Author Comments to Referee #2

Interactive comment on "Tidal flood area mapping fronts the climate change scenarios: case study in a tropical estuary of Brazilian semiarid" by Araújo et al.

Response to General Comment:

Referee #2: General comments: I have just finished reviewing the manuscript entitles 'Tidal flood area mapping fronts the climate change scenarios: case study in a tropical estuary of Brazilian semiarid' by Araújo et al. Overall the deals with a very interest subject in an area with little published information. I believe that the article is of interest and within the scope of the journal but in my opinion needs significant improvements before publishing both methodological and scientific (see detailed comments). The most important of the problems is that the hazard methodology and classification is not presented correctly (looks confusing) and it needs further improvements. The data and methods used are presented in a way that is not easy to judge is the analysis used is correct.

Authors' reply: Many thanks for review; we are pleased that the reviewer finds the manuscript to be interesting and relevant. We would like to thank you for your positive remarks and for taking the time to criticize positively our manuscript.

Referee #2: Abstract and Introduction sections very general and they do not help the reader to understand the processes related. Finally, the objective presented at the end othe Introducion are rather technical. Study area has a lot of information that is not necessary or related with the objectives of the article an results and discussion need further work.

Authors' reply: We analyzed all considerations and restructured the text of manuscript to solve the questions mentioned by Referee #2. However, we believe that the goal of work is not merely technical, but also scientific. Since the mapping of tidal flood risk will be the result of a complex analysis, adopting unprecedented information, and will support an update art study of tidal flood and also bring key concerns in the study area to policy makers and decision takers priorities.

Referee #2: Abstract 'Previous studies on tidal flood mapping are mostly with continental and/or global scale approacher' this statement is not correct. There are far more local scale flooding studies, it is true that the impact of the global or continental wide studies tends to be higher but the number of studies is not.

Authors' reply: Respectfully, we disagree. Although the number of studies on "floods" (generic term) are larger at the local scale, specific studies on "tidal floods" are scarce, mainly in Brazil and other South American countries. In greater numbers, there are some more in a continental and/or global approach.

Referee #2: Introduction LINE 26: 'has occurred at an accelerating rate' is occurring, as it continues to occur.

Authors' reply: We agree with Referee # 2 and changed "During the last quarter-century, the global mean SLR has occurred at an accelerating rate, averaging about +3 mm/year" by "The SLR global mean is occurring at an accelerating rate, averaging

about +3 mm/year (recorded for during the last quarter-century)". We changed "flood risk" by "tidal flood risk" in abstract (line 3).

Referee #2: LINES 33-34: 'Decades ago, the flooding usually happened only during a powerful or localized storm now can happen when a steady breeze or a change in coastal current overlaps with high tide (NOAA, 2019).' This statement is only valid for the US area and for 'sunny day flooding' no storm conditions. It cannot be extrapolated to other areas since local environmental and infrastructure (drainage system) parameters are important. Please rephrase. Also explain in the introduction with what type of flooding this work is focused marine flooding, flooding through the drainage system or both.
Authors' reply: We agree with Referee # 2 and changed to "Decades ago, the flooding usually happened only during a powerful or localized storm now can happen when a steady breeze or a change in coastal current overlaps with high tide, as occurs for example in USA (NOAA, 2019)".

Referee #2: LINE 35: 'In Brazil, the current panorama of coastal flooding is extremely worrying (Losada et al., 2013).' In what terms, this statement is not supported by the paper. Please explain which are the worrying factors according to Losada et al. Since this is a local study please provide information related with the specific study area.
Authors' reply: We agree with Referee # 2 and changed the sentence.

Referee #2: LINE 55: the objective as it expressed looks more technical than scientific. Please try to reformulate it.
Authors' reply: We agree with Referee # 2 and changed the sentence: "the objective of this work was develop and apply a methodology for tidal flood risk mapping, given the current scenarios of rising sea level trends, adopting as a case study the Piranhas-Açú Estuary, the northern portion of the state of Rio Grande do Norte, Brazil".

Referee #2: Study Site: The first and the third paragraph have a lot of repeated information (in the first one without proper referencing). Please remove.
Authors' reply: We agree with Referee # 2 and changed the sentence.

