Reviewer Reports for “The need for open, transdisciplinary, and ethical science in seismology”

Date: June 26, 2023

Dear Irina Dallo, Marcus Herrmann, Mariano Supino, José A. Bayona, Asim M. Khawaja, Chiara Scaini:

I hope this email finds you well. I am pleased to say that I have now received two peer-review reports for your submission to Seismica, "The need for open, transdisciplinary, and ethical science in seismology." Thank you once again for submitting your work to Seismica, and I apologize for the delay in my response. I appreciate your help identifying additional reviewers.

Both reviewers are supportive of your work being published in an Opinion format in Seismica. If you think a different format/article type is more appropriate, please advise. However, I agree with their assessment that several revisions are needed before publication. In particular, I agree with Reviewer B that situating the conclusions beyond the RISE project and clarifying terminology and concepts (transdisciplinary vs. stakeholder engagement; including earthquake science and engineering disciplines as well as seismology; defining dynamic seismic risk) would strengthen the work. In addition, although not originally required, please add an abstract for resubmission.

Please find below the comments submitted by Reviewer A and Reviewer B.

When you are ready to resubmit the revised version of your manuscript, please upload:

- A 'cleaned' version of the revised manuscript, without any markup/changes highlighted.
- A pdf version of the revised manuscript clearly highlighting changes/markup/edits.
- A 'response-to-reviewers' letter that shows your response to each of the reviewers' points, together with a summary of the resulting changes made to the manuscript.

Please note that Seismica does not have any strict deadlines for submitting revisions, but naturally, it is likely to be in your best interest to submit these fairly promptly, and please let me know of any expected delays.

Once I have read your revised manuscript and rebuttal, I will then decide whether the manuscript either needs to be sent to reviewers again, requires further minor changes, or can be accepted.

I wish you the best with working on the revisions. Please don't hesitate to contact me with any questions or comments about your submission, or if you have any feedback about your experience with Seismica.

Kind regards,

Samantha Teplitzky, Executive Editor for Open Science at Seismica

Reviewer A:

For author and editor

The paper is valuable and timely case study of current interest.

The manuscript is clear and easy to follow, with an adequate and accurate title. No abstract is provided though.

The methods are appropriate and described in sufficient detail. And the conclusions are adequate and supported by the data in most cases. Below are some suggestions for improvement and I think some minor revisions are required.

I would add open access **publications** in the following sentence 88-89: It encompasses practices such as making research outputs open (e.g., open access, open data, and open source)... - It encompasses practices such as making research outputs open (e.g., open access publications, open data, and open source)...

I am not sure I understand this sentence: 90 "This openness provides many additional benefits, for instance making it easier to publish" - why does openness make it easier to publish? Perhaps publish could be replaced with disseminate or communicate or share?

And I am not sure I understand "particularly when technical data issues arise" in this sentence: 93-95 "Moreover, open data can help identify systematic data misuse (i.e., a potentially adverse use that was not originally intended), particularly when technical data issues arise (e.g., Flaherty et al., 2022). Perhaps some examples of technical data issues arising could be added.

I would replace open access licenses with open content licenses in 97: "Moreover, open access licenses..."

I don't agree that open approach only makes scientists responsible for potential misuse - 180 "An open approach makes us scientists responsible for potential misuse of data and models involved in dynamic seismic risk." Perhaps this could be rephrased as When data and models of dynamic seismic risk are open, this may lead to potential misuse.

And how is false earthquake early warning alert part of open science? In 181 "For instance, a false earthquake early warning alert could cause widespread panic and significant financial losses." It could cause the same in closed science as well picked up by the media for example.

How useful is "(iii) ‘I do not care’, where ethical implications are ignored or considered irrelevant." in 195-196? I am not sure a scientist could allow this kind of attitude and I would remove this.

And I would also add FOSTER Open Science Toolkit https://www.fosteropenscience.eu/toolkit to 221 Table 1: A selection of practical guidelines for each of the three subjects (middle column).

Finally, I would recommend reading Schymanski, E.L., Schymanski, S.J. Water science must be Open Science. *Nat Water* 1, 4–6 (2023). https://doi.org/10.1038/s44221-022-00014-z. It addresses similar issues, but provides more specific and actionable recommendations - e.g.

specific Creative Commons licenses are mentioned with CC0 (public domain) and CC-BY (re-use with attribution) being the most permissive.

