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Natural Hazards and Earth System Sciences
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Interactive comment on "Uncertainties in Coastal Flood Risk Assessments in Small Island Developing States" *by* Matteo U. Parodi et al.

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Dear Editor and Dear Reviewers,

We appreciate the reviewers' constructive comments. We addressed the comments and suggestions in this reply and have accordingly implemented changes in the manuscript, which have surely improved its quality. Please do not hesitate to contact me if you have further questions.

Kind Regards,

Matteo Parodi

Reviewer #1

1) Page4, line20, the authors straight away analysed a 100-year return period for the analyzed region. Although for most of the developed nations, ïňĆood protection standard assumes 100-year as the benchmark, however, for pristine locality like the two analyzed here, directly moving to a 100-year return level may lead to erroneous results based on a limited number of records available. Further, the study uses data from different sources, such as GTSR data, which is based on a 35-year record, which may not be equivalent to the length of other available records used in the analysis. Hence, data from different sources with varying record lengths would impart additional uncertainty in the analysis. Although the return period could approximate the hazard potential beyond the record length, however, in this case, the uncertainty bound would be larger with longer return period estimates. Hence, it would be interesting to know the hazard potential on smaller return levels such as 10-year or 25-year ïňĄrst that covers the analysis period before moving to the larger one.

Authors: We thank the reviewer for the very good comment. We analysed different return periods and found that, for the considered locations, smaller return periods had a very little difference in the range of values between the 5th and 95th percentile values (13 cm spread for the 10-year return value and 28 cm spread for the 100-year return value for offshore significant wave height; 5 cm spread for the 10-year return value and 8 cm spread for the 100-year return value for storm surge level). The estimated values for different return periods for the two variables (i.e. significant wave height and storm surge levels) are shown in Fig. 1 and Fig. 2 which have been added for completeness to the rebuttal letter. In the top left of the figure, the 50th percentile, together with the 5th and 95th percentile values in brackets, are shown for each return period.

Furthermore, the 50th percentile value did not increase significantly from a 1-year return value to a 100-year return value for both investigated variables (1.10 m to 1.35 m for offshore significant wave height; 1 m to 1.08 m for storm surge level). Therefore, the hazard potential on smaller return periods (e.g. 10-year or 25-year) would have not differed significantly from the one computed using the 100-year return period. More-

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over, the 5th to 50th percentile values range for the 100-year return period, which was analysed as part of this paper, included the 50th percentile value for the 10-year return period. The choice of the 100-year return period, instead of the use of other return periods, was arbitrary and with the only objective to investigate uncertainty. This has been clarified in the manuscript: "In this analysis, arbitrarily chosen 100-year return period extreme sea levels event were modelled since, for this case, events with smaller return periods had only a small difference in intensity and computed flood damages than the 100-year return period event. ", see page 4, line 25.

We agree that using data with varying record lengths would impart additional uncertainty on the analysis and the issue has been mentioned: "Separate datasets with different recorded lengths were used for the statistical estimation of the storm surge level and significant wave height 100-year return period values, which is an additional source of uncertainty in the damage prediction", see page 12, line 16.

(2) Throughout the manuscript, no-where the start year and the end year is mentioned for any of the dataset except pointing to either 30- or 35-year. In that way, it is rather abstract, what was the baseline period.

Authors: The issue has been addressed and the start and end dates of each dataset that we used are mentioned on page 5 line 7 and 22 for significant wave height and storm surge, respectively. "The ERA-Interim dataset (Dee et al. 2011) by ECMWF (European Centre for Medium-Range Weather Forecast), which covers the period from January 1st, 1989 until present, was used."

"The estimation of storm surge levels was based on the dataset by Muis et al. (2016), a global water level reanalysis based on daily maxima over the time period 1979-2014."

(3) For sampling extreme, authors directly have taken 98th percentile as the threshold criterion for signiïňĄcant wave height. For ïňĄxing threshold, authors need to ensure the sampled extremes are un-autocorrelated and iid. Further, for any coastal storms,3-day consecutive extremes should not be sampled together. Hence, authors should

ensure sampled extremes follow iid behavior.

Authors: The choice of the threshold was based on literature (Wahl et al. 2017), and the 98th percentile was chosen as the authors recommended. Furthermore, coastal storms have been sampled with a 60-hours span time in between, in order to, as rightly mentioned by the reviewer, ensure that sampled extremes followed iid (independent and identically distributed) behaviour and were not autocorrelated. This has been specified in the manuscript: “To ensure the clustered peaks were independent and identically distributed, 60 hour consecutive extremes were not sampled together.”, see page 5, line 11.

(4) On page 4, line 15, please specify the temporal resolution of storm surges, which is 6-hourly I guess, please check. And also please explain the time frame.

Authors: The time frame of the investigated storm surge are the 6 hours peak of a 24hour storm. The temporal resolution is one hour. This information has been specified accordingly on page 4, line 9.

(5) Please specify the source and download the link for the SSP scenario.

Authors: The source has been specified on page 8, line 2 and a footnote has been made for the download link: https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=about.

(6) On page 11, in the present-day scenario, interdependency between various ESL components are neglected. For example, surge and tide are often correlated (Devlin et al., 2017): Devlin, A. T., Jay, D. A., Talke, S. A., Zaron, E. D., Pan, J. and Lin, H.: Coupling of sea level and tidal range changes, with implications for future water levels, ScientiïňĄc reports, 7(1), 17021, 2017.