Referee #2: LINES 82-87: The tidal information is not properly provided. What is the mean tidal range, the mean high water spring tide and the mean high water neap tides? The reduction level (RT) is a national level that is not explained until the methods section. Please refer ranges relative to MSL.
Authors' reply: The Hydrography and Navigation Directorate (DHN) of the Brazilian Navy (MB), the institution responsible for maritime monitoring, adopts the so-called reduction level (RL) as a reference for maritime quota. The RL is level that corresponds to the average of low tides of syzygy, to eliminate the variations of tides and to guarantee to navigator that it does not find any depth less than those represented in the nautical chart. We added the information in updated manuscript.

Referee #2: LINE 103: 'been suffering lately' what do you mean by lately? Since when? How many events per year?

Authors' reply: Recent reports, from the years 2010, were found in local newspapers and blogs, as well as personal observation *in loco* (personal communication). Since then, frequently, due to the effects of the hydrodynamic forcing, streets and houses are flooded; bringing harmful consequences to several communities of the northern coast of Rio Grande do Norte, and many other places in Northern Brazilian coast. We added the information in updated manuscript.

Referee #2: LINE 116: It is not possible to have a one line section. Please provide more information on the tidal data. Length of the record, precise location, gaps in the record frequency of data recording, reference level and data treatment.
Authors' reply: The sentence is actually just a presentation for the next subtopics. The goal was that the sentence was short and to point. We decided to keep the sentence.

Referee #2: LINE 120: provide model resolution and other models parameters. Any indicators on the ability of this model to predict correctly the observed storm surge? Please provide calibration and validation information.
Authors' reply: The meteorological tidal GOS database consists of a time series selection of regional reanalysis along the Brazilian coast, numerically simulated with the three-dimensional circulation model ROMS (Regional Ocean Modeling System). ROMS consists of sea level variation data due to atmospheric factors. To generate the series, the barotropic module (2DH) of the model in global mesh with 0.25° spatial resolution and bathymetry data of ETOPO2 model (NOAA) was used. As forcing the model, pressure data at sea level and global winds (10m high) from Reanalysis 1 (NCEP / NCAR) were used. The wind and pressure data have a spatial resolution of 1.9° and a 6-hour temporal resolution, covering the period from 1948 to 2008. We added the information in updated manuscript.

Referee #2: LINE 124: No need to define the Astronomical tide
Authors' reply: Despite being a widespread concept, we believe it is pertinent to maintain the sentence.

Referee #2: LINE 130: It is not clear if the data are measured or predicted water levels. If the data are max and min measured then they are not purely astronomical data but they have also meteorological and judging by the figure 1also river components. If on the other hand the data are predicted max. and min. values from tidal constituents then there is no reason to calculate the return period of the data there is no probabilistic part only deterministic. Please describe better the data and adjust the statistical methods used in the text.
Authors' reply: For this job, the Astronomical Tide data are the result of deterministic forecasts prepared and provided by the Brazilian Navy's Directorate of Hydrography and Navigation (DHN). The maximum annual astronomical tide level was used from the astronomical tide forecast data released by DHN. We added the information in updated manuscript. Despite being a deterministic method, the return period inference (probabilistic inference) is used in the final model, since it will be used the tidal behavior parameter and not the raw tide data.

Referee #2: LINE 141: see comment above.

Authors' reply: We answered above.

Referee #2: LINE 153: change 'payback' with 'return'
Authors' reply: We accepted and modified in manuscript.

Referee #2: LINE 195: 'Church et al., 2013)' not in the reference list. Also is this a global MSL estimation? Since it is a local study a local estimate would be better. You do not explain where you use the climate change data. Their use in Table 1 is confusing since extreme climate change scenarios are related with low hazard level. In general the use of CC scenarios in Hazard levels is confusing.
Authors' reply: We add reference Church et al. (2013). Regarding MSL estimation, we used the scenarios found in literature. RCPs are scenarios with a global projection, whereas the IBGE scenario is a projection at a regional level (for Brazilian northeaster). The latter result of reports on data from IBGE tidal network. IBGE is the Brazilian Institute of Geography and Statistics.
Each rate of sea level rise in scenarios used is due to robust modeling of sea level projection under face climate change.
In fact, in many studies the largest projections correspond to greatest risk and/or danger. The weights assigned to each scenario are associated with the MSL rise that projection establishes. However, for our study, the highest weights correspond to small rise, since the probability of occurring is more palpable (probability to occurring), that is, the level at which that danger already occurs. When we increase an MSL projection, we decrease the weight, since the probability of that variation occurring is more uncertain. Therefore, the greatest dangers correspond to areas with the lowest rates and the lowest dangers correspond to areas with the highest rates. It is a logical and pertinent thought for flood hazard mapping, as seen in Araújo et al (2019).
We restructured the text of manuscript to clarify the mentioned questions.