Signed: Iryna Kuchma

Reviewer B:

For author and editor:
This is an opinion paper by early career researchers from the EU Horizon-2020 RISE project. The authors discuss the relevance of open science, transdisciplinary* approaches, and ethical implications in domain-specific training and research efforts in seismology. The manuscript ends with a list of practical recommendations and suggestions for addressing open, transdisciplinary, and ethical earthquake science. The basis of the opinion piece is insights from a three-day workshop organized by the authors on the theme of 'dynamic seismic risk'.

The manuscript is generally well-written, and the issues discussed are timely and important. Nonetheless, the manuscript presents several shortcomings, particularly around some of the terminology/concepts used/discussed throughout the document and the depth of the discussion.

In my opinion, the manuscript can be reconsidered for publication if the authors are prepared to implement substantial revisions and modifications, as detailed in the specific comments below.

*Throughout the manuscript, the authors seem to use the word "transdisciplinary" to indicate stakeholder/end-user engagement. I am sorry, but transdisciplinary is something different. See for instance, https://doi.org/10.1111/risa.13777 or https://doi.org/10.3389/fbuil.2020.00110. This is a major shortcoming of this manuscript.

Specific comment:

The manuscript has no abstract.

Title: I would consider adding "and earthquake science" (and potentially even "earthquake engineering") as the issues you are discussing are relevant not just to seismology.

Line 29, page 1: I don't think it is an issue of just "seismological" knowledge but also of engineering knowledge and governance. Why are the author limiting their discussion just to the seismology aspects of the problem? Moreover, references supporting this statement are necessary.

Line 30, page 1: "(i.e., highly seismically active and densely populated)", what about vulnerability, physical and social? One can have high seismicity in densely populated areas but with safe and resilient infrastructure and low social vulnerability, for instance.

Line 31, page 1: what do the authors mean by "societal conditions"?

Lines 39-54, pages 1-2: this reads as an advertisement for the RISE project rather than a scientific paper. The need for open, transdisciplinary, and ethical science is the basis of any

research project within the Horizon 2020 program, and recently within the Horizon Europe program, as well as in many research frameworks around the world (e.g., by the UK Research and Innovation or the US National Science Foundation) – it is not just a prerogative of RISE. The authors should briefly discuss other similar initiatives around the world supporting and implementing those principles.

Page 2: the author should provide a definition of “dynamic seismic risk” and clearly define their scope. Lines 71-76 (page 3) refer to issues such as operational earthquake forecasting, earthquake early warning, and (post-event) rapid response. However, these are issues related to short-term earthquake risk. Dynamic earthquake risk is much broader than this. What about long-term earthquake risk, for instance, in terms of exposure (urban and economic growth, population increase, etc.) and vulnerability (aging, structural degradation, retrofit, etc.) changes?

Line 71, page 3: I believe social vulnerability is equally important (or even more important) than physical vulnerability.

Line 101, page 4: “Dynamic (seismic) risk assessment requires linking information from different assets and different phases of the disaster cycle, therefore significantly benefitting from an open approach.” -> the link between an “open approach” and “dynamic seismic risk” feels like a stretch here. The benefits of an open approach are broader and related to any modeling effort relying on data and tools (e.g., computational tools). Again, there is a strong emphasis on RISE, but pretty much any research project within the Horizon 2020/Horizon Europe frameworks well addresses those issues.

Line 114, page 4: “… following the concept of open science, thereby setting an example for making the fundamental assets of dynamic (seismic) risk assessment available.”, it is unclear what the fundamental assets of dynamic (seismic) risk assessment are.

Line 118, Page 4: the authors should also discuss the issue of costs related to open science as a major barrier to it.

Section 2.2: see my comment above. This is not about transdisciplinarity but stakeholder/end-user engagement.

Line 169, page 6: ethics is essential not just in data collection but even more in data use/processing. The authors should comment on these aspects.

Line 181, page 6: I am not sure that “a false earthquake early warning” is an issue of ethics. It is just a potential consequence of the uncertainties involved in real-time seismology and suboptimal decision making.

Section 3 is a bit shallow. Some recommendations (e.g., “Professors should actively share their knowledge about stakeholders’ decision-making processes with their junior scientists, e.g., by dedicated seminars.”) seem a bit naïve.

Appendices are mentioned throughout the manuscript, but I can't find them in the submission.
Signed: Carmine Galasso

LETTER OF ACTION

The need for open, transdisciplinary, and ethical science in seismology

Dear Dr. Teplitzky,

We would like to thank you and the two reviewers for the careful consideration and meaningful suggestions to improve our opinion paper. We addressed all comments in the revisions, and are pleased to resubmit our paper entitled “The need for open, transdisciplinary, and ethical science in seismology”.

