Dear reviewers and community members,

We sincerely thank you for taking part in the review process of our article. The assessment of coastal hazard changes is a complex subject that requires crossing points of view. This was the rationale for bringing together specialists from different disciplines for the initial writing. Thanks to your insights on the fields of coastal risk management, but also hydrology and water resource management, we were able to specify our systemic method and the conditions of its implementation.

The responses to your reports are gathered below (these responses were updated to be consistent with the revised version). Your recommendations and suggestions appear in italics and are underlined. Our answers are in bold when they induce changes to our article and in normal characters when they relates to supplementary comments.

For a better traceability of the changes, in accordance with the editor's instructions, we send you in addition to the revised version of our article, a marked-up version of our revised manuscript. As you can see, the changes are very substantial and we hope that the revised version will give you full satisfaction.

Anonymous Referee #1

1. How the author correlates the hazard with climate change?

The impact of climate change on coastal hazards is the result of the interaction between climate and ocean variables (which may be highly correlated with one another). For this reason, we considered that « given the multiple effects of climate change on sea levels (GMSL and RSL), atmospheric conditions, and wave conditions, the evolution of the factors and parameters can only be assessed using global development hypotheses » (line 136).

2. How the frequency variations of extreme sea levels (ESL) was studied by the author?

General principles are presented in the introduction (line 73-89) and a more detailed presentation is given in the method (line 159 – 176). The method focuses on changes in the magnitude and frequency of occurrence of the present 100-year ESL (ESL_{100}), following Vousdoukas et al. (2017).

3. Why author have selected France for study purpose?

They are two main reasons.

The first reason is explained at the end of the introduction (line 95-99): "France and its overseas territories are located in different latitudes (equator, tropics and temperate zones), exposed to different climates, and characterized by different geomorphological configurations (continental or island)." Indeed, the application of this method to selected territories allowed to highlight the expected differences in the future evolution of coastal hazards.

The second reason is that the authors had a good access to French territory data:

- bathymetric maps (provided by the SHOM)
- analysis of storm surges computed from the national REFMAR database (provided by the SHOM)
- Continuous water height and wave measurements from the French national observation services ReefTEMPS and DYNALIT (provided by the LIttoral ENvironment et Sociétés (LIENSs) laboratory)
- Scientific reports relative to extreme sea levels and morphodynamics along French coasts (provided by Cerema).

4. Have authors compared their work with the other researchers?

First, we have considered the work of other researchers on physical and biological changes due to climate change on the ocean and the coast (sea level, wave, geomorphology, coral reefs, sea ice extent, etc.). The main references cited in this field are :

- the Concepts and Terminology for Sea Level (e.g. Gregory et al., 2019)
- the mechanisms generating sea-level rise (e.g. Cazenave and Le Cozannet, 2013 ; Frederikse et al., 2020 ; Haigh et al., 2020; Talke et al., 2020) and storm surges (e.g. Bertin et al., 2012; Dodet et al., 2019; Calafat et al., 2022)
- sea level rise projections (e.g. Lowe et al., 2010 ; Church et al., 2013; Slangen et al., 2017; Bamber et al., 2019; Dayan et al., 2021)
- Height and frequency variations of ESL (Hunter, 2012; Buchanan et al., 2016; Vitousek et al., 2017; Vousdoukas et al., 2017; Vousdoukas et al., 2018)

- Changes in the wave directional frequencies (Casas-Prat and Sierra, 2010) and shoreline changes (Ruggiero et al., 2010; Forbes, 2010 ; Lantuit et a., 2011 ; Lamoureux et al., 2015, Masselink et al., 2016 ; Ranasinghe, 2016; Lavaud et al., 2022 ; Martins et al., 2022)
- Coral Reefs changes (Hoegh-Guldberg, 2007 ; Albright et al., 2018)
- How to translate hazards into Impacts or Risks.

Second, we have studied how these biophysical changes were integrated in coastal hazard and risk analysis. It appears that some authors adopted an analytical approach that is convenient for the issue they are addressing, for example the implications of extreme coastal water levels for potential coastal overtopping (Almar et al., 2021). But in many cases, as indicated in the introduction (line 40-44), the analytical approach should be completed with a more systemic approach. For example, to assess future flood damage in the major coastal cities (see e.g. Nicholls et al., 2008; Hallegatte et al., 2013; Rassmussen et al., 2022) or on the coast worldwide (Tiggeloven et al., 2020), the hazard should not be represented only by ESLs. In particular, when the objective is to assess risk in a comprehensive way, further reflection is needed on the definition of hazard in the context of climate change.

Therefore, we considered that a shortcoming existed in the scientific litterature and we proposed a systemic assessment method, as indicated in the abstract, "to analyze coastal hazard changes at regional scales, integrating parameters influencing sea-levels, as well as factors describing the geomorphological context (length and shape of the coast, width of the continental shelf), meteocean events (storms, cyclones and tsunamis), and the marine environment (e.g., coral reef state and sea ice extent)".

5. Through some light regarding need of the study?

In addition to justifying our proposal scientifically (as indicated above, filling a gap in the state of the art), we could actually add in the text an explanation of the need to disseminate our method in response to operational needs. We propose to add the following sentence, at the end of the introduction (after line 95):

The proposed systemic method emphasizes the need to focus on the analysis and interpretation of the modelling results, by putting them into perspective with respect to the biophysical conditions (both current and forecasted).

6. Steps are explained in a detailed manner. It is requested to minimize the same.

For step 1, we propose to shorten three paragraphs (line 178-192). They would be replaced by :

In general, tidal simulations show no significant impacts of RSL rise on tidal amplitude during the 21st century at regional scales, although this does not exclude potential local effects (Haigh et al., 2020 ; Idier et al., 2017). Given the strong uncertainties on RSL rise, we will assume here that the tides are in a steady state and, consequently, that the tidal range does not change the allowance.

For step 2, we propose to shorten one paragraph relative to meteocean event types (line 204-209). It would be replaced by :

The increase in wave damage could also be assessed, considering local changes in significant wave height (average height of the highest one-third of the waves in a given sea state). However, trends in coastal wave climates are reported, with a low confidence level, in the IPCC (2019) report. Therefore, these trends will not be explored in detail: the focus will be on the strong differences that already exist between the wave climates of the maritime facades.

For step 3, we propose to delete one paragraph (261-267).

It will avoid redundancy and information that are not essential for the implementation of the method.

Paragraphs justifying the choice of qualitative parameters would be kept unchanged.

7. What is the importance of geomorphology in your study?

The main interest of our study is to consider geomorphology in conjunction with the other factors determining coastal hazards, which appears in our conclusions (lines 640 to 663).

8. Give citations wherever required.

It is interesting, as you suggest, to refer to work on water resource management and flood risk in the continental domain. This enriches the reflection on the methods, even if it goes a bit beyond the scope of the current work. Additional quotations have been added (those you mentioned and two others relating to regional sea-level change and the use of artificial intelligence in the field of coastal risks). On the other points, we made sure to systematically cite the authors we referred to.

9. Add below mentioned papers and cite them in the text:

The first, third and fourth references can be cited line 44, by indicating :

In comparison, on land, systemic approaches are used in studying surface runoff and defining strategies in water resource and flood risk management (Shaikh et al. 2022; Verma et al., 2023; Mehta et al., 2023).

The second reference could be mentioned at the very end of the conclusion :

As a follow-up of this study, our method may be improved in the future, by exploring the capabilities of artificial intelligence (AI). In addition to large-scale hydrodynamic model outputs and other environmental data, analyses may integrate deep learning method outputs. AI has already provided interesting results in the field of hydrology (Kumar et al., 2023) and for the prediction of storm surges (Tiggeloven et al., 2021).

Finally, the references we propose to add are as follows:

Hamlington, B. D., Gardner, A. S., Ivins, E., Lenaerts, J. T. M., Reager, J. T., Trossman, D. S., et al. (2020). Understanding of contemporary regional sea-level change and the implications for the future. Reviews of Geophysics, 58, e2019RG000672. https://doi.org/10.1029/2019RG000672

Kumar, V., Kedam, N., Sharma, K. V., Mehta, D. J., & Caloiero, T. : Advanced Machine Learning Techniques to Improve Hydrological Prediction: A Comparative Analysis of Streamflow Prediction Models. Water, 15(14), 2572, 2023

Mehta, D., Hadvani, J., Kanthariya, D., and Sonawala, P. : Effect of land use land cover change on runoff characteristics using curve number: A GIS and remote sensing approach. International Journal of Hydrology Science and Technology, 16(1), 1-16, 2023.

Shaikh, M. M., Lodha, P., Lalwani, P. and Mehta, D.: Climatic projections of Western India using global and regional climate models. Water Practice & Technology, 17(9), 1818-1825, 2022.

