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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Damage functions for climate-related hazards: unification and uncertainty analysis" *by* B. F. Prahl et al.

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We would like to thank the anonymous reviewer for his helpful and well-expressed criticism of our manuscript. We will take up the individual points and revise the manuscript thoroughly. Our specific remarks to the reviewer's comments are marked in blue, throughout.

The submitted manuscript by Prahl et al. aims at a universal formalism for using damage function to study natural hazards and their impacts. They approach damage functions from a micro-scale (single item) and a macro-scale (granular portfolio of homogeneous and independent items) approach in their attempt to develop a unification, or

better crossover, that could support a comprehensive damage assessment at an intermediate level of complexity. A large portion of the manuscript discusses uncertainties and reviews limitations arising from uncertainties at both a microscale and macroscale level.

I am puzzled by this confusing manuscript and this referee does not claim that he understood the line of argumentation or how the 37 pages of manuscript elucidate the study's aims. Instead he ended up jumping back and forth between the draft's main part, figures, appendix, and supplements in the hope to find a convincing discussion of what he thought was promised in the abstract. This referee is also somewhat familiar with other excellent work authored by the same scientists. He is therefore particularly wondering what happened to the logical order and depth of argumentation in this draft? In its present condition, it is difficult for this referee to judge what "new concepts, ideas, methods, or data" are covered. The authors certainly succeed in "considering relevant related work" and they include "appropriate references". Their "clarity of concepts and discussion", however, needs to be significantly improved. The figures have a very high quality and the choice of colours is excellent, but they should be placed at the appropriate positions in the text and be better discussed. I understand that this is likely not the authors' fault, but instead due to the "draft style" forced upon them by the publisher. Nevertheless, given the confusing arrangement of main body and appendix it adds to the difficulties this referee has with identifying and understanding the main message conveyed.

We feel deeply concerned about the apparent confusion that has been caused by the structure of our manuscript. We will reconsider and simplify the structure of the manuscript and clarify our line of argument.

Suggestions for a revision: 1. General Structure I find the manuscript does not need an appendix. The authors should instead aim for weaving its present content into the main part. It seems odd that the appendix A and B are currently much stronger and easier to

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read than the actual argumentation in the manuscript's body. That being said appendix C is worth expanding. In particular an actual discussion or conclusion seems to be missing. I think C could be merged with the discussion of uncertainties in section 3 of the main part while adding a better discussion of results. The "Lisbon case study", for example, reads more like a recipe on how the authors approached the problem than an actual study with some conclusion. Where is the result? What did the authors learn? How did their approach improve our understanding or support a certain hypothesis that other researchers had before?

We do agree with the reviewer that the structure of the manuscript should be revised considerably. It appears that the separation into main text and appendices have caused some unintended confusion. The revised manuscript will see the integration of appendices A & B into the main text. Regarding Appendix C, we do understand the reviewer's interest into drawing conclusions from the Lisbon case study. However, the prime intention of the case study parametrisation is to provide a basis for the sensitivity analysis, together with a more general discussion of uncertainty. We hence propose to keep and improve Appendix C, while making the additional changes the reviewer has requested.

2. Rewrite Abstract and Deliver on Your Sales Pitch It seems odd that both title and abstract point towards a "unification" and "universal approach" that has common grounds in storm damage, coastal-flood, and heat mortality, while the later focus seems to be mostly on flooding. Can the message of universality be clarified or extended? Or is unification meant to be the cross over between micro- and macro scale?

The focus of the paper is to provide a general view on a type of damage function that was found in the fields of storm and flood damage assessment. The approaches differ in their setup: one being statistical top-down, the other being synthetic bottom up. We hence elaborate on the unified model, which we extend to incorporate uncertainty.
Since quite a few comments relate to this aspect, we will make this more clear in

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the revised manuscript and carefully check the use of attributes such as ‘universal’ or ‘unification’.

While it appears that the focus of the remainder of the work is on flood damage, the conclusions drawn from the sensitivity analysis are of a general nature. We chose the Lisbon case to provide an easy to follow exemplary parametrisation of the damage function, which could then form the basis for the sensitivity analysis. As such, the focus is not on the particular case study but rather on the general conclusions for the damage function.