In our revision, we have addressed the reviewers' comments, which have improved the clarity and relevance of our opinion piece. Here is a summary of the main changes:

1) We clarified the definition of dynamic seismic risk, addressing the short- and long-term dynamics.
2) We better explained transdisciplinarity and adjusted the corresponding section, by stressing the importance of interdisciplinary research groups, as well as the need to involve stakeholders from civil society (including the public and private sector).
3) We discussed Open Science in more detail (e.g., added a further challenge (costs) and provided diamond OA, like Seismica, as a solution).
4) We revised the Ethics section, i.e. changed the misuse example and explained when ethical assessments are needed.
5) We reduced the promotion of our parent project RISE and now provide a broader context.
6) Additional changes resulting from an internal review:
    a) improved the Open Science section (added open experiment design as a further example, explained better the pyCSEP toolkit and reproducibility packages, added Savran et al. 2022b, and added two more fundamental assets of dynamic risk developed within RISE).
    b) improved the Ethics section (added some factual on releasing earthquake forecasts, and connected it to Open Science and Transdisciplinarity).
    c) for Transdisciplinarity in Table 1, added one more resource and two more general suggestions.
    d) clarified and improved various statements.

All minor changes are listed below.

As the reviewers mentioned, our study addresses timely subjects. To stimulate a reflection and discussion of currently ongoing efforts (regarding open, transdisciplinary, and ethical science) in the scientific community, we hope for a full consideration of our revised opinion paper.

Kind regards,

the authors

REVIEWER COMMENTS

Based on the editor's and reviewers' comments, we have revised our manuscript. In the following, we list and explain all the amendments taken in the manuscript in detail.

Editor

Both reviewers are supportive of your work being published in an Opinion format in Seismica. If you think a different format/article type is more appropriate, please advise. However, I agree with their assessment that several revisions are needed before publication. In particular, I agree with Reviewer B that situating the conclusions beyond the RISE project and clarifying terminology and concepts (transdisciplinary vs. stakeholder engagement; including earthquake science and engineering disciplines as well as seismology; defining dynamic seismic risk) would strengthen the work. In addition, although not originally required, please add an abstract for resubmission.

We appreciate hearing that the reviewers see our manuscript as an opinion piece. We addressed all comments by the reviewers and especially (i) clarified the introduced concepts and terminologies, (ii) went more into detail for some concepts, and (iii) broadened the conclusions, going beyond RISE. We also added an abstract as requested.

Reviewer A

The paper is a valuable and timely case study of current interest.

The manuscript is clear and easy to follow, with an adequate and accurate title. No abstract is provided though.

An abstract was not required for an opinion piece, but we have added one as requested by the editor too.

> **Abstract.** Reducing the seismic risk for societies requires a bridge between scientific knowledge and societal actions. In recent years, three subjects that facilitate this connection gained growing importance: open science, transdisciplinarity, and ethics. We outline their relevance in general and specifically at the example of 'dynamic seismic risk' as explored in a dedicated workshop. We argue that these reflections can be transferred to other research fields for improving their practical and societal relevance. We provide recommendations for scientists at all levels to make science more open, transdisciplinary, and ethical. Only with a transition can we, as scientists, address current societal challenges and increase societies' resilience to disasters.

The methods are appropriate and described in sufficient detail. And the conclusions are adequate and supported by the data in most cases. Below are some suggestions for improvement and I think some minor revisions are required.

*I would add open access **publications** in the following sentence 88-89: It encompasses practices such as making research outputs open (e.g., open access, open data, and open source)... - It encompasses practices such as making research outputs open (e.g., open access publications, open data, and open source)...*

We agree that this specification is needed because *open access* does not clarify what should be openly available.

> Open science envisions transparent and accessible knowledge that is shared and developed collaboratively (UNESCO, 2022). It encompasses practices such as making research outputs open (e.g., open access publications, open data, and open source software), verifiable, and reproducible, as well as openly designing experiments, methods, and analyses. This openness

I am not sure I understand this sentence: 90 "This openness provides many additional benefits, for instance making it easier to publish" - why does openness make it easier to publish? Perhaps publish could be replaced with disseminate or communicate or share?

Again a good point, we changed it as suggested.

> reproducible, as well as openly designing experiments, methods, and analyses. This openness provides many additional benefits, for instance making it easier to ~~publish~~ disseminate and communicate scientific knowledge, expedite the scientific process by saving time for re-

And I am not sure I understand "particularly when technical data issues arise" in this sentence: 93-95 "Moreover, open data can help identify systematic data misuse (i.e., a potentially adverse use that was not originally intended), particularly when technical data issues arise (e.g., Flaherty et al., 2022). Perhaps some examples of technical data issues arising could be added.

