

## ***Interactive comment on “Beyond the stage-damage function: Estimating the economic damage on residential buildings from storm surges” by Lea Skraep Svenningsen et al.***

### **Anonymous Referee #2**

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#### General comments:

This study uses a dataset of damage costs from building-level insurance claims to build a multivariate cost model for a storm surge event which occurred in Denmark, and finds that adding variables from a variety of sources (emergency response data, building/household data, past flood experience) improves the model's explanatory power over a simple depth-damage approach.

The subject matter is interesting, and the use of a novel set of explanatory variables with insurance data from a storm surge event merits this manuscript's inclusion in the published literature on this topic. However, I find the manuscript to be confusing in

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sections from a structural and content perspective. A high-level comment is that depth-damage models must use a “relative” damage degree to be valid (damage relative to total value). Including “building area”, “building size”, “building type”, “quality of heating/cooling system” or some other proxy for “total value” will always improve such a damage model! This is a flaw with the manuscript: the “simplest” model should use both inundation and floor area as explanatory variables if “total insured value” (TIV) or “replacement cost value” (RCV) or some other value cannot be used to make damage a “relative” variable. In this sense, “Model 1” should use both “depth” and “size”, or an equivalent model should be added using both “depth” and “value”. As mentioned before, all “damage costs” would ideally be normalized by “insured value” or “replacement cost”. This is the biggest flaw in the study and should be addressed before acceptance.

Overall, the paper could be improved by (a) shortening the literature review, (b) clarifying some of the methods, and (c) separating results from the discussion to create a clearer and more distilled message. The readability can be improved substantially with relatively minor edits to the structure and content.

#### Specific comments:

Section 1 (the introduction) is too long and the literature review should be edited to improve the flow of the paper and properly introduce the subject without too much repetition. The paragraph from lines 37 – 48 would be more effective if it were moved towards the end of the introduction and combined with other sentences describing your study. This is not essential, but papers are usually most readable when the “motivation” and structure of the paper come at the end of the introduction, after existing studies have been discussed. The paragraph from lines 49 to 60 is vague in its discussion of the existing literature (see detailed comments below) and should more explicitly mention the specific contributions from the papers that are cited. In lines 61-64, you essentially repeat the point made from lines 49-60.

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Section 2.1 (data) in the Materials and methods section can also be shortened. In Section 2.1.2, it is not clear to me how the simulation approach works, or which method was used for the model development in the paper. Do you run both a bathtub model which uses the “nearest gage”? How does the “nearest gage” depth approach differ from the static 2d model? This section should be edited for clarity and simplified (it sounds like lines 119-123 contain the full approach). Any literature comparing “bathtub” or “static” surge models with hydrodynamic models for modeling storm surge events would be helpful here as well to support the approach.

Section 3, OLS regression results, is too long and dense, and overinterpretation of the results gets in the way of a good discussion. I think this would be better split into a “regression results” and then “discussion” section rather than mixing results with discussion/interpretation. The section from line ~200 to line 265 is too long and is confusing. It would be better to shorten this section substantially; Table 2 is sufficient to get the main message across. For some of the variables into the model (e.g. building characteristics), there is a nice explanation. For others (e.g. share of retired persons, expenditure on medical consultations) the interpretation of the results is confusing, and these variables may be interrelated.

Technical Corrections:

Line 24 – Just an opinion: “a storm surge” sounds unnatural. It would be better to use “a storm surge event” or some such phrasing. In line 79 “storm surge-induced coastal flooding” is used which also seems like a good phrase to use.

Line 33 – I would say “.. using surveys of affected communities”. “Survey methods” is vague.

Line 35-36 – This sentence is a little confusing – the comma is not used correctly here as “insured damage costs being of interest to insurance companies” is not a separate (parenthetical) statement.

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Line 41 – I would say “many” uncertainties instead of “a lot of”.

Line 50 – “while at the same time highlighting the need for proper data” – I think you can cut this phrase, unless there is a more specific point you’d like to make.

Line 52 – “improve the performance when transferred to other settings both temporally and spatially.” This is again a vague phrasing – I’m not sure what is meant here, and likewise Lines 53-54 “However, having used several damage-function models drawn from the literature, they also emphasize that the overall structure of the model is a controlling factor in its performance.” This is too general.

Line 89 – “levels” should probably be “spatial level”, or maybe “spatial scale” (whichever you use, keep it consistent with the words used in Table 1)

Table 1 – what is “Tokes Data (?)”. Also, why use three “distance to waterbody” measurements in the model? What is the difference between distance to lake, coast, and harbor? If this is storm surge flooding, distance to lake should have no impact at all. And distance to coast and distance to harbor are confusing because they sound the same.

Line 130-131 – “the model does not account for the natural infiltration and filling of drainage systems” – what is meant here? If there are specific drainage systems in place in these municipalities to mitigate storm surge hazard, they should be mentioned here (separate from the physical barriers used in the water depth model).

Line 133 – “Building” rather than “building” characteristics (header of 2.1.3 misspelled)

Lines 163-165 – Section 2.1.7 can be removed after moving Lines 163-165 to section 2.1.1. I would argue that this section is redundant after making that restructuring move.

Lines 221-223 – I do not understand this sentence: “The hypothesis is that the vulnerability of a local community could influence the municipality’s overall efforts to reduce the expected damage costs so that municipalities that are more vulnerable have less economic and social capital with which to respond to extreme events such as storm

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surges.” It is a run on sentence and seems to make a number of vague statements and suggestions.

Line 227 – what is a % increase in inundation depth? Relative to maximum inundation depth in the entire dataset? In the municipality? This should probably be expressed in a % increase in damage per meter of increased inundation depth.

Line 231 – what is the “size of the building”? The size in square meters of floor space? Building value? Number of stories?

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2020-30>, 2020.