Adrián José Rosario Beltré
CN IGME-CSIC
La Calera, 1
28760 Tres Cantos
Madrid, SPAIN

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*M*anuscript title: "**Probabilistic and *Deterministic Seismic Hazard assessments of the area comprised between west Gulf of Cadiz and east Alboran Sea"*** by Adrián José Rosario Beltré, Carlos Paredes Bartolomé and Miguel Llorente Isidro.

Dear Veronica Pazzi, Ph.D. (NHESS Editor):

On behalf of my co-authors, I am pleased to resubmit the revised version of our manuscript entitled "Probabilistic and Deterministic Seismic Hazard Assessments of the area Comprised between west Gulf of Cádiz and east Alboran Sea". We are sincerely thankful for the comments received by all the reviewers. We found these comments highly positive and constructive, and they have been helpful to improve the final quality of our manuscript, providing more consistency to some parts, making the discussion more comprehensive and up to date, and overall, clarify certain points. We have carefully followed all the recommendations and suggestions provided by the reviewers. We attach a point-by-point response document where we detail the changes that we have made to fulfil with the reviewers' requirements. In addition, we include a document where we indicate the changes introduced in the text with the Track-Changes tool of MS word.

We sincerely hope that the manuscript can now meet the required standards of the journal. We confirm, once more, that the work is original, and that neither the manuscript nor any parts of its content are currently under consideration or published in another journal.

All authors have approved the resubmission of this manuscript.

Sincerely,

Adrián José Rosario Beltré
Researcher at CN IGME-CSIC
E-mail: aj.rosario@csic.es

RESPONSE TO REVIEWER

Ms. Ref. No.: Egusphere-2025-3248

Title: Probabilistic and Deterministic Seismic Hazard Assessments of the area comprised between west Gulf of Cádiz and east Alboran Sea.

Dear Alexandra Carvalho Ph.D.

Reply (R): Thank you very much for the time and effort you have devoted to reviewing our manuscript, and for serving once again as a reviewer of our work. We sincerely appreciate your constructive and valuable suggestions. We believe that the quality of this manuscript has improved considerably after the revision process. All changes made are shown in the Revised manuscript (with changes marked) submitted.

1. General Comments

The authors have made a substantial effort to address the reviewer's comments, and the manuscript has clearly improved in several aspects. Key improvements include the reformulation of the DSHA methodology, the implementation of a weighted logic tree, an improved discussion of uncertainties, and the public availability of the DSHA code.

R: We sincerely thank the reviewer for these valuable comments.

I have only a few remaining comments that I encourage the authors to address before publication.

- The justification for using GMPEs developed for the Japan Trench has been improved. Nevertheless, the authors should acknowledge more explicitly that the tectonic analogy remains imperfect, as the IMR is a complex plate-boundary region with diffuse deformation and is not directly comparable to the well-defined subduction setting of Japan. This remains one of the main sources of uncertainty in the study. A short statement highlighting this limitation in the conclusions would be sufficient.

  R: We thank the reviewer for this observation and agree that the tectonic analogy between the IMR and the Japan Trench is necessarily imperfect. We agree that this limitation represents one of the main sources of epistemic uncertainty in the study, and we now explicitly acknowledge this in the Conclusions section by adding the following statement on line 564:

  "*However, some limitations remain to be addressed. The scarcity of direct offshore strong-motion records and the use of a uniform Vs30 proxy to represent soft soils in the IMR required the adoption of GMPEs derived from analogue seismotectonic contexts, such as the Japan Trench.* ***While this approach was statistically validated, the use of offshore GMPEs developed for the Japan Trench region represents one of the main sources of uncertainty in the study. Although these models represent the most suitable currently available formulations for offshore applications and***

capture several physical processes specific to seafloor ground motions, the tectonic analogy remains imperfect. The IMR is a complex plate boundary region characterized by diffuse deformation, whereas the Japan Trench represents a more clearly defined subduction setting*. These uncertainties should be addressed in future studies through the expansion of OBS monitoring networks in the region and region-specific GMPE calibration. Similarly, the DTM resolution, though consistent with regional studies, may benefit from refinement in areas of steep bathymetric gradients to improve hazard detail, accordingly, to include possible site-effects. Moreover, the potential interaction between earthquakes and coseismic hazards (such as landslides and tsunamis) requires further research. This could be approached through integrated, multihazard assessment frameworks to better understand and manage these complex interdependencies.*"

- The discussion of the highest PGA values and the influence of HZ23 is appreciated. However, I recommend adding one or two sentences explicitly stating that the highest values obtained for the longest return periods should be interpreted with caution because they are partly controlled by extrapolation beyond the calibration range of the GMPEs. Extremely high values may reflect methodological artefacts rather than physically meaningful hazard levels.

  R: We thank the reviewer for this recommendation and agree completely. We now clarify that part of the extreme PGA estimates may be influenced by extrapolation beyond the validated GMPE domain and therefore may reflect modelling artefacts associated with the upper tail of the hazard distribution rather than fully constrained physical shaking levels.

  The following statement was included in line 530:

  "*Although the hazard results remain consistent with the prevailing seismicity of the study region,* ***the highest PGA values obtained for the 2475- and 5000-year return periods should be interpreted with caution. Because these hazard levels are increasingly controlled by rare large-magnitude scenarios and by extrapolation beyond the calibration ranges of some of the GMPEs, a portion of the largest PGA estimates may reflect methodological artefacts associated with the upper tail of the hazard calculation, rather than fully constrained physical ground motion levels.*** *This limitation should be taken into account, and priority should be given to the future development of regionally calibrated offshore GMPEs for the tectonic context of the IMR to reduce uncertainty in the large magnitude range.*"

- Although the authors have substantially improved the discussion of the study limitations, some methodological constraints remain, particularly regarding the interpretation of offshore ground motion, the reliance on PGA-only hazard representation, and the limited validation of the selected offshore GMPEs under IMR conditions. These limitations should be acknowledged more clearly when discussing the potential engineering applications of the results. I recommend moderating the conclusions and avoiding strong statements regarding the direct implications of the findings for the seismic design of subsea structures (eg. "The findings have significant implications for the seismic design and risk management of subsea structures").

R: We appreciate this comment and agree that the engineering implications of the results should be presented more cautiously. The primary objective of this study is to provide a regional-scale offshore seismic hazard characterization and methodological framework rather than direct design values for specific structures.

Although the presented PGA maps provide useful information for first-order hazard screening and regional planning, detailed engineering design requires additional analyses, including spectral acceleration estimates, structure-specific dynamic response evaluation, site characterization, and regionally calibrated offshore ground-motion models. We have therefore moderated the Conclusions accordingly.

The sentence in line 656 was rewritten as follows:

"*The findings provide a regional-scale hazard characterization and a first-order screening framework for assessing potential seismic exposure of subsea infrastructure, including pipelines, submarine telecommunication cables, offshore energy facilities, and potential transcontinental tunnels*."

2. Recommendation

The manuscript has substantially improved and most of the major issues raised during the previous review have been satisfactorily addressed. I recommend publication after revision of the minor points listed above.

R: We sincerely thank the reviewer for these valuable comments.