We modified the sentence and added a specific example as suggested.

> collaborative, cross-disciplinary, and inclusive research practices. Moreover, open data can help identify systematic data misuse (i.e., a potentially adverse use that was not originally intended), particularly when ~~technical data~~ issues in data analysis arise (e.g., geographical correlation associated with causality; Flaherty et al., 2022). Open science is further guided by

I would replace open access licenses with open content licenses in 97: "Moreover, open access licenses..."

We changed it to ‘open licenses’ to be more general and use a more common term.

Interoperability, and **R**euse of digital assets. For instance, a Digital Object Identifier (DOI; Paskin, 2010) is key to guarantee correct attribution and access of an asses in the long term (Schymanski & Schymanski, 2023). Moreover, open ~~access~~ licenses (see Table 1) ensure an unrestricted use of data, models, or other outputs while appropriately crediting the creator. By complying with these standards and principles, cross-disciplinary efforts are possible ~~and long-term access can be ensured~~ (COAR et al., 2021).

I don't agree that open approach only makes scientists responsible for potential misuse - 180 "An open approach makes us scientists responsible for potential misuse of data and models involved in dynamic seismic risk." Perhaps this could be rephrased as When data and models of dynamic seismic risk are open, this may lead to potential misuse.

We agree that scientists per se are not responsible when their data is misused. However, we want to motivate scientists to reflect on potential misuses and how they could be prevented. We thus added to your rephrasing a subclause addressing the reflection process.

Granting public access to data, models, or products of a dynamic risk framework may lead to potential misuse by third parties, which should be considered by the providers and/or scientists beforehand, e.g. by clarifying the responsibility of any consequences. ~~An open~~

And how is false earthquake early warning alert part of open science? In 181 "For instance, a false earthquake early warning alert could cause widespread panic and significant financial losses." It could cause the same in closed science as well picked up by the media for example.

We agree that this was not a suitable example. We thus added another one.

~~widespread panic and significant financial losses.~~ For example, an open earthquake forecasting (or risk) model could either be incorrectly used or its results misinterpreted, which may eventually reduce the trust in those models, or be intentionally manipulated to provide exaggerated forecasts, which may create fear and panic among the public. Ethics also matters

How useful is "(iii) 'I do not care', where ethical implications are ignored or considered irrelevant." in 195-196? I am not sure a scientist could allow this kind of attitude and I would remove this.

We completely agree that (iii) is not or should not be an option. But we have had experiences where scientists tended to have this attitude. We added a respective sentence to the text.

arguments; and (iii) 'I do not care', where ethical implications are ignored or considered irrelevant (which we think is not a solution but have had experiences where scientists had this attitude). For the second category, which is the most difficult one, one may not find a consensus

And I would also add FOSTER Open Science Toolkit https://www.fosteropenscience.eu/toolkit to 221 Table 1: A selection of practical guidelines for each of the three subjects (middle column).

We have not been aware of this toolkit; indeed very useful. We added it to the practical guidelines; as well as two further resources, including a practical guide for early career researchers that was published after our first submission.

– FOSTER: Open Science Toolkit
– Open Science: A Practical Guide for Early-Career Researchers

Finally, I would recommend reading Schymanski, E.L., Schymanski, S.J. Water science must be Open Science. Nat Water 1, 4–6 (2023). https://doi.org/10.1038/s44221-022-00014-z. It addresses similar issues, but provides more specific and actionable recommendations - e.g. specific Creative Commons licenses are mentioned with CC0 (public domain) and CC-BY (re-use with attribution) being the most permissive.

Thank you for sharing this paper with us. It is nice to see that also other fields foster the discussion of the emerging subjects we address. To enrich our piece, we mentioned the importance of reproducibility and a Digital Object Identifier. But, to not bias the reader, we did not mention a specific license in the text; instead, we already referred to resources in Table 1 that allow for a proper choice of a suitable license.

correlation associated with causality; Flaherty et al., 2022). Open science is further guided by the FAIR principles (Wilkinson et al., 2016), ensuring **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets. For instance, a Digital Object Identifier (DOI; Paskin, 2010) is key to guarantee correct attribution and access of an asses in the long term (Schymanski & Schymanski, 2023). Moreover, open ~~access~~ licenses (see Table 1) ensure an

Reviewer B

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The manuscript is generally well-written, and the issues discussed are timely and important. Nonetheless, the manuscript presents several shortcomings, particularly around some of the terminology/concepts used/discussed throughout the document and the depth of the discussion.