3. What is the intention of the paper? Is it a review? Is there a novel contribution to the field? Why did the authors spend their valuable time preparing this manuscript? What was their motivation? The authors list many valid thoughts and items that are "unknown", "not well understood", or "remain elusive" and they name several aspects that, for instance, "go beyond our envisaged intermediate level"– envisioned?– but they seem not to attempt to fill this present gap in our understanding. For this referee– who is tasked by the editor with judging the manuscript’s novelty– it is difficult to decide what part of the manuscript is a review and what is a new contribution by the authors. Can this be made clearer? For instance, on page 9 / page 10 we hear a lot about what the authors do "for the work at hand", but on page 10, i.e. 1/4th into the paper, I have indeed still problems to identify what this "work at hand" actually comprises.

We see our contributions as follows:
In our work we notice how mathematical functions are commonly used to describe different hazards. We believe that this commonality should be highlighted and explored. The first half of our manuscript is hence devoted to a general description of the damage functions and its applications from a statistical top-down and synthetic bottom-up perspective. We expand the mathematical description by including uncertainty into the framework. This contribution will be emphasised by integrating the appendix into the main body of the manuscript, as the reviewer suggested elsewhere. We also

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propose using the damage function in a heat-related mortality context. We complete the characterisation of the damage function by discussing the role of uncertainties. Here, for the first time, we analyse the role of uncertainty at different flood levels and at different scales (for the individual structures as well as for the portfolio).
We will rewrite the manuscript carefully to make clear our novel contributions to the field.

Page 6: "From first principles, [..] Without loss of generality [...] This assumption will be relaxed [...]" This paragraph might facilitate a feeling of over-simplification in the reader's mind. Considering the derivations of the appendix, however, this is far from the authors' intention.

As the reviewer suggested, we will merge the appendix with the main body in the revised manuscript. The revised paragraph will hence be more comprehensive.

Page 7: Equations All properties are explained in the text with the exception of the function g(x-nlambda). g, however, is only defined later in the appendix. Merging main body and appendix would resolve this issue.

The description of g must have been lost during preparation of the manuscript. We fully agree with the reviewer on this point.

Page 9: Could examples of "conceptual, mathematical, and computational uncertainty" be added here?

We will clarify and elaborate our discussion of uncertainties in the revised manuscript.

Page 10: "Precise understanding of the data uncertainty not only is key for the application of the damage function but is also a necessary prerequisite both for calibration and

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validation." I fully agree with the authors and therefore it is important to actually define data uncertainty. The following paragraph on data uncertainties is, however, confusing. Could an example be used to illustrate each step in the "causal chain" and, more importantly, "local variation or random fluctuation within the considered portfolio" or "external modelling". I read this paragraph multiple times and while it is grammatically correct, I still have difficulties to grasp what it actually says.

As stated before, we will clarify and elaborate our discussion of uncertainties in the revised manuscript.

Page 12: Is this actually Monte Carlo simulation? It sounds more like bootstrapping or leave-N-out cross validation. What is the stochastic component other that randomly drawing from the data? Maybe a stochastic building-portfolio distribution model was fitted and then used for a Monte Carlo simulation?

It appears that this paragraph is too compact to convey the methods applied. In fact, the sensitivity analysis is based on a Monte Carlo approach, where random values are generated from the probability distributions defined for each variable. We then go one step further and re-sample this data. The second step (i.e. the resampling) is employed to bootstrap the confidence intervals. We will clearly describe both methods in the revised manuscript.

Conclusions: "A unified damage function was developed on common grounds in the assessment of flood and storm hazards." This is the second time that I read this– the first being in the abstract– but I seem to have missed where you actually developed this unified damage function? Where is it?

We apologise for maybe being to assertive in this statement. We will reconsider the wording of both the abstract and the conclusion. In the following we have briefly summarised how we see our contribution on this matter:

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We have identified and referenced the use of similar damage functions for storm and flood damage and give a general description of this damage function. This, as a matter of fact, constitutes a unification. We extended the original damage function by incorporating uncertainty of input variables. Additionally, we proposed an extension to heat -related mortality. We conclude that the shown damage function can be employed to unify the damage assessment of the discussed hazards, and potentially more.

Referee's summary: I think the manuscript has strong potential, but it requires a significant rewrite that should not be done lightly. I enjoy an easy to read content, but the style of reporting in this manuscript feels a little too informal and imprecise for this referee's taste. This might be subjective as I cannot really pinpoint specific sentences, but only describe an overall impression that arises from reading through the paper. Maybe the authors could try to use more precise and focussed formulations for their resubmission? Maybe reordering the manuscript to a more logical and causal line of argument is all that is really needed to avoid this "feeling of confusion".

If the authors carefully rewrote the complete article using better formulations and adding more substance to the discussion that puts their contribution into context, it would become acceptable for publication. In its current condition, however, this referee has true difficulties to speak of only "minor" revisions.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 6845, 2015.