Tiggeloven, T., Couasnon, A., van Straaten, C. et al. : Exploring deep learning capabilities for surge predictions in coastal areas. Sci Rep 11, 17224. https://doi.org/10.1038/s41598-021-96674-0, 2021.

Verma, S., Verma, M. K., Prasad, A. D., Mehta, D., Azamathulla, H. M., Muttil, N., and Rathnayake, U.: Simulating the Hydrological Processes under Multiple Land Use/Land Cover and Climate Change Scenarios in the Mahanadi Reservoir Complex, Chhattisgarh, India. Water, 15(17), 3068, 2023.

Anonymous Referee #2

1 Overall assessment

The paper titled "A systemic and comprehensive assessment of coastal hazard changes: method and application to France and its overseas territories" is an attempt to, as the title suggests, systemic (e.g, coast as a system) and comprehensive assessment of coastal hazard change (in the context of climate change). The paper goes long discussion about its method, then appears to pull observation from some available repositories (in France), pull climate projection from other studies and proposes to provide a systemic (or systematic?) and comprehensive assessment of coastal hazard changes. The final result boils down to a table of regions where qualitative/quantitative measurements from the above-mentioned data are put together, and a mixture of subjective and objective opinion is provided.

The main contribution of the paper is the proposed method, not the results obtained in the case study. If these results, considered separately or jointly, are also of intrinsic interest, they are mainly presented to demonstrate the interest of our method.

The objective of this paper is ambitious, and necessary in the context of the risk of multiple coastal hazards, and their unknown/uncertain evolution in the changing climate. I would like to thank the authors to take time to work on this topic. However, unfortunately, after reading the manuscript, I was left with a hollow impression. At the current condition of the manuscript, I do not recommend it's publication in NHESS, and my decision would be to reject.

We hope that the adaptations we propose below in response to your comments will help to better highlight the contributions and clarify the objectives of our article.

Although we have not tried to make a significant contribution to the quantitative evaluation of the physical phenomena, including extreme water levels and their frequencies, we think that our method of evaluating the evolution of the hazard with a more global approach is still of real interest. The concepts of risk and hazard are at the heart of our reflection, and the apprehension of the hazard for complex systems like the Earth are possible, in our opinion, only if systemic approaches complement the analytical approaches (deterministic or probabilistic). We thus feel like this paper is appropriate for a journal that aims to « embrace a holistic Earth system science approach ».

2 Reasoning for the decision

Despite my negative decision, below I have tried to provide a relatively broad reasoning of my decision and some ways the work can be improved (in my opinion). I have also marked some smaller matter in the line-by-line comments. I hope it helps the authors to rethink about their approach, analysis, and presentation.

Thank you for clarifying the reasons for your suggestion to reject the paper. Below are our answers.

We also thank you for reviewing the document line by line, as these detailed comments will improve the paper on most of the points you report to us.

The first one is regarding the physics, and the referencing of the existing knowledge of the physical processes that constitute the hazard. There are countless profound claims regarding storm surge characteristics, tide-surge interactions, contribution of wave setup, link between shoreline and hazard and many more are written, but for which very little or often no reference are provided. For each region *in France, for practically each component of hazard in question, there are many available literature that should be cited, but it was not the case. Particularly, the consideration of wave is very highlighted in this paper as a novelty. However, the well outdated (and overused) eqn. of 0.2 Hs [1] is too oversimplification of an important foctor. One way-around would be to get the best assessment from available studies regarding the scaling, if not there are already existing literature that proposes alternative beach-slope dependent formulations (e.g., [2]). The non-linear interaction between various components - tide, surge, wave-setup are now well established (e.g, [3]) and needs to be well thought too.*

The first reference you cite (Aucan et al., 2018) notes the importance of the effect of waves on the sea level. However, our objective is not to evaluate the evolution of a parameter at a precise time, but to improve the overall assessment of coastal hazards in the long term, taking into account that this assessment is carried out using hypothetical scenarios and that there are high uncertainties related to the multiple factors determining the hazard, which are reinforced by the interactions between these factors. In this context, the precise calculation of the effect of waves on the sea level is of relative importance. In particular, concerning the wave set-up estimate, line 172 stated:

« 0.2 H_s is a generic approximation of the wave set-up (U.S. Army Corps of Engineers, 2002). This equation is a conservative estimate of the wave set-up, which mostly depends on the local slope, breaking wave height, and wave period, and may be closer to 10% of the breaking wave height. Larger values may only be observed at steep sandy beaches (e.g. Martins et al., 2022) or steep shore platforms (Sheremet et al., 2014; Lavaud et al., 2022). This expression is used here since the objective of this work is not to improve existing deterministic methods, but to present a systemic and comprehensive method for assessing the evolution of coastal hazards. »

The method for estimating sea levels is given by default and, if desired, the user of the method can produce other estimates. This position may be justified as follows by completing the introduction of Part 2, with three new paragraphs starting with line 142 (and replacing the last sentence of the paragraph) :

« For the assessment of sea levels, Table 1 shows the projections for the GMSL under the SSP5-8.5 scenario at three time scales: 2050, 2100 and 2300.

Table 1: GMSL projections for 2050, 2100 and 2300 for the SSP5-8.5 scenario. Median values and ranges (17th to 83rd percentiles) are shown using the 1986-2005 period as a reference (IPCC, 2019).

Climate scenario	**2050 Median**	**2050 17-83% range**	**2100 Median**	**2100 17-83% range**	**2300 Median**	**2300 17-83% range**
SSP5-8.5	**+ 32 cm**	**23 cm to 40 cm**	**+ 84 cm**	**61 cm to 110 cm**	**+385 cm**	**230 cm to 540 cm**

The GMSL values displayed in Table 1 show high uncertainties in the long term. For example, in 2100, the median value is 0.84 m and the 17th to 83rd percentile range is 0.61 to 1.10 m (the high value is almost double the low value). These GMSL estimates were established for the SSP5-8.5 scenario, but greater differences exist if other scenarios are considered in a complementary manner. Similar (or higher, since other local phenomena must be considered) uncertainties exist for the RSL and the centennial ESL.

In conclusion, to make long-term management and adaptation décisions, a general description of the evolution of the hazard, including the estimated uncertainties, is considered more appropriate than a forecast of the evolution of a parameter at a given date, which is likely to be imprecise.

Accordingly, conservative assumptions will be used when assessing sea level components in this method. »

In complement:

At line 157, we will refer to Aucan et al. (2018) and Gomes da Silva et al. (2020) to justify that we do not take wave run-up into account in our method for regional studies.

On line 167, equation (3) will be followed by this comment :

« We must here appreciate the need to use a more detailed method for each particular case, because according to Idier et al. (2019), depending on the type of environments (e.g., morphology, hydrometeorological context), non-linear interactions between various components - tide, surge, wave set-up - can reach several tens of centimeters. For instance, using a numerical modeling approach, focusing on the German Bight area (SE of North Sea) and assuming a sea level rise of 0.54 m, Arns et al. (2015) show that taking into account the interactions between mean sea level, tide and atmospheric surge leads to positive changes in extreme water levels relative to the MSL rise. The largest non-linear increases in the order of +0.15 m occur in the shallow areas of the Wadden Sea. However, introducing a novel approach to statistically assess the non-linear interaction of tide and non-tidal residual, Arns et al. (2020) demonstrate that extreme sea levels are up to 30% (or 70 cm) higher if non-linear interactions are not accounted for. The largest effects of Tide Surge Interaction (TSI) are found for the US East Coast and the Gulf of Mexico, the UK North Sea coastline, and parts of the southern Japanese coast. The highest value, 66 cm, is found in Cromer along the UK North Sea coastline. On the selected coasts, other values are generally between 20 and 50 cm. In conclusion, while statistical methods demonstrate that, globally, non-linear interaction modulates extreme sea levels, numerical modeling shows that non-linear interaction can locally induce increases up to tens of centimeters. Given the high uncertainties regarding the long-term evolution of sea levels and geomorphological changes, we shall consider that equation (3) provides in the general case a conservative estimate of the ESL and, if not, that the other sources of uncertainty are greater than the water level rise related to these non-linear interactions. »

At the end of the conclusion, we propose to add a paragraph :

« In parallel with research on systemic approaches, the assessment of water levels remains an essential topic. Future efforts could benefit from recent developments on ocean modeling like the new generation Global Tide and Surge Model Version 3.0 (GTSMv3.0), which can be used to simulate dynamically tides, storm surges, and changes in MSL, including interaction effects (Muis et al., 2020); or the new global, fully coupled, unstructured model of Mentaschi et al. (2023), coupling waves, storm surge and tides. »

Please note that advances in modelling are rapid. While our case studies do not take into account the latest modelling developments, if necessary our method can integrate the results provided by the new models.