In my opinion, the manuscript can be reconsidered for publication if the authors are prepared to implement substantial revisions and modifications, as detailed in the specific comments below.

**Throughout the manuscript, the authors seem to use the word "transdisciplinary" to indicate stakeholder/end-user engagement. I am sorry, but transdisciplinary is something different. See for instance, https://doi.org/10.1111/risa.13777 or https://doi.org/10.3389/fbuil.2020.00110. This is a major shortcoming of this manuscript.*

We agree that the definition we gave for transdisciplinary research was a bit misleading. We adjusted it accordingly. Further, we also realized that we addressed in the sub-chapter for transdisciplinarity mainly the stakeholder engagement processes, neglecting the importance of interdisciplinary research teams. Since we wanted to stress that we have to make the step from interdisciplinarity to transdisciplinarity, we adjusted the corresponding sections accordingly. We also referenced one of the two papers, which indeed provides insightful background.

address dynamic seismic risk ~~by managing the entire disaster cycle~~ (Alexander, 2018). As outlined in the following three sections, these assets can only be combined meaningfully if interdisciplinary research groups ~~the inputs and outputs are~~ openly share~~d~~ and document~~ed,~~ their inputs and outputs (sec. 2.1), ~~(societal) stakeholders are~~ actively involve (societal stakeholders (sec. 2.2)~~d~~, and ~~ethical issues are~~ appropriately consider ethical issues (sec. 2.3)~~ed~~.

Addressing current societal challenges requires transdisciplinary approaches (Peek et al., 2020; Vienni Baptista et al., 2022), that is, ~~not only~~ integrating knowledge from different scientific disciplines (interdisciplinary) and~~, but also~~ considering the values, knowledge, and ~~expertise~~ needs of~~from~~ stakeholders in the~~of the~~ society, including the public and private sectors, the general public, etc. (stakeholder engagement). ~~(transdisciplinarity; Vienni Baptista et al., 2020). This~~ Ttransdisciplinary approaches acknowledge~~s~~ the societal and scientific

Transdisciplinary efforts to assess risk perception and awareness across communities and stakeholders are essential for disaster risk reduction (UNDRR, 2022a). The dynamic seismic risk framework develops products for different stakeholders who actively participate in all phases of the disaster cycle. In RISE, for example, interdisciplinary groups (consisting of engineers, seismologists, IT specialists, and communication experts) co-designed products and services by involving civil protection, authorities, and the general public~~different stakeholders, including scientific experts from different disciplines, professional stakeholders, communication experts, and the general public, were involved in~~ through focus groups, interviews, and surveys ~~to collect their feedback and develop communication guidelines~~ (Fallou et al., 2022; Marti et al., 2023). It became apparent that a key factor in improving risk mitigation

Transdisciplinarity is not yet fully practiced by ~~actors~~ scientists involved in disaster risk reduction activities, and is not included in current discipline-specific academic education programs despite the desire of early career scientists (Bridle et al., 2013; Supplement 3). Two main challenges are (i) building interdisciplinary groups and ensuring effective interactions between the disciplinary experts, and (ii) engaging with civil society (a structured and sometimes lengthy process) ~~One of the main challenges is the difficulty of engaging civil society, particularly minority groups, and assessing their knowledge, perception, and preparedness. This engagement requires a structured and sometimes long process~~ by building trust between scientists and stakeholders (UNDRR, 2022b). Research infrastructures can foster the development of a transdisciplinary research community in the field of disaster risk (Peek et al., 2020) and provide powerful tools (e.g., data, codes, expertise) to research groups (e.g., Dañibeitia et al., 2022; Folch et al., 2023; Calatrava et al., 2023). Access and interaction with research infrastructures should therefore be promoted and encouraged among the disaster risk community to exploit these opportunities. Further, ~~D~~developing effective risk-related communication, in particular for the general public, is also challenged by potential misinformation, disinformation, and/or misunderstandings ~~among the wide range of actors involved, for which targeted information is defined depending on their role and needs~~. This has been again observed in the 2023 Türkiye–Syria earthquake sequence (e.g., Panjwani, 2023).

The manuscript has no abstract.

An abstract was not required for an opinion piece, but we have added one as requested by the editor too (see second answer to Reviewer A).

Title: I would consider adding "and earthquake science" (and potentially even "earthquake engineering") as the issues you are discussing are relevant not just to seismology.

In our view, 'seismology' *is* 'earthquake science' and includes every aspect of earthquakes, including the engineering part (engineering seismology, which applies seismology for engineering purposes [wikipedia]).