Authors: Indeed, in the presented work ESL components are considered independent. The authors have assumed that storm surge and tidal level, as well as offshore wave height and tidal level are independent. However, as the reviewer noted, interdependency between various ESL components can occur. The issue has been mentioned as a limitation of the study: “Moreover, the interdependency between different ESL components has been neglected, although tide and sea level changes are often correlated, adding further uncertainty in the analysis (Devlin et al. 2017)” In Section 5, page 12, line 12.

(7) In page 11, please also include the factor, “technological advancement” since this also affects future ïňĆood risk assessment.

Authors: We agree that technological advancement may also affect future flood risk assessment and it has been mentioned on page 12, line 23.

Minor comments:

(1) Authors have cited several studies related to coastal and riverine ïňĆood risk assessment and associated uncertainties. However, in the low-lying deltas, the compound ïňĆooding resulting from both coastal and riverine ïňĆoods during a major storm episode can cause signiïňĄcant damage. A few references on this could broaden the scope of the article.

Authors: We agree with the comment. Indeed, compound flooding can increase significantly the damages than if they had occurred for a coastal or riverine flood alone. The topic has been mentioned: “Compound flooding events (e.g. coastal and riverine) can significantly increase the damages than single events only (Kumbier et al., 2018; Wahl et al., 2015; Ward et al., 2017), and further research could estimate the added uncertainty.”, see Section 5, page 12, line 10.

(2) Page 4, line 10, no citation is available for De Ridder et al., 2019 in the reference section

Authors: The reference has been removed, since the cited manuscript is still under review.

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2019-392/nhess-2019-392-AC1-supplement.pdf

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2019-392, 2019.

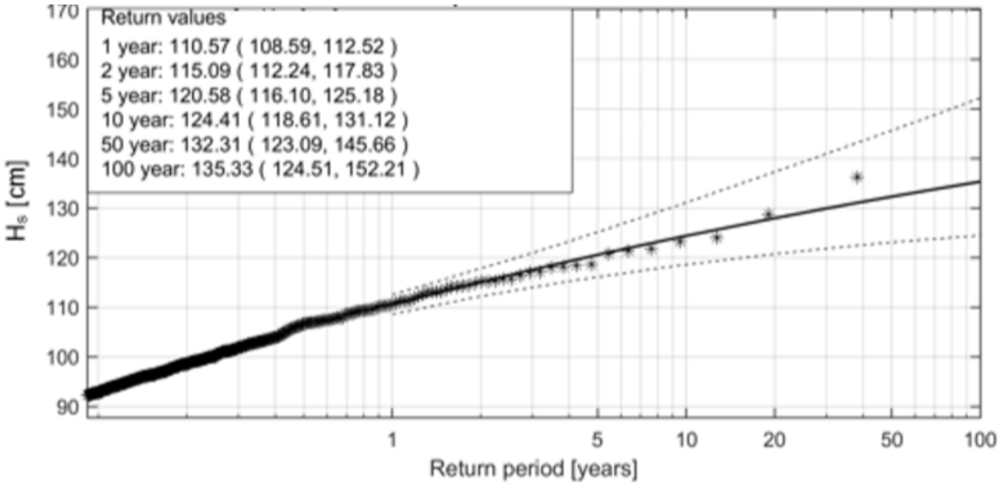

Fig. 1. Figure 1 Estimated Significant wave height values for different return periods. Values are expressed in cm. The black crosses show the 50th percentile. The black dotted lines show the lower and upper

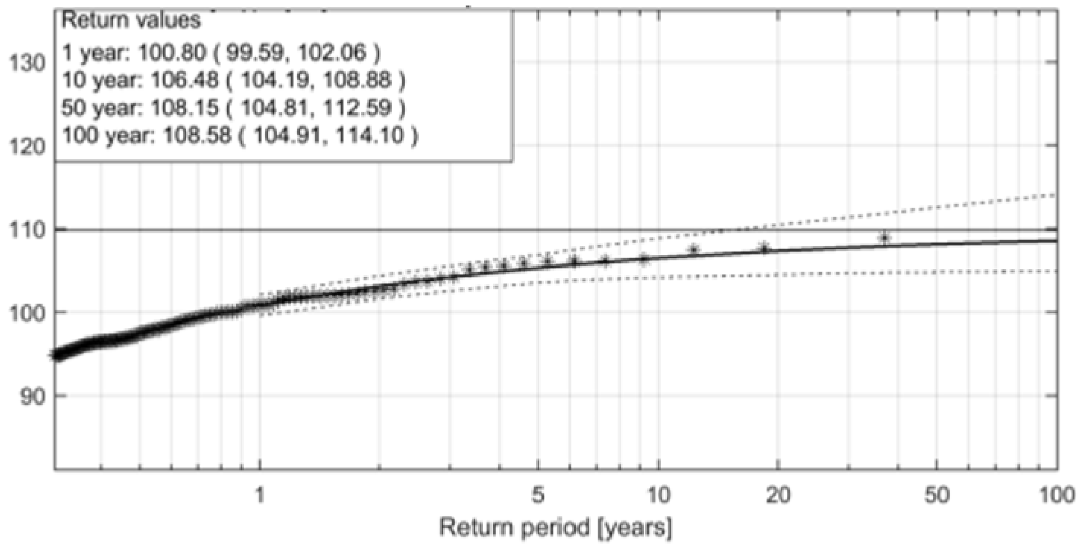

Fig. 2. Figure 2 Estimated Storm surge level values for different return periods. Values are expressed in cm. The black crosses show the 50th percentile. The black dotted lines show the lower and upper bounds

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