On line 173, after equation (4), we will refer to Stockdon et al. (2006) that propose an alternative beach-slope dependent formulation.

On line 175, we propose to replace the sentence:

« This expression is used here since the objective of this work is not to improve existing deterministic methods, but to present a systemic and comprehensive method for assessing the evolution of coastal hazards. »

By:

« In the current state of the art, numerical simulations of set-up have been carried out only locally (e.g., Lange et al. (2021), van Ormondt et al. (2021)). Such retrospective simulations are

computationally expensive (e.g. to simulate accurately set-up, model grid resolution of ~10-50 m may be needed for study sites with large variations in local bathymetry and the wave field). In addition : (i) accurate and high resolution wave set-up modeling requires high resolution bathymetric data (Stephens et al., 2011), which are not available at the spatial scales of our case study; (ii) significant morphological changes are expected in nearshore areas, especially with rising sea levels, which can have a significant effect on the wave set-up at different timescales (e.g. especially for sandy beaches exposed to waves: Ruggiero et al., 2001 ; Thiébot et al., 2012 ; Brivois et al., 2012). Thus, at large spatial (e.g. global) and long temporal (e.g. 21st century) scales, simplified models such as the one used here (Vousdoukas et al., 2018) may provide a first estimate of the expected wave set-up. »

We feel as though the work of Vousdoukas et al. (2018) framework is an appropriate choice for the desired spatial and temporal scales in this study.

For the overseas areas of France, there are excellent paper that uses sophisticated modelling with thousands of cyclones to quantify hazards (e.g., [4, 5]) - they are needed to be consulted. In broader sense, much more effort must be given to harvest the existing knowledge, particularly over France, the case-study of this paper.

In principle, since we defend a systemic approach in addition to the analytical approach, our method should promote the use of all the knowledge available in a territory. **We have therefore included additional relevant references in the case studies (these references are presented in our responses to your detailed comments).** You will understand however that our first intention for the presentation of the nine case studies, is to show the form that can take the results (our second intention is to show the differences that may appear in the results obtained on the different sites).

Secondly, The organisation of the paper is odd. The method section (section 2) is very long, with a lot of reasoning (which reads like a discussion rather than a method), and always referring to things in France - the study area - which is actually presented afterwards (section 3). It appears like, although I hope my guess is wrong, that the paper was first drafted for France, and then it was re-organise to present as a globally applicable method with an application to France. As such, if the Section 3 and Section 2 are switched, the text makes more sense.

Since the primary objective of the paper is to present a method, section 2 is devoted a detailed presentation of the approach, explaining the underlying concepts (that of risk in particular) and the assessment principles (qualitative systemic approach to accompany the quantitative analytical approach, how to take into account the high uncertainties generated by climate change on the various components of the hazard).

The order and format of presentation of the data associated with the different sites is an integral part of the application of our method. Therefore, it is necessary to maintain the structure of the article "introduction - method - data of study sites and results - discussion - conclusion", even if a plan "introduction - data of study sites - method - results - discussion - conclusion" would have been possible without this constraint.

In response to your comment (and the comments of the first reviewer), we will present the method more concisely. These changes will reduce the number of references to metropolitan France (only one reference will remain (line 215)) and rebalance with references to other regions of the world (e.g. West Indies (line 222), United States (line 223), La Reunion (line 228), Polar regions (line 253)).

Finally, for a paper this ambitious, no data analysis is done, most of the figures are off-the-shelves, and most of the results are table, which are not often compact, with repeated results. I was looking for a map that summarises these coastal hazards over France, but it was disappointing to not find one.

To give all the necessary follow-up to this comment (and the previous one), we propose to replace the last two paragraphs of the introduction (line 90-99) with the following paragraphs which specify the objectives of the study and its protocol of elaboration:

« The objective of this paper is to present a comprehensive method to assess the evolution of coastal hazards at regional scales in the context of climate change. The proposed systemic method emphasizes the need to focus on the analysis and interpretation of the modelling results, by putting them into perspective with respect to the biophysical conditions (both current and forecasted).

This method was developed as the result of an empirical process, considering diverse situations. This process has the advantage of demonstrating the wide applicability of the proposed method. The case studies used to develop the method are in France and French territories, but they are located in different latitudes (equator, tropics and temperate zones) where they are exposed to different climates and are characterized by different geomorphological configurations (including continental or island). This study highlights that considering the qualitative factors describing the geomorphological context, metocean events and the marine environment in a systemic approach was necessary to assess the evolution of hazards.

To ensure that the method can be applied for operational purposes, the use of freely accessible data has been promoted. However, applications of this method should include a thorough bibliographic analyse or even additional observational or modeling studies at the chosen case study sites. It is important to emphasize here that the application of the method depends strongly on the available data, and therefore it is necessary to gather the best data for each site. Since the quantity and quality of data is not the same everywhere, the uncertainties in the results will also vary and must be addressed.

Finally, following the application of the method to the case studies, the results obtained using this systemic approach can contribute to improving predictions of the evolution of different types of coastal hazards (shoreline erosion, rapid submersion and/or permanent flooding). »

In addition, we can merge and refine some tables to present the data in a more compact format (see our responses to your detailed comments).

Regarding the representation of the evolution of hazards in France and French territories in the form of a map, this would not bring additional information compared to the text, in particular since regional hazard analyses should extend to the local scale, as indicated in Section 4.

One approach, that might be of interest for the further development of this paper, would be to do a consensus based assessment, where all the contributing factors listed in this paper are assessed based on existing literature. From there to find how consensus the results are - e.g., IPCC approach. Then, how this consensus differs from the results of the current study - which will potentially identify the research gaps in this line of study.

Extending the research by the consensus method could be interesting, provided that consensus can be reached, which is not obvious given the diversity of coastal contexts. In all cases, we cannot present in the same paper both our method developed on an empirical basis and other methodological principles developed by consensus. On this point, **we propose to include in the conclusion as a research perspective your suggestion of a consensus evaluation based on bibliographic studies on each of the determining factors.**

Note that two questions you ask in the detailed comments are fundamental for our paper:

-in line 40 : *Why ESL is not sufficient to describe the evolution of the coastal hazards?*

-in line 250-252 : *How does these sentences [relative to the functional collapse of coral reefs] fit to the current discussion of hazard ?*

We plan to respond to this in the introduction of the paper, starting at line 45 (where you correctly pointed out that a transition was missing):

« To answer this problem [hazard cannot be represented by a single parameter: the maximum water level reached during an event] in the coastal domain, it is necessary to highlight that during a metocean event, the phenomena of flooding and coastal erosion are not only determined by the maximum sea level, but also by coastal waves and currents, and overtopping and overflow discharges over flood protection structures (Formentin et al., 2018; Igigabel et al., 2022). Estimating these discharges and hydrodynamic conditions for the duration of an event requires a good understanding of the physical phenomena that generate the hazard. Retrospective analyses of events help to understand correctly the mechanisms that cause the observed flooding or erosion. For example, by simulating Total Water Levels (TWLs) along the Bight extending from North Carolina to Florida during three historical Tropical Cyclones (TCs) with similar tracks, Hsu et al. (2023) found that the magnitude and duration of the increase in TWLs and wind waves are influenced by TC intensity, translational speed and distance from the shore. In particular, the authors showed that a decrease in TC translation speed led to longer exceedance durations of TWLs, which may result in larger impacts. However, it is not possible to predict deterministically the physical characteristics of future events, nor to assess the corresponding hydrodynamic conditions. To compensate for this, probabilistic approaches have been developed. For example, using a large number of synthetic hurricanes that consider the natural variability in hurricane frequency, size, intensity and track, Krien et al. (2015) estimate the 100-year and 1000-year surge levels for the archipelago of Guadeloupe. Following the same principle, Krien et al. (2017) estimate 100-year surge levels in Martinique for the present climate or considering a potential sea level rise. These results help to determine the necessary levels of protection structures in the short and medium term. However, a single parameter (the maximum water level) is not enough to characterize the hazard and define all the crisis management measures, particularly when water levels exceed the level of protection or when protection structures fail (for example, breaches in levees or dunes). In addition, the accuracy of these estimates decreases in the long term due to: (i) high uncertainties in sea levels beyond 2050 (IPCC, 2019); (ii) the increase in the proportion of high-intensity cyclones worldwide (Masson-Delmotte et al., 2021); and (iii) environmental instability, notably because of geomorphological (e.g., subsidence, coastline retreat) and biological (e.g., degradation of coral reefs and mangroves) changes. These changes modify hydrodynamic and hydrosedimentary processes on the coast both in the long term and during individual events.