Line 29, page 1: I don't think it is an issue of just "seismological" knowledge but also of engineering knowledge and governance. Why are the author limiting their discussion just to the seismology aspects of the problem? Moreover, references supporting this statement are necessary.

We agree with your comment and adjusted it accordingly. We also added an exemplary paper, which discusses the gap between science and society.

The devastating 2023 M7.8 Türkiye–Syria earthquake sequence once again highlighted the gap between scientific ~~(seismological)~~ knowledge and action (e.g., Toomey, 2016): Although

Line 30, page 1: "(i.e., highly seismically active and densely populated)", what about vulnerability, physical and social? One can have high seismicity in densely populated areas but with safe and resilient infrastructure and low social vulnerability, for instance.

You are right. We also added the component of vulnerability to ensure that all components defining seismic risk are covered, i.e. hazard, exposure, and vulnerability.

The devastating 2023 M7.8 Türkiye–Syria earthquake sequence once again highlighted the gap between scientific ~~(seismological)~~ knowledge and action (e.g., Toomey, 2016): Although the impacted region is known to be at high seismic risk (i.e., highly seismically active, ~~and~~ densely populated, and high physical and social vulnerability), the political and societal conditions have complicated and delayed protective measures (e.g., Hussain et al., 2023). To

Line 31, page 1: what do the authors mean by "societal conditions"?

With societal conditions, we refer to poverty, quality of housing, racial residential segregation, and current tensions in the two countries. We added a reference which discusses these conditions.

The devastating 2023 M7.8 Türkiye–Syria earthquake sequence once again highlighted the gap between scientific ~~(seismological)~~ knowledge and action (e.g., Toomey, 2016): Although the impacted region is known to be at high seismic risk (i.e., highly seismically active, ~~and~~ densely populated, and high physical and social vulnerability), the political and societal conditions have complicated and delayed protective measures (e.g., Hussain et al., 2023). To

Lines 39-54, pages 1-2: this reads as an advertisement for the RISE project rather than a scientific paper. The need for open, transdisciplinary, and ethical science is the basis of any research project within the Horizon 2020 program, and recently within the Horizon Europe program, as well as in many research frameworks around the world (e.g., by the UK Research and Innovation or the US National Science Foundation) – it is not just a prerogative of RISE. The authors should briefly discuss other similar initiatives around the world supporting and implementing those principles.

The RISE project (i.e., dynamic seismic risk) served as a concrete and illustrative example and was not intended as an advertisement. As mentioned earlier, our considerations and recommendations are applicable to all other research efforts/projects, and the conclusions apply to seismology and science in general. To make this clear, we have modified the paragraphs you mentioned accordingly. We have also pointed out that there are various initiatives around the world, but have only listed a few examples to keep the article short. We kept the description of our process to give other groups the opportunity to try an interactive method for promoting interdisciplinary exchange.

In recent years, three subjects have become increasingly relevant to build that needed bridge between scientific knowledge and societal action, namely~~:~~ open science, transdisciplinarity, and ethics (see Figure 1). These subjects~~y~~ have influenced scientific discussions on how to transition from purely scientific research to practical and societally relevant applications that increase societies' resilience to disasters (e.g., Marti et al., 2022) – ~~just as envisioned by the European Union's Horizon 2020 project 'Real-time earthquake rIsk reduction for a reSilient Europe' (RISE) concerning earthquake risk.~~ just as envisioned by several initiatives around the world, including the EU Horizon 2020 programme, the US National Science Foundation, and the UK Research and Innovation funding agency

Page 2: the author should provide a definition of "dynamic seismic risk" and clearly define their scope. Lines 71-76 (page 3) refer to issues such as operational earthquake forecasting, earthquake early warning, and (post-event) rapid response. However, these are issues related to short-term earthquake risk. Dynamic earthquake risk is much broader than this. What about long-term earthquake risk, for instance, in terms of exposure (urban and economic growth, population increase, etc.) and vulnerability (aging, structural degradation, retrofit, etc.) changes?

Good point. We adjusted the explanation of 'dynamic seismic risk' accordingly.

