

Reviewers' Notes

General Answers

We thank the Editor-in-Chief for the opportunity and the reviewers for their insightful and constructive contributions. Their comments were fundamental in improving the methodological clarity, conceptual consistency, and presentation of the results. Below we respond point by point. The revisions also contributed to strengthening the scientific and applied relevance of the manuscript. It is hoped that the study can serve as a methodological reference for future research on coastal flood risk, especially in coastal cities with limited financial resources, where approaches based on accessible data and replicable methods are particularly necessary.

Responses to Reviewer 01

1) Thank you for your comment. The unique feature of this study is not only the analysis of coastal flood risk, but also the structured methodological integration for contexts with low technical availability, combining:

- Multi-criteria calibration of free DEMs;
- Validation with local tide gauges;
- Systematic application of the bathtub technique under MSLR scenarios;
- Overlay with real estate grids as a proxy for property exposure.

It is a valid strategy and an important differential in terms of assessing low-lying coasts in the context of the global south with poor data infrastructure.

While previous studies analyze coastal risk, few:

- Integrate DEM calibration with local validation;
- Apply a replicable structure explicitly focused on the Global South;
- Incorporate spatial proxies of economic exposure in semi-arid areas with low institutional infrastructure. Finally, the methodology applied will become a benchmark to be replicated in several coastal cities with low financial resources.

We will include an additional paragraph at the end of the introduction explaining these contributions.

2) We fully agree. Acronyms will be better managed in the manuscript, including a table with all acronyms used in the manuscript. Regarding the observation about SGB: in fact, the Brazilian Geodetic System corresponds to BGS, not SGB. Its use will be reviewed to maintain institutional and linguistic consistency.

3) We appreciate the pertinent observation.

In fact, the formulation adopted in Equation (1) structures risk as a function of hazard (H) and vulnerability (V), not explicitly including exposure as a multiplicative term, an approach that has also been adopted in several studies in the literature (e.g., Araújo et al., 2021 - cited in the manuscript), and which is in line with the conceptual framework presented in the IPCC Sixth Assessment Report (IPCC, 2022).

However, exposure was considered in the spatial stage of the analysis, through the intersection between potentially flood-prone areas and the urban real estate grid. This procedure allowed us to quantify the assets located in hazard zones, characterizing a

spatial operationalization of exposure, even though it was not mathematically formalized in the risk equation.

However, we can clarify further in the text that exposure is operationalized spatially. We also emphasize that the explicit inclusion of exposure as a multiplicative term could alter the absolute magnitude of the risk values, but would not change the spatial pattern of the priority areas identified, which is the main result of the study.

A brief section discussing this conceptual framework will be included.

4) We agree. The statement will be removed from the subtitles.

5) We fully agree. A table will be added containing:

- Source
- Spatial resolution
- Temporal scale
- Reference system
- Data type
- Application in the study
- Collection point

The text will be condensed as suggested.

6) We agree. All commas will be replaced by decimal points.

7) We appreciate the extremely pertinent observation.

We recognize that the bathtub technique may overestimate flooded areas by not considering hydrodynamics. However, its application was based on:

- Regional scale;
- Absence of high-resolution bathymetric data;
- Context of applicability in regions with technical restrictions;
- Objective of initial risk screening.

We will include:

1. Expanding the methodological justification for choosing the static approach;
2. Including explicit discussion of its limitations and potential overestimations;
3. Inserting the suggested reference on uncertainties;
4. Reducing older citations, prioritizing recent literature.

We emphasize that, in the context of the study, the technique was used as a preliminary and comparative assessment tool between different DEMs, and not as a substitute for physics-based hydrodynamic modeling. We also emphasize that previous studies, published in NHESS by co-authors of this work, applied the bathtub technique in regions of the study area and obtained satisfactory results (Araújo et al., 2021 - cited in the manuscript).

8) Correction accepted. We will adjust the description to maintain consistency with Table 1.

9) Thank you for your comment.

The units will be included in Tables 2 and 3, as suggested.

Regarding Table 2, to facilitate verification and ensure consistency between the statistics presented, the column “Denominator (S)”, which represents the root of the variance of S, we propose replacing the value of S to facilitate verification. This modification makes it easier to verify the relationship between S, Z, and Kendall's Tau, while maintaining the mathematical consistency of the results.

At the discretion of the checker, the values of S were as follows: for ATM (-214), ATAB (-95), MTM (-21), and MTAB (-498).

This change does not alter the values or interpretations discussed in the manuscript.

10) The following will be added:

- Area name and tide variable.

In the lower panel, the points represent the observed annual maximums, while the curve corresponds to the theoretical quantiles estimated by the Gumbel distribution adjusted by maximum likelihood. The parametric fit does not consist of an interpolation of empirical data, but rather a probabilistic modeling of the extreme behavior of the series.