With the aim of making progress in the global assessment of coastal hazards in the long term, the guiding principle of this paper is to promote the use of the latest advances in research on changes in metocean events and water levels, while also showing the importance of studying other factors whose evolution is more predictable than storm surge and that may be equally important, namely: tidal regimes, geomorphological settings and environmental changes (particularly those modifying hydrodynamic conditions at the coast).

Although water levels are not the only parameter to consider, it is necessary to begin by clarifying the definitions of the different levels to which we will refer regularly. »

3 Line-by-Line comments

1. Abstract: Is appears that "meteocean events" is the main character of your study. Please consider giving a brief definition of what a "metecean event" is in the context of the study.

For clarity, by convention, we will use " metocean events" throughout the document to generically name storms, cyclones, and tsunamis (even if the former have no meteorological components).

2. L12: Perhaps you meant "metocean" instead of "meteocean"? In the existing literature, I can only find reference to "metocean" which refers to the combined effect of the meteorologic and oceanographic conditions. If "meteocean" (as currently written in the manuscript) was the term you wanted to introduce, please consider introducing it in this line by incorporating briefly the definition to make its meaning clear (compared to "metocean").

Idem.

3. L27: Please consider adding a few relevant references to the line "Recent research. . . ".

We will cite Cazenave and Llovel (2010), Cazenave and Le Cozannet (2013), Hamlington et al. (2020) and Fox-Kemper et al. (2021).

4. L36: What does "very likely" refers to in this context? Same as IPCC terminology?

Yes, the probability is between 90 and 100%.

5. L40: Why ESL is not sufficient to describe the evolution of the coastal hazards? Please consider brief elaboration of the explanation to come, or provide relevant reference or cases where it was found not enough (e.g., Igigabel et al. 2021 that is cited in L44).

Response provided at the end of the general comments.

6. L46: Please consider adding a connecting line to indicate for which purpose we need to "First, it is necessary to . . . ".

Response provided in the general comments.

7. L122: Does "consequence" here means the same as "impacts" as described in IPCC AR5 WG2 report?

Yes.

8. L141: "The application of the proposed method . . . " for which purpose? It appears that something is missing from this line.

OK, the text has been edited. Please see the response provided in the general comment (Table 1 and the following text).

9. L142-144: This statement is interesting and thought-provoking, please elaborate.

Response provided at the end of the general comments.

10. L184: What would be the 3-maritime facades of France? Perhaps consider adding a bit more somewhere about the coastline of France.

OK, the localisation of these facades has been improved through map showing the French territories considered in our study (Figure 2).

11. L190: Pickering et al. 2012 - The impact of future sea-level rise on the European Shelf Tides

OK, thank you for this reference.

12. L201: Is "meteo-oceanic" event is the same as metocean/meteocean event?

Yes, and **we will prefer « metocean » throughout the paper.**

13. L213-214: What kind of analysis? How about literature review?

We will replace the sentence

« First, the analysis of storm surges computed from the national REFMAR database reveals that they are controlled not only by storm tracks but also by the width of the continental shelf and the presence of shallow waters. »

By :

« **Storm surges are controlled not only by the characteristics of metocean events (e.g. for tropical cyclones (TC), the TC intensity, the distance to the TC eye, the TC heading direction and the TC translation (Hsu et al., 2023)), but also by the width of the continental shelf and the relative water depth (Kennedy et al., 2012).** »

In the next paragraph we will refer to Krien et al. (2015) and Krien et al. (2017) to support the fact that « on the islands of the West Indies, the storm surges rarely exceed 3 m ».

14. L229: "maritime facade" is mentioned again here (directly translated from french façade maritime perhaps? it does not seem to exist in English), please elaborate what it means somewhere in the text.

« Facade » is a word also used by English native speakers. **The localisation of these facades on a map will definitely help to understand the text.** Thank you.

15. L231: Please consider providing proper journal/article reference (which exists) instead of a generic website from noaa.

We will refer to Flather (2001), Rego and Li (2010) and Kennedy et al. (2012).

16. L234: Please consider adding a real example from published literature.

We will refer to Bertin et al. (2012), Krien et al. (2015) and Krien et al. (2017).

17. L247: "should" -> "expected to".

To avoid redundancy with « expected », we propose « may ».

18. L250-252: How does these sentences fit to the current discussion of hazard? Please consider rewriting/revising/deleting.

As indicated in the answers to general comments, biological changes should be taken into account in the assessement of hazard changes.

In complement, we could add in the discussion (L. 581), as indicated in Krien et al. (2017) : « Moreover, coastal ecosystems such as mangroves, coral reefs or seagrass beds may not be able to adapt to climate change (e.g., Waycott et al., 2009; Wong et al., 2014), which could have large impacts on coastal hazards (e.g., Alongi, 2008; Wong et al., 2014). »

19. L280: Why French coast was chosen to demonstrate the method?

Response provided in the general comments.

20. Figure 2: Please consider a bit more elaborate caption and add reference to the figure if it is adapted from somewhere else.

OK.

21. Figure 2: Please consider putting different colour for so called "marine facade".

OK, good idea. Thank you. **Finally, we propose to use lines of dots, dashes and crosses to represent the 3 facades, so that this representation can be readable on a black and white print.**

22. L280-300: I do not understand the objective of the paragraph regarding the GMSL projections. Neither in your equation of ESL (eq 3.) nor in the list presented in L270 there is GMSL present.

OK, you're right. In an earlier version of the paper, this text was positioned at line 144.

Here, we propose « The choice of the scenario and the time scales should take into account the existence of the high value assets at the considered coasts (coastal cities, port and industrial facilities) and the strong uncertainties about the contributions of ice caps to the rise in water levels (Bamber et al., 2019; Dayan et al., 2021). For these two reasons, we use the SSP5-8.5 scenario. »

And the rest of the paragraph will be moved to section 2 to explain the high uncertainties in sea level changes.

23. L304: Consider giving a 1-2 line summary of Vousdoukas et al. (2018) framework.

We propose to replace:

« Projections of waves and storm surges were based on hydrodynamic simulations driven by atmospheric forcing from six Coupled Model Intercomparison Project Phase 5 (CMIP5) climate models. »

By:

« The framework developed by Vousdoukas et al. (2018) is used to evaluate the contributions of each of these components, of which the baseline values are calculated in global reanalyses of waves and storm surges. Then, CMIP5 models are used to estimate future relative changes to the meteorological water levels. Lastly, changes in sea level, the astronomical tide, and meteorological water levels are combined to produce the ESL values. »

24. L305: Are these projections of waves and storm surges published already? Has there been any bias correction done to CMIP5 data?

No bias correction is needed since we are using the CMIP5 simulation results only to obtain relative changes. In addition the results have been validated in the following articles:

Vousdoukas, M.I., Mentaschi, L., Voukouvalas, E., Verlaan, M., Jevrejeva, S., Jackson L. P. & Feyen, L., 2018. Global probabilistic projections of extreme sea levels show intensification of coastal flood hazard. Nat Commun 9, 2360. https://doi.org/10.1038/s41467-018-04692-w.

Mentaschi, L., M. I. Vousdoukas, E. Voukouvalas, A. Dosio, and L. Feyen, 2017. Global changes of extreme coastal wave energy fluxes triggered by intensified teleconnection patterns, Geophys. Res. Lett., 44, 2416–2426, doi:10.1002/2016GL072488.

Vousdoukas, M. I., Mentaschi, L., Voukouvalas, E., Verlaan, M., and Feyen, L., 2017. Extreme sea levels on the rise along Europe's coasts. Earth's Future, 5, 304–323. doi:10.1002/2016EF000505.

25. L308-310: Where are these projection coming from? I do not see a reference here. Is it from CMIP 6 project?

As indicated, it is CMIP5 and not CMIP6.

26. Table 2: Please add lon,lat location of the tide gauges. Please also add another column with tidal range.

Good idea to add latitude and longitude.

Tidal ranges are presented in 3.1.2. To keep the structure of the section and avoid redundancy, we prefer not to add this information in Table 2.