To assess the impact of earthquakes on the built environment and people's well-being, seismic risk combines the knowledge about the potential ground shaking due to future earthquakes (seismic hazard) with the knowledge about the exposure and vulnerability of buildings, ~~and~~ infrastructure, and communities. However, ~~Since~~ seismic risk is not constant but dynamic (~~it varies~~varying in time, space, and context) due to changes in short- and long-term temporal variation of the hazard (e.g., occurrence of earthquake sequences, secondary effects such as tsunamis, fires or landslides), exposure (e.g., population growth and displacements, time of the day), and vulnerability (e.g., retrofitting, structural degradation) as well as complex interactions between individual and social vulnerabilities (e.g., Orru et al., 2022). To address these dynamics and related challenges, different approaches are needed ~~must address the various challenges~~ in different phases of the disaster cycle (i.e., before, during, and after an earthquake sequence) such as operational earthquake forecasting (Jordan et al., 2011), dynamic exposure and vulnerability modelling (Pittore et al., 2017; Schorlemmer et al., 2020; Orlacchio et al., 2021), earthquake early warning (Allen & Melgar, 2019; Cremen & Galasso, 2020), rapid loss assessment (Erdik et al., 2014), and recovery and rebuilding efforts (Miles & Chang, 2006); see also Supplement S2a

Line 71, page 3: I believe social vulnerability is equally important (or even more important) than physical vulnerability.

We agree with that. We have included it in the introduction (see answer above) and changed this section accordingly.

Line 101, page 4: "Dynamic (seismic) risk assessment requires linking information from different assets and different phases of the disaster cycle, therefore significantly benefitting from an open approach." -> the link between an "open approach" and "dynamic seismic risk" feels like a stretch here. The benefits of an open approach are broader and related to any modeling effort relying on data and tools (e.g., computational tools). Again, there is a strong emphasis on RISE, but pretty much any research project within the Horizon 2020/Horizon Europe frameworks well addresses those issues.

In the manuscript, we mention a couple of open access assets produced within RISE; however, we also mention initiatives carried out by several other research groups to support dynamic risk reduction strategies, particularly for the 2023 Türkiye-Syria earthquake sequence.

earthquake sequence) such as operational earthquake forecasting (Jordan et al., 2011), dynamic exposure and vulnerability modelling (Pittore et al., 2017; Schorlemmer et al., 2020; Orlacchio et al., 2021), earthquake early warning (Allen & Melgar, 2019; Cremen & Galasso, 2020), rapid loss assessment (Erdik et al., 2014), and recovery and rebuilding efforts (Miles & Chang, 2006); see also Supplement S2a.

software for developing and testing probabilistic earthquake forecasts (Savran et al., 2022a; Savran et al., 2022b), and so-called reproducibility packages that contain code, data, and other resources to reproduce research outcomes without additional effort (e.g., ~~(Savran et al., 2022;~~ Bayona et al., 2022; ~~Khawaja~~ Asim et al., 2023; Bayona et al., 2023), an open sensor firmware platform that supports creating real-time monitoring networks (quakesaver.net), and a dynamic exposure model based on crowd-sourced/citizen-science building data (Schorlemmer et al., 2020). These ~~packages~~ developments set ~~permit readers and users to fully reproduce research outcomes without additional effort following the concept of open science, thereby setting~~ an example for making the fundamental assets of dynamic (seismic) risk assessment available. For the 2023 Türkiye–Syria earthquake sequence, in particular, various initiatives (e.g., EERI, 2023; GDACS, 2023; GSNL, 2023) collected open data and reports to facilitate scientific investigation, understanding, and dynamic risk reduction strategies.

trust between scientists and stakeholders (UNDRR, 2022b). Research infrastructures can foster the development of a transdisciplinary research community in the field of disaster risk (Peek et al., 2020) and provide powerful tools (e.g., data, codes, expertise) to research groups (e.g., Dañibeitia et al., 2022; Folch et al., 2023; Calatrava et al., 2023). Access and interaction with research infrastructures should therefore be promoted and encouraged among the disaster risk community to exploit these opportunities. Further, ~~D~~developing effective risk-related

Line 114, page 4: "… following the concept of open science, thereby setting an example for making the fundamental assets of dynamic (seismic) risk assessment available.", it is unclear what the fundamental assets of dynamic (seismic) risk assessment are.

We added two examples to clarify what we mean in this sentence with assets.

assessments (EFEHR); thus connecting the different assets along the disaster cycle. Also in RISE, some open science assets have been created, such as the pyCSEP toolkit, an open source software for developing and testing probabilistic earthquake forecasts (Savran et al., 2022a; Savran et al., 2022b), and so-called reproducibility packages that contain code, data, and other resources to reproduce research outcomes without additional effort (e.g., ~~(Savran et al., 2022;~~ Bayona et al., 2022; ~~Khawaja~~ Asim et al., 2023; Bayona et al., 2023), an open sensor firmware platform that supports creating real-time monitoring networks (quakesaver.net), and a dynamic exposure model based on crowd-sourced/citizen-science building data (Schorlemmer et al., 2020). These ~~packages~~ developments set ~~permit readers and users to fully reproduce research outcomes without additional effort following the concept of open science, thereby setting~~ an example for making the fundamental assets of dynamic (seismic) risk assessment available. For

Line 118, Page 4: the authors should also discuss the issue of costs related to open science as a major barrier to it.