Thus, differences between the observed values and the fitted curve are expected, since the model seeks to represent the overall statistical pattern of the sample, and local deviations between empirical and theoretical quantiles may occur. These differences reflect the variability inherent in finite series of annual maximums and do not indicate inconsistency in the adjustment.

An additional explanation will be included in the text to clarify this behavior.

11) We agree. The ocean area will be masked to improve visualization.

12) A scale bar will be included.

13) Formatting error confirmed. Will be corrected.

14) The expression will be replaced by:

“mitigate and adapt to the impacts of climate change”.

Responses to Reviewer 02

1) Thank you for your comment.

Brazil was selected as a study area because it presents characteristics representative of various coastal contexts in the Global South, i.e., a cross-section of the proposed geographical area, including:

- Extensive coastline with semi-arid stretches and low topographical altitude;
- High socioeconomic vulnerability in coastal areas;
- Availability of consistent public data;
- Institutional and coastal planning challenges similar to those faced by other countries in the Global South.

However, we recognize that the original title may suggest an empirical generalization for the entire Global South, while the study is specifically applied to the Brazilian context. Thus, to avoid overly broad interpretations, we propose adjusting the title to:

We propose adjusting to:

“Regional modeling of the impacts of tidal flooding in the context of average sea level rise in low-lying areas of Brazil's semi-arid coast”.

2) We appreciate the comment. Section 3.6 will be restructured to explicitly clarify the modeling of risk and vulnerability.

Risk was operationalized as the spatial combination of flood hazard and the vulnerability of exposed elements. This approach has also been adopted in several studies in the literature (e.g., Araújo et al., 2021 - cited in the manuscript) and is consistent with the conceptual framework presented in the IPCC Sixth Assessment Report (IPCC, 2022).

The hazard was defined based on the extreme hydrodynamic scenario, consisting of: (i) projected mean sea level rise (MSLR), (ii) extreme astronomical tide, (iii) extreme meteorological tide, and (iv) the vertical uncertainty of the digital elevation model (RMSE), incorporated as a conservative margin in the delimitation of the potentially floodable area.

Vulnerability was estimated based on land use and land cover classification, assigning relative levels of susceptibility to different classes, following an approach similar to that adopted in recent studies in the international literature. This strategy represents the physical vulnerability associated with different types of land use in the face of flooding.

The revised section will detail the classification criteria and the form of spatial integration between hazard and vulnerability in the derivation of risk.

3) We agree completely.

The following will be included:

- Complete methodological flowchart;
- Reorganization of subsections;
- Textual revision;
- Explanation of the connections between data and methods.

4) We agree. Acronyms used only once will be removed.

SMC-Brazil will be explained appropriately.

5) We fully agree. A table will be added containing:

- Source
- Spatial resolution
- Temporal scale
- Reference system
- Data type
- Application in the study
- Collection point

The text will be condensed as suggested.

6) A figure illustrating the Digital Elevation Models (DEMs) used will be included.

7) Thank you for your comment.

Section 3.1.5 will be revised to clarify that the mean sea level rise (MSLR) projections on three scales (global, intermediate, and regional) were used exclusively as additional vertical increments in the composition of flood elevations, in order to clarify the different scenarios inherent in the projections, especially in relation to the quality of the projection data.

The final flood elevation for each scenario was obtained by summing: (i) the return period of the extreme astronomical tide, (ii) the return period of the extreme meteorological tide, (iii) the increment corresponding to the MSLR projection at the scale considered, and (iv) the RMSE of the DEM, incorporated as a margin of vertical uncertainty.

Each MSLR rate therefore generated a distinct elevation scenario, with the delimitation of flood-prone areas being carried out by classifying the rasters in the GIS based on these final elevations.

The revised section will explicitly detail this systematization.

8) Figures illustrating land use and land cover data, as well as urban data used in the analysis, will be added.

We clarify that urban data corresponds to vector layers derived from real estate cadastral databases, produced from the interpretation of high-resolution orthomosaics obtained by UAV and GNSS surveys (for geodetic calibration purposes). The images were processed photogrammetrically to generate georeferenced orthomosaics, from which built features and urban infrastructure were delimited.

The revised section will detail the vector nature of this data and the procedure for acquiring and processing the images.

9) We agree.

10) Agreed. It will be corrected.

11) The header of the first column will be corrected from “Datas” to “Data”, in order to correctly reflect the content presented in the table.

As for the phrase “Initially, differences between the different processes in the region can be observed,” we recognize that the wording is not appropriate for the table caption, as it introduces preliminary interpretation in a space that should be strictly descriptive. The text will be revised to make it more objective and compatible with the informative function of the caption.

12) It will be included.

13) We agree.

The figure will be removed or replaced by:

- Formal citation in the text;
- Complete reference in the bibliography section.

We will follow the journal's writing guidelines.

14) It will be implemented.

15) It will be reviewed in its entirety.