			Projection of RSL rise (m)	
	Latitude	Longitude	2050	2100
Calais	50.972122801049395	1.8400588679271384	0.19	0.86
Le Havre	49.485774012966544	0.0897840202510471	0.19	0.87
Saint-Malo	48.641170797005124	-2.0313888026241402	0.19	0.87
Brest	48.368792381060274	-4.4887286031866935	0.19	0.83
La Rochelle	46.14879125637811	-1.1691588857635562	0.16	0.76
Saint-Jean-de-Luz	43.39842588942395	-1.676715829943722	0.17	0.79
Port Vendres	42.52411089711506,	3.1143835886292806	0.16	0.76
Sète	43.39330679508365	3.699492031443802	0.16	0.76
Marseille	43.29569227471328	5.352448215467127	0.17	0.78
Saint-Pierre (Saint-Pierre-et-Miquelon)	46.786272435631275	-56.16190646722868	0.19	0.83
Pointe-à-Pitre (Guadeloupe)	16.23300045952869	-61.53571250198115	0.20	0.90
Cayenne (French Guiana)	4.93572687841612	-52.340676954198194	0.20	0.90

Pointe des Galets (La Réunion)	-20.936178918145654	55.280686667086655	0.19	0.92
Papeete (French Polynesia)	-17.53479287238126	-149.58674796473545	0.20	0.91

27. L322: In the "standard classification" are there more than 3 types? Please add a reference to standard classification, like Book of Pugh and Woodworth 2014.

We will refer to Masselink and Short (1993).

28. Figure 3: The figure contains an incomplete description. The Mediterranean is missing, so is the other french islands. What is type of the data? How it was generated? Model? Altimetry? Tide gauges? Please provide further detail.

The objective of our article is not to detail as much as possible the quantitative assessment of the different components of the water level. As for the wave set-up, the goal is to provide the order of magnitude.

The map is provided by the SHOM, which produces the reference maritime and coastal geographic information in France. It aims at illustrating tidal ranges along macrotidal coastlines. That's why the information is limited to English Channel and the Atlantic. The other coasts are microtidal or mesotidal.

29. Table 3: Please consider combining Table 3 with Table 2.

To keep the structure of the section, we would prefer not to combine Table 3 with Table 2.

30. L359: Please provide the link for ReefTEMPS and DYNALIT services.

DYNALIT: https://www.dynalit.fr/ and REEFTEMPS: https://www.reeftemps.science/

31. L361: Why infragravity waves with Hs ~1m can be superimposed on this set-up? Reference?

Bertin et al. (2020) showed that infragravity waves of Hs~1.5 m were superimposed to a surge (wind + wave setup) of 0.5 to 1.0 m.

Baumann et al. (2017) showed that IG waves could reach 2 m during storm Hercules.

In Truc Vert, Ruessink (2010) measured IG waves of Hs~1.5 m during storm Johanna, he did not provide estimates of wave setup but Nicolae-Lerma et al. (2017) provided estimates of wave setup up to 0.8 m for this storm.

To keep the text short, we propose to add only the reference to Bertin et al. (2020).

32. L363: "This information" -> which information? Which geo-morphological configuration?

« This information confirms » can be replaced by « These observations confirm ».

33. Table 4-5: Are the results taken directly from Vousdoukas et al. (2018) or reanalyzed? It is not clear to me.

As indicated in lines 304, 366 and 386, the results are taken directly from the framework developped by Vousdoukas et al. (2018). The reasons for this choice are explained in the general comments and will be transcribed in the paper.

34. L380: Reference for this claim about Mediterranean? Or is it analyzed somewhere in this manuscript? It is not clear.

We will refer to Vitousek et al. (2017), since this reference is cited concerning this subject in the introduction.

35. Why Table 5 and Table 7 is separated?

The idea is to analyse separately mainland France and overseas territories. If you want, we can merge the tables and adapt the texts accordingly.

36. Same question as above for Table 4 and Table 6.

Idem.

37. L405: Repeated, not needed.

OK.

38. Table 8: Please add relevant reference to another column. Since it is a "qualitative" assessment, without reference it does not hold enough validity. Adding reference to each cases will also add values to all the past regional studies that are done over these various regions. Same goes for related text, where there appears to be no references currently (L428-446). In addition, it is not clear how these subjective labels are provided - e.g., Very high, High etc.

The diversity of situations does not really make it possible to set up a calibration and weighting system. Here our method aims to help experts to make a structured judgment on the « surge potential associated with the geomorphological configuration » based on a list of criteria. We agree that experts should also be encouraged to integrate past study results in their jugments. To this end past regional studies should indeed appear in Table 8. Here are the references we propose to cite on the different coastlines considered for our case studies.

For the three metropolitan French facades :

- **English Channel – North Sea : Le Gorgeu and Guitonneau (1954), Hequette (2010), Bardet et al. (2011), Haigh et al. (2011), Weisse et al. (2012), Idier et al. (2012), Maspataud et al. (2013), Hamdi et al. (2014), Vousdoukas et al. (2016), Latapy et al. (2017), Vousdoukas et al. (2017), Hamdi et al. (2018), and DREAL Nord Pas-de-Calais (2024)**

Bardet, L., Duluc, C.-M., Rebour, V., and L'Her, J.: Regional frequency analysis of extreme storm surges along the French coast, Nat. Hazards Earth Syst. Sci., 11, 1627–1639, https://doi.org/10.5194/nhess-11-1627-2011, 2011.

DREAL Nord Pas-de-Calais : Détermination de l'aléa de submersion marine intégrant les conséquences du changement climatique en région Nord – Pas de Calais. Phase 1: Compréhension du fonctionnement du littoral, https://www.hauts-de-france.developpement-durable.gouv.fr/IMG/pdf/50292_-_sub_npc_-_phase_1_-_version_4.pdf, last access: 08 February 2024.

Haigh I., Nicholls R. and Wells N.: Rising sea levels in the English Channel 1900 to 2100. Marit Eng 164(MA2):81–92, 2011.

Hamdi, Y., Bardet, L., Duluc, C.-M., and Rebour, V.: Extreme storm surges: a comparative study of frequency analysis approaches, Nat. Hazards Earth Syst. Sci., 14, 2053–2067, https://doi.org/10.5194/nhess-14-2053-2014, 2014.

Hamdi, Y., Garnier, E., Giloy, N., Duluc, C.-M., and Rebour, V.: Analysis of the risk associated with coastal flooding hazards: a new historical extreme storm surges dataset for Dunkirk, France, Nat. Hazards Earth Syst. Sci., 18, 3383–3402, https://doi.org/10.5194/nhess-18-3383-2018, 2018.

Hequette A.: Les risques naturels littoraux dans le Nord-Pas-de-Calais, France, VertigO, hors ser. 8, 2010.

Idier, D., Dumas, F., and Muller, H.: Tide-surge interaction in the English Channel, Nat. Hazards Earth Syst. Sci., 12, 3709–3718, https://doi.org/10.5194/nhess-12-3709-2012, 2012.

Latapy, A., Arnaud, H., Pouvreau, N., and Weber N.: Reconstruction of sea level changes in Northern France for the past 300 years and their relationship with the evolution of the coastal zone, in: Coast 2017, Bordeaux, https://doi.org/10.13140/RG.2.2.14180.07041, 2017.

Le Gorgeu, V. and Guitonneau, R. : Reconstruction de la Digue de l'Est à Dunkerque, Coast. Eng., 5, 555–586, https://icce-ojs-tamu.tdl.org/icce/index.php/icce/article/viewFile/2043/1716, 1954.

Maspataud A., Ruz M.-H. and Vanhée S.: Potential impacts of extreme storm surges on a low-lying densely populated coastline: the case of Dunkirk area, Northern France. Nat Hazards 66:1327–1343, 2013.

Vousdoukas, M., Voukouvalas, E., Annunziato, A., Giardino, A., & Feyen, L.: Projections of extreme storm surge levels along Europe. *Climate Dynamics*, 47, 3171, 3190. https://doi.org/10.1007/s00382-016-3019-5, 2016.

Weisse R., von Storch H., Niemeyer H.D. and Knaack H.: Changing North Sea storm surge climate: an increasing hazard? Ocean Coast Manag 68:58–68, 2012.

Vousdoukas, M. I., Mentaschi, L., Voukouvalas, E., Verlaan, M., & Feyen, L.: Extreme sea levels on the rise along Europe's coasts. Earth's Future, 5, 304–323. https://doi.org/10.1002/2016EF000505, 2017.

- **Bay of Biscay : Allgeyer et al. (2013), Bertin et al. (2014), Hamdi et al. (2014), Bertin et al. (2015), Hamdi et al. (2015), Bulteau et al. (2015), Vousdoukas et al. (2016) and Vousdoukas et al. (2017), Garnier et al. (2018) and Khan et al. (2023).**

Allgeyer, S., Daubord, C., Hébert, H., Loevenbruck, A., Schindelé, F., and Madariaga, R.: Could a 1755-like tsunami reach the French Atlantic coastline? constraints from twentieth century observations and numerical modeling. *Pure and Applied Geophysics*, *170*(9–10), 1415–1431, 2013.

Bertin X., Li K., Roland A., Zhang Y.J., Breilh J.-F. and Chaumillon E.: A modeling-based analysis of the flooding associated with Xynthia, central Bay of Biscay. Coast Eng 94:80–89, 2014.

