42. Geodesic distance calculations or an appropriate global projection should be used.
43. The treatment of the antimeridian and global coordinate discontinuities should be explained.
44. The use of standard deviation ellipses for globally distributed and multimodal earthquake-impact data should be justified.
45. The contraction of the standard deviation ellipse should not be overinterpreted as a robust global reorganization pattern.
46. Temporal-window inconsistencies should be corrected.
47. The manuscript should resolve the inconsistency between 1995–2009/2010–2024 and 1995–2010/2011–2024.
48. The selection of the three study periods should be justified.
49. Decade-based periods, moving windows, or statistically detected breakpoints should be considered.
50. The assignment of multinational earthquake events to countries should be clarified.
51. The manuscript should explain whether one event affecting several countries was duplicated in the national aggregation.
52. The allocation of affected population, fatalities, and economic losses across countries for transboundary events should be clarified.
53. The treatment of missing economic loss values in EM-DAT should be explained.
54. The underreporting of economic losses in low-income countries should be discussed.
55. EM-DAT results should be compared with at least one independent earthquake or disaster-loss database.
56. A summary table should be provided with the number of events by period, continent, magnitude range, data completeness, and impact-variable availability.
57. Uncertainty estimates or confidence intervals should be included for temporal trends.
58. Temporal trends should be tested with and without megaevents.
59. Possible autocorrelation should be assessed before applying the Mann–Kendall test.
60. Linear regression slopes should not be used alone for highly episodic disaster-impact series.
61. Medians and quantiles should be reported in addition to means and cumulative values.
62. The readability and resolution of all figures should be improved.
63. Extreme events should be clearly labeled in the temporal figures.
64. Additional methodological details should be provided to ensure reproducibility.
65. The discussion of limitations should be strengthened.
66. The results should be more directly linked to operational disaster risk reduction strategies.
67. The discussion should move beyond general statements on governance and provide clearer implications for risk management, preparedness, exposure reduction, and resilience planning.