We added to the three other challenges the challenge of the costs for publishing open access and provide two recommendations on how to address it.

DORA, Leiden Manifesto, CoARA); (iv) The costs of open access publishing are usually high (in particular for journals of repute, which not all research institutions can afford; Sample, 2012), potentially discrediting research, leading to inequity (favoring those who have the funds), and fueling 'predatory' journals (Pourret, 2022); diamond open access journals like this one support a transition in open access publishing (Rowe et al., 2022).~~.~~

Section 2.2: see my comment above. This is not about transdisciplinarity but stakeholder/end-user engagement.

See first answer.

Line 169, page 6: ethics is essential not just in data collection but even more in data use/processing. The authors should comment on these aspects.

We list some examples for these aspects and now also stress in the leading sentence that ethics does not only refer to data collection but also the use and processing of it. We also added more details in the second paragraph (when is an assessment needed and when do issues arise).

Ethics is relevant to data collection, use, and processing, as well as to ~~and~~ data-driven decision-making – ~~so~~ it must be consciously considered by researchers. In general, experts differentiate between internal and external (research) ethics (ALLEA, 2013). Internal ethics
An assessment of ethical implications is required when personal data (e.g., socio-economic data) are used to assess social vulnerability (Ferreira et al., 2015) and/or consequences of disasters (Mezinska et al., 2016; Louis-Charles et al., 2020). Ethical issues could arise if outcomes of such assessments identify vulnerable or minority groups which can be targeted for other purposes (e.g., insurance plans). Granting public access to data, models, or products of a dynamic risk framework may lead to potential misuse by third parties, which should be considered by the providers and/or scientists beforehand, e.g. by clarifying the responsibility of any consequences. ~~An open approach makes us scientists responsible for potential misuse of~~

Line 181, page 6: I am not sure that "a false earthquake early warning" is an issue of ethics. It is just a potential consequence of the uncertainties involved in real-time seismology and suboptimal decision making.

We agree that this was not a suitable example. We thus added other examples that show the ethical implications in broader terms.

~~widespread panic and significant financial losses.~~ For example, an open earthquake forecasting (or risk) model could either be incorrectly used or its results misinterpreted, which may eventually reduce the trust in those models, or be intentionally manipulated to provide exaggerated forecasts, which may create fear and panic among the public. Ethics also matters

Section 3 is a bit shallow. Some recommendations (e.g., "Professors should actively share their knowledge about stakeholders' decision-making processes with their junior scientists, e.g., by dedicated seminars.") seem a bit naïve.

Although some recommendations might sound 'naive', these are often not done and not even discussed. Taking up your example, often the professors or senior scientists actively collaborate and exchange with societal stakeholders, and the knowledge transfer to the junior scientists is missing or only weak. However, junior scientists would need to set the boundaries of their research efforts and understand the context in which their efforts are part of. Of course, our recommendations are not exhaustive but intend to help/motivate scientists to make a first step towards open, transdisciplinary, and ethical science. We included additional insights on the role of research infrastructures to foster the

creation of a transdisciplinary community in the field of disaster risk which potentially goes beyond the impact of single research projects and broadens the manuscript perspective.

> We further suggest that researchers' activities and projects should also ~~need to~~ be evaluated based on their contributions in terms of transdisciplinarity, openness, and ethical compliance to promote excellence and fairness. Finally, on an university, institutional, or project level, we argue that sessions with practical guidelines are needed to ensure that current and future research excellence considers the three subjects. We are aware that a fixed set of practices and guidelines are not sufficient; for instance, achieving openness in science is also a process of negotiation and dialogue with attention to sociocultural contexts and diverse perspectives (Leonelli, 2023) – i.e., the interaction of three subjects outlined here. Likewise, open and transdisciplinary approaches can help with a better training in the 'ethical dimension' of science. Only by embracing this open and inclusive system of knowledge production ~~then~~ can we, as scientists, help address current societal challenges and ultimately contribute to increasing societies' resilience to disasters.

Appendices are mentioned throughout the manuscript, but I can't find them in the submission.

Since it is an opinion piece, we did not add an Appendix but we provide supplementary material in a separate document, which is linked at the end of the manuscript and was accessible for the reviewers: https://polybox.ethz.ch/index.php/s/pqadhYVzcxONFPb.

We have now reserved a DOI at the ETH Research Collection and will active it if the opinion paper gets accepted.