Bertin, X., Li K., Roland A., and Bidlot J.-R.: The contribution of short-waves in storm surges: two case studies in the Bay of Biscay, Continental Shelf Research, 96, 1-15, doi:10.1016/j.csr.2015.01.005, 2015.

Bulteau, T., Idier, D., Lambert, J., and Garcin, M.: How historical information can improve estimation and prediction of extreme coastal water levels: application to the Xynthia event at La Rochelle (France), Nat. Hazards Earth Syst. Sci., 15, 1135–1147, https://doi.org/10.5194/nhess-15-1135-2015, 2015.

Garnier, E., Ciavola, P., Armaroli, C., Spencer, T., and Ferreira, O.: Historical analysis of storms events: case studies in France, England, Portugal and Italy, Coast. Eng., 134, 10–23, https://doi.org/10.1016/j.coastaleng.2017.06.014, 2018.

Hamdi, Y., Bardet, L., Duluc, C.-M., and Rebour, V.: Extreme storm surges: a comparative study of frequency analysis approaches, Nat. Hazards Earth Syst. Sci., 14, 2053–2067, https://doi.org/10.5194/nhess-14-2053-2014, 2014.

Hamdi, Y., Bardet, L., Duluc, C.-M., and Rebour, V.: Use of historical information in extreme-surge frequency estimation: the case of marine flooding on the La Rochelle site in France, Nat. Hazards Earth Syst. Sci., 15, 1515–1531, https://doi.org/10.5194/nhess-15-1515-2015, 2015.

Khan, M. J. U., Beld, I., Wöppelmann, G., Testut, L., Latapy, A. and Pouvreau, N.: Extension of a high temporal resolution sea level time series at Socoa (Saint-Jean-de-Luz, France) back to 1875. Earth System Science Data. 15. 5739-5753. 10.5194/essd-15-5739-2023, 2023.

Vousdoukas, M., Voukouvalas, E., Annunziato, A., Giardino, A., and Feyen, L.: Projections of extreme storm surge levels along Europe. *Climate Dynamics*, 47, 3171, 3190. https://doi.org/10.1007/s00382-016-3019-5, 2016.

Vousdoukas, M. I., Mentaschi, L., Voukouvalas, E., Verlaan, M., and Feyen, L.: Extreme sea levels on the rise along Europe’s coasts. Earth's Future, 5, 304–323. https://doi.org/10.1002/2016EF000505, 2017.

- **Mediterranean : Ullmann et al. (2007), Fita et al. (2007), Campins et al. (2011), Conte and Lionello (2013), Cavicchia et al. (2014), Androulidakis et al. (2015), Vousdoukas et al. (2016), Romero and Emanuel (2016), Vousdoukas et al. (2017), Muis et al. (2020), Elkut et al. (2021), Patlakas et al. (2021), and Toomey et al. (2022).**

Androulidakis, Y. S., Kombiadou, K. D., Makris, C. V., Baltikas, V. N., and Krestenitis, Y. N.: Storm surges in the Mediterranean sea: Variability and trends under future climatic conditions. *Dynamics of Atmospheres and Oceans*, 71, 56–82. https://doi.org/10.1016/j.dynatmoce.2015.06.001, 2015.

Campins, J., Genovés, A., Picornell, M. A., and Jansà, A.: Climatology of Mediterranean cyclones using the era-40 dataset. International Journal of Climatology, 31(11), 1596–1614. https://doi.org/10.1002/joc.2183, 2011.

Conte, D., and Lionello, P.: Characteristics of large positive and negative surges in the Mediterranean sea and their attenuation in future climate scenarios. Global and Planetary Change, 111, 159–173. https://doi.org/10.1016/j.gloplacha.2013.09.006, 2013.

Cavicchia, L., Von Storch, H., and Gualdi, S.: A long-term climatology of medicanes. Climate Dynamics, 43, 1183, 1195. https://doi.org/10.1007/s00382-013-1893-7, 2014.

Elkut, A. E., Taha, M. T., Abu Zed, A. B. E., Eid, F. M., and Abdallah, A. M.: Wind-wave hindcast using modified ECMWF era-interim wind field in the Mediterranean sea. Estuarine, Coastal and Shelf Science, 252, 107267. https://doi.org/10.1016/j.ecss.2021.107267, 2021.

Fita, L., Romero, R., Luque, A., Emanuel, K., and Ramis, C.: Analysis of the environments of seven Mediterranean tropical-like storms using an axisymmetric, nonhydrostatic, cloud resolving model. Natural Hazards and Earth System Sciences, 7, 41, 56. https://doi.org/10.5194/nhess-7-41-2007, 2007.

Patlakas, P., Stathopoulos, C., Tsalis, C., and Kallos, G.: Wind and wave extremes associated with tropical-like cyclones in the Mediterranean basin. *International Journal of Climatology*, 41(S1), E1623–E1644. https://doi.org/10.1002/joc.6795, 2021.

Romero, R., and Emanuel, K.: Climate change and hurricane-like extratropical cyclones: Projections for north Atlantic polar lows and medicanes based on cmip5 models. *Journal of Climate*, 30(1), 279–299. https://doi.org/10.1175/JCLI-D-16-0255.1, 2016.

Toomey, T., Amores, A., Marcos, M., Orfila, A., & Romero, R.: Coastal hazards of tropical-like cyclones over the Mediterranean Sea. Journal of Geophysical Research: Oceans, 127, e2021JC017964. https://doi.org/10.1029/2021JC017964, 2022.

Ullmann A., Pirazzoli P. A. and Tomasin A.: Sea surges in Camargue: Trends over the 20th century. Cont Shelf Res 27:922–934, 2007.

Vousdoukas, M., Voukouvalas, E., Annunziato, A., Giardino, A., and Feyen, L.: Projections of extreme storm surge levels along Europe. *Climate Dynamics*, 47, 3171, 3190. https://doi.org/10.1007/s00382-016-3019-5, 2016.

Vousdoukas, M. I., Mentaschi, L., Voukouvalas, E., Verlaan, M., and Feyen, L.: Extreme sea levels on the rise along Europe’s coasts. Earth's Future, 5, 304–323. https://doi.org/10.1002/2016EF000505, 2017.

For overseas coastlines :

- **Saint-Pierre-et-Miquelon : Catto and Batterson (2011), Han et al. (2012) and Masson (2014)**

Catto N. R., Batterson M. J.: Igor and other hurricane and extratropical transitions in Newfoundland: geomorphologic and landscape impacts. Geohydro 2011 2011:1–4, 2011.

Han, G., Ma, Z., Chen, D., deYoung B. and Chen N.: Observing storm surges from space: Hurricane Igor off Newfoundland. Sci Rep 2, 1010. https://doi.org/10.1038/srep01010, 2012.

Masson, A.: The extratropical transition of Hurricane Igor and the impacts on Newfoundland. Nat Hazards 72, 617–632. https://doi.org/10.1007/s11069-013-1027-x, 2014.

- **Guadeloupe : Pagney (1991), Zahibo et al. (2007), Dorville and Zahibo (2010), Lin and Chavas (2012), Krien et al. (2015)**

Dorville, J.-F. M. and Zahibo, N.: Hurricane Omar Waves Impact on the West Coast of the Guadeloupe Island, October 2008, Open Oceanography Journal, 4, 83–91, 2010.

Krien, Y., Dudon, B., Roger, J., and Zahibo, N.: Probabilistic hurricane-induced storm surge hazard assessment in Guadeloupe, Lesser Antilles, Nat. Hazards Earth Syst. Sci., 15, 1711–1720, https://doi.org/10.5194/nhess-15-1711-2015, 2015.

Lin, N. and Chavas, D.: On hurricane parametric wind and applications in storm surge modeling, J. Geophys. Res., 117, D09120, doi:10.1029/2011JD017126, 2012.

Pagney, F.: Genese et dynamique de l'ouragan Hugo sur la Guadeloupe, Ann. Geogr., 100, 152–165, 1991.

Zahibo, N., Pelinovsky, E., Talipova, T., Rabinovich, A., Kurkin, A., and Nikolkina, I.: Statistical analysis of cyclone hazard for Guadeloupe, Lesser Antilles, Atmos. Res., 84, 13–29, 2007.

- **French Guiana : Gratiot et al. (2007), Chevalier et al. (2008), Thiéblemont et al. (2023)**

Chevalier C., Froidefond J.-M. and Devenon J.-L.: Numerical analysis of the combined action of littoral current, tide and waves on the suspended mud transport and on turbid plumes around French Guiana mudbanks, Continental Shelf Research, Volume 28, Issues 4–5, Pages 545-560, ISSN 0278-4343, https://doi.org/10.1016/j.csr.2007.09.011, 2008.