Araújo, P. V. N., Amaro, V. E., Silva, R. M., and Lopes, A. B.: Delimitation of flood areas based on a calibrated a DEM and geoprocessing: case study on the Uruguay River, Itaqui, southern Brazil, Nat. Hazards Earth Syst. Sci., 19, 237–250, https://doi.org/10.5194/nhess-19-237-2019, 2019.

Referee #2: LINE 205-210: It is no clear on how you select your hazard levels and also which is your hazard indicator (see Ferreria et al., 2017 Process-based indicators to assess storm induced coastal hazards. Earth-Science Reviews 173). It is always better to select a proxy that is a measure of hazard (e.g. inundation depth instead of total water level.).
Authors' reply: We explained previously. For this study, the highest weights correspond to small rise, since the probability of occurring is more conspicuous (probability to occurring), that is, the level at which that danger already occurs. When we increase an MSL projection, we decrease the weight, since the probability of that variation occurring is more uncertain. Therefore, the greatest dangers correspond to areas with the lowest rates and the lowest dangers correspond to areas with the highest rates. It is a logical and pertinent thought for flood hazard mapping.

Referee #2: Table 1 is not easy to understand as RCP8.5 is a low hazard scenario. In general this section is not clear and needs more work. Normally hazard can take a value of 0 'no hazard'.
Authors' reply: The highest weights correspond to small rise, since the probability of occurring is more palpable (probability to occurring), that is, the level at which that danger already occurs. When we increase an MSL projection, we decrease the weight, since the probability of that variation occurring is more uncertain. Therefore, the greatest dangers correspond to areas with the lowest rates and the lowest dangers correspond to areas with the highest rates.

Referee #2: LINE 212: The vulnerability is actually land use vulnerability. Which were the parameters used for the classification. Economic importance or other? The classification was based of regional or national stakeholders or was made by the authors?
Authors' reply: We added a new topic in updated manuscript: "3.5 Land use and cover map".

Referee #2: LINES 230-237: It is not easy to observe trend with relative short time-series. Have you checked if there is a correlation with any of the large weather patterns and indices that affect the area? It is important to explain what kind of tidal data you present see my comment in methods section. Is it possible to extend the surge and tidal data to cover the events you have measurements?
Authors' reply: We understand. Unfortunately, the temporal series of meteorological tide data is limited 2008´s. We believe that after this period, the meteorological tide has been influencing in the phenomenon of tide flooding more strongly. However, for this work it will not be possible to build the data. We are in the process of expanding this time series with several researchers, but it will take some time to complete (around years). Corroborating for publication this manuscript. Soon this work becomes the pioneer of many that will come on the phenomenon of tidal flooding in this study area, and we will mention this research in near future as an initial starting point of investigations.

Referee #2: LINES 240-247: this information is better in the study area.
Authors' reply: Yes. It would also fit the Study Area topic; however, we use the sentence as an engine of discussion.

Referee #2: LINES 251_301: it is difficult to comment on the results since I the hazard classification is not clear. Up to the results you do not mention which is the process of inundation (flooding form the see or drainage water). Please introduce this earlier in the text with the appropriate information of the type and location of the drainage system. Also how you do the mapping in GIS? Are you using an algorithm with hydraulic connectivity or it is a bathtub model?
Authors' reply: Tidal flooding is the focus of the work. However, due to the flat and low region, very close to sea level and inserted in an anastomosed estuary, the tidal flooding also occurs through the rain drainage system. Occurring the return of water through the system. We reinforce that the river mentioned in work is a tidal channel.

We updated the information in updated manuscript. The algorithm used was only a bathtub model (as mentioned in table 4).