Gratiot N., Gardel A. and Anthony E. J.: Trade-wind waves and mud dynamics on the French Guiana coast, South America: Input from ERA-40 wave data and field investigations, Marine Geology, Volume 236, Issues 1–2, 2007, Pages 15-26, ISSN 0025-3227, https://doi.org/10.1016/j.margeo.2006.09.013, 2007.

Thiéblemont, R., Le Cozannet, G., D'Anna, M. et al.: Chronic flooding events due to sea-level rise in French Guiana. Sci Rep 13, 21695. https://doi.org/10.1038/s41598-023-48807-w, 2023.

- **La Réunion : Lecacheux et al. (2012), Sahal and Morin (2012), Quentel et al. (2013), Allgeyer et al. (2017)**

Allgeyer, S., Quentel, É., Hébert, H. et al.: Tsunami Hazard in La Réunion Island (SW Indian Ocean): Scenario-Based Numerical Modelling on Vulnerable Coastal Sites. Pure Appl. Geophys. 174, 3123–3145. https://doi.org/10.1007/s00024-017-1632-9, 2017.

Quentel, E., Loevenbruck, A., Hébert, H., and Allgeyer, S.: Tsunami hazard in La Réunion island from numerical modeling of historical events, Nat. Hazards Earth Syst. Sci. Discuss., 1, 1823–1855, https://doi.org/10.5194/nhessd-1-1823-2013, 2013.

Lecacheux, S., Pedreros, R., Le Cozannet, G., Thiebot, J., De La Torre, Y. and Bulteau, T.: A method to characterize the different extreme waves for islands exposed to various wave regimes: a case study devoted to Reunion Island, Nat. Hazards and Earth Syst. Sci., 12(7), 2425-2437, 2012.

Sahal, A. and Morin, J.: Effects of the October 25, 2010, Mentawai tsunami in La Réunion Island (France): observations and crisis management. Nat Hazards 62, 1125–1136. https://doi.org/10.1007/s11069-012-0136-2, 2012.

- **French Polynesia : Pirazzoli and Montaggioni (1988), Aubanel et al. (1999), Larrue and Chiron (2010), Webb and Kench (2010), Becker et al. (2012), Yates et al. (2013), Le Cozannet et al. (2013), Martinez-Asensio et al. (2019) and Barriot et al. (2023)**

Aubanel, A., Marquet, N., Colombani, J.M., and Salvat, B.: Modifications of the shore line in the Society islands (French Polynesia). Ocean and Coastal Management, 42, 419–438, 1999.

Barriot, J-P., Zhang, F., Ducarme, B., Wöppelmann, G., André, G. & Gabillon, A.: A database for sea-level monitoring in French Polynesia. *Geoscience Data Journal*, 10, 368–384. Available from: https://doi.org/10.1002/gdj3.172, 2023.

Becker, M., Meyssignac, B., Letetrel, C., Llovel, W., Cazenave, A., and Delcroix, T.: Sea level variations at tropical Pacific islands since 1950. Global and Planetary Change, 80–81, 85–98. doi: 10.1016/j.gloplacha.2011.09.004, 2012.

Larrue S. and Chiron T.: « Les îles de Polynésie française face à l'aléa cyclonique », VertigO, Volume 10 Numéro 3 URL : http://journals.openedition.org/vertigo/10558 ; DOI : https://doi.org/10.4000/vertigo.10558, 2010.

Le Cozannet, G., Garcin, M., Petitjean, L., Cazenave, A., Becker, M., Meyssignac, B., Walker, P., Devilliers, C., Le Brun, O., Lecacheux, S., Baills, A., Bulteau, T. Yates, M., and Wöppelmann, G.: Exploring the relation between sea level rise and shoreline erosion using sea level reconstructions: an example in French Polynesia. Journal of Coastal Research 65(sp2), 2137-2142. https://doi.org/10.2112/SI65-361.1, 2013.

Martinez-Asensio, A., Wöppelmann, G., Ballu, V., Becker, M., Testut, L., Magnan, A.K. et al.: Relative Sea-level rise and the influence of vertical land motion at tropical Pacific Islands. *Global and Planetary Change*, 176, 132–143. https://www.sciencedirect.com/science/article/pii/S0921818118306751, 2019.

Pirazzoli, P. A. and Montaggioni, L. F.: Holocene sea level changes in French Polynesia, Paleogeography, paleoclimatology paleoecology, 68 (2-4), 153-175, 1988.

Webb, A.P. and Kench, P.S.: The dynamic response of reef islands to sea level rise: Evidence from multi-decadal analysis of island change in the Central Pacific. Global and Planetary Change, 72, 234–246, 2010.

Yates M., Le Cozannet G., Garcin, M., Salaï, E. and Walker, P.: Multi-decadal shoreline change on Manihi and Manuae, French Polynesia. Journal of Coastal Research, 2013.

39. Section 3.2.3: How these factors are taken into account? Any subjective or objective comparison?

In the proposed method, we suggest checking that such factors (changes in the swell climate related to the decrease in seasonal sea ice extent, and coral reefs degradation) are not likely to significantly change the hydraulic conditions in the long term. It is difficult to make comparisons with the influence of other factors (e.g. geomorphological configuration, reference metocean event, tidal range, frequency and intensity of extreme climate events).

40. Why Table 9 and 10 are separated? It seems the tide gauge stations are now aggregated. Why it is so?

The goal is to avoid too much information in the same table.

The aggregated data provide regional conclusions. If conclusions are sought at a more local scale, as explained in Section 4, it is necessary to extend the investigations.

41. It is not very clear how in Table 9 and 10, the "important" and "most important" labels are applied. Are they coming from assessment of available literature?

Indeed, it would be better to qualify the factors by the terms "slightly detrimental ", " detrimental " and "highly detrimental".

In this method, each factor should not be considered independently. On the contrary, the joint effects of the different factors should be assessed to understand the dynamics of the system. However, the diversity of the different observed contexts prevents proposing a quantitative calibration and weighting system. This is the main reason why this method is called « systemic », in reference to the study of a system (the coast). However, this method should not be called « systematic ». Even though the analysis framework incorporates multiple factors, the expert in charge of the study of a particular site should consider the qualitative and quantitative factors together. In summary, this method aims to help experts to make a structured evaluation.

We propose to insert this explanation at the end of the presentation of the method (line 279).

42. L614: I believe GMSL is not taken into account here as global sense, rather it was included into RSL. Is it?

You're right.

43. L665: How the impact of sea level changes on human communities are evaluated in paper? I do not see it. I do not also see where the "anthropogenic structures" are considered, and how it was considered.

Anthropogenic structures are mentioned explicitly in section 4.1 for estuaries and polar regions. We can also mention them for sandy coasts.

Additional references

Alongi, D. M.: Mangrove forests: resilience, protection from tsunamis, and response to global climate change, Estuar. Coast. Shelf S., 76, 1–13, 2008.

Arns A., Wahl T., Dangendorf S., Jensen J.: The impact of sea level rise on storm surge water levels in the northern part of the German Bight. Coast Eng 96:118–131. https://doi.org/10.1016/j.coastaleng.2014.12.002, 2015

Arns, A., Wahl, T., Wolff, C., Vafeidis A., Haigh I., Woodworth P., Niehüser S. and Jensen J.: Non-linear interaction modulates global extreme sea levels, coastal flood exposure, and impacts. Nat Commun 11, 1918. https://doi.org/10.1038/s41467-020-15752-5, 2020.

Aucan J., Hoeke R. K., Storlazzi C. D., Stopa J., Wandres M., and Lowe R.: Waves do not contribute to global sea-level rise. Nature Climate Change, 9(1):2–2, December 2018.

Bertin X., Martins K., de Bakker A., Chataigner T., Guérin T., et al.: Energy Transfers and Reflection of Infragravity Waves at a Dissipative Beach Under Storm Waves. Journal of Geophysical Research. Oceans, 125 (5), pp.e2019JC015714, 2020.

Brivois O., Idier D., Thiébot J., Castelle B., Le Cozannet G., Calvete D.: On the use of linear stability model to characterize the morphological behaviour of a double bar system. Application to Truc Vert beach (France). CR Geosci 344:277–287. https ://doi.org/10.1016/j.crte.2012.02.004, 2012.

Cazenave, A. and Llovel, W.: Contemporary sea level rise. Ann. Rev. Marine Sci. 2, 145‑173, 2010.

Cazenave, A. and Le Cozannet, G.: Sea level rise and its coastal impacts, Earth's Future, 2, 15–34. doi:10.1002/2013EF000188, 2013.

Flather, R.A.: Storm surges. In: Steele, J., Thorpe, S., Turekian, K. (Eds.), En- cyclopedia of Ocean Sciences. Academic, San Diego, California, pp.2882–2892, 2001.

Formentin, S.M. and Zanuttigh, B.: A new method to estimate the overtopping and overflow discharge at over-washed and breached dikes. Coast. Eng., 140, 240–256. https://doi.org/10.1016/j.coastaleng.2018.08.002, 2018.

Fox-Kemper, B. et al., 2021. Ocean, cryosphere and sea level change. In IPCC AR6 (eds Fox-Kemper, B. et al.) 1211–1362. Cambridge University Press.

Gomes da Silva, P., Coco, G., Garnier, R., Klein, A.H.: On the prediction of runup, setup and swash on beaches. Earth-Sci. Rev. 204, 103148. http://dx.doi.org/10.1016/j.earscirev.2020, 2020.

Hamlington, B. D., Gardner, A. S., Ivins, E., Lenaerts, J. T. M., Reager, J. T., Trossman, D. S., et al.: Understanding of contemporary regional sea-level change and the implications for the future. Reviews of Geophysics, 58, e2019RG000672. https://doi.org/10.1029/2019RG000672, 2020.

Hsu, C.-E., Serafin, K. A., Yu, X., Hegermiller, C. A., Warner, J. C., and Olabarrieta, M.: Total water levels along the South Atlantic Bight during three along-shelf propagating tropical cyclones: relative contributions of storm surge and wave runup, Nat. Hazards Earth Syst. Sci., 23, 3895–3912, https://doi.org/10.5194/nhess-23-3895-2023, 2023.

Idier D., Bertin X., Thompson P., and Pickering M. D.: Interactions between mean sea level, tide, surge, waves and flooding: Mechanisms and contributions to sea level variations at the coast. Surveys in Geophysics, 40(6):1603–1630, 2019.

Igigabel, M., Nédélec, Y., Bérenger, N., Flouest, N., Bernard, A., Chassé, P., et al.: Guidelines for Analysing Coastal Flood Protection Systems After a Submersion. Water 14, 15. doi:10.3390/w14010015, 2022.

IPCC: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.- O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer (eds.)]. Available online : https://www.ipcc.ch/srocc/ (accessed on 12 January 2024), 2019.

Kennedy, A.B., Westerink, J.J., Smith, J.M., Hope, M.E., Hartman, M., Taflanidis, A.A., Tanaka, S., Westerink, H., Cheung, K.F., Smith, T., Hamann, M., Minamide, M., Ota, A., Dawson, C.: Tropical cyclone inundation potential on the Hawaiian Islands of Oahuand Kauai. Ocean Model. 52–53, 54–68. http://dx.doi.org/ 10.1016/j.ocemod.2012.04.009, 2012.

Krien, Y., Dudon, B., Roger, J., and Zahibo, N.: Probabilistic hurricane-induced storm surge hazard assessment in Guadeloupe, Lesser Antilles, Nat. Hazards Earth Syst. Sci., 15, 1711–1720, https://doi.org/10.5194/nhess-15-1711-2015, 2015.

Krien, Y., Dudon, B., Roger, J., Arnaud, G., and Zahibo, N.: Assessing storm surge hazard and impact of sea level rise in the Lesser Antilles case study of Martinique, Nat. Hazards Earth Syst. Sci., 17, 1559–1571, https://doi.org/10.5194/nhess-17-1559-2017, 2017.

Lange, A.M.Z., Fiedler, J.W., Becker, J.M., Merrifield, M.A., Guza, R.T.: Estimating runup with limited bathymetry. Coast. Eng., 172, 104055, 2021.

Masselink, G. and Short, A. D.: "The effect of tidal range on beach morphodynamics and morphology: a conceptual beach model". Journal of Coastal Research. 9 (3): 785–800. ISSN 0749-0208, 1993.

Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S. L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M. I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J. B. R., Maycock, T. K., Waterfield, T., Yelekçi, O., Yu, R., and Zhou, B.: Climate Change 2021: The Physical Science Basis, Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_TS.pdf, 2021.

Mentaschi L, Vousdoukas MI, García-Sánchez G, Fernández-Montblanc T, Roland A, Voukouvalas E, Federico I, Abdolali A, Zhang YJ and Feyen L: A global unstructured, coupled, high-resolution hindcast of waves and storm surge. Front. Mar. Sci. 10:1233679. doi: 10.3389/fmars.2023.1233679, 2023

Muis, S., Apecechea, M. I., Dullaart, J., de Lima Rego, J., Madsen, K. S., Su, J., et al.: A high-resolution global dataset of extreme sea levels, tides, and storm surges, including future projections. Frontiers in Marine Science, 7, 263. https://doi.org/10.3389/fmars.2020.00263, 2020.

Pickering M.D., Wells N.C., Horsburgh K.J., Green J.A.M.: The impact of future sea-level rise on the European Shelf tides. Continental Shelf Research, Volume 35, 2012, Pages 1-15, ISSN 0278-4343, https://doi.org/10.1016/j.csr.2011.11.011, 2012.

Rego, J.L., LI, C.: Nonlinear terms in storm surge predictions: effect of tide and shelf geometry with case study from Hurricane Rita. J. Geophys. Res. 115, C06020, 2010.

Ruggiero, P., Komar, P.D., McDougal, W.G., Marra, J.J., Beach, R.A.: Wave runup, extreme water levels and erosion properties backing beaches. J. Coast. Res., 17, 407–419, 2001.

Stephens, S.A., Coco, G., Bryan, K.R.: Numerical simulations of wave setup over barred beach profiles: Implications for predictability. J. Waterw. Port Coast. Ocean Eng. 137 (4), 175–181. http://dx.doi.org/10.1061/(ASCE)WW.1943-5460.0000076, 2011.

Stockdon, H.F., Holman, R.A., Howd, P.A., Sallenger, A.H.: Empirical parameterization of setup, swash, and runup. Coast. Eng. 53, 573-588. https://doi.org/10.1016/j.coastaleng.2005.12.005, 2006.

Thiébot J., Idier D., Garnier R., Falquès A., Ruessink G.: The influence of wave direction on the morphological response of a double sandbar system. Cont Shelf Res 32:71–85. https ://doi.org/10.1016/j.csr.2011.10.014, 2012.

van Ormondt, M., Roelvink D., and van Dongeren A.: "A Model-Derived Empirical Formulation for Wave Run-Up on Naturally Sloping Beaches" Journal of Marine Science and Engineering 9, no. 11: 1185. https://doi.org/10.3390/jmse9111185, 2021.

Vitousek S., Barnard P. L., Fletcher C. H., Frazer N., Erikson L., and Storlazzi C. D.: Doubling of coastal flooding frequency within decades due to sea-level rise. Scientific Reports, 7(1), 2017.

Waycott, M., Duarte, C. M., Carruthers, T. J. B., Orth, R. J., Dennison, W. C., Olyarnik, S., Calladine, A., Fourqurean, J. W., Heck, K. L., Hughes, A. R., Kendrick, G. A., Kenworthy, W. J., Short, F. T., and Williams, S. L.: Accelerating loss of seagrasses across the globe threatens coastal ecosystems, P. Natl. Acad. Sci. USA, 106, 12377–12381, 2009.

Wong, P. P., Losada, I. J., Gattuso, J.-P., Hinkel, J., Khattabi, A., K. L. McInnes, Saito, Y., and Sallenger, A.: Coastal systems and low-lying areas, in: Climate Change 2014: Impacts, Adaptation, and

Vulnerability, Part A: Global and Sectoral Aspects, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, edited by: Field, C. B., Barros, V. R., Dokken, D. J., Mach, K. J., Mastrandrea, M. D., Bilir, T. E., Chatterjee, M., Ebi, K. L., Estrada, Y. O., Genova, R. C., Girma, B., Kissel, E. S., Levy, A. N., MacCracken, S., Mastrandrea, P. R., and White, L. L., Cambridge University Press, Cambridge, UK and New York, NY, USA, 361–409, 2014.

References cited in this document that will not be included in the paper

Baumann J., Chaumillon E., Bertin X., Schneider J.-L., Guillot B., Schmutz M. : Importance of infragravity waves for the generation of washover deposits, Marine Geology, Volume 391, Pages 20-35, ISSN 0025-3227, https://doi.org/10.1016/j.margeo.2017.07.013, 2017.

Nicolae-Lerma A., Pedreros R., Robinet A., Sénéchal N.: Simulating wave setup and runup during storm conditions on a complex barred beach, Coastal Engineering, Volume 123, Pages 29-41, ISSN 0378-3839, https://doi.org/10.1016/j.coastaleng.2017.01.011, 2017.

Ruessink, B. G.: Observations of turbulence within a natural surf zone. Journal of Physical Oceanography 40, 2696–2712, 2010.