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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Quantifying the effect of sea level rise and flood defence – a point process perspective on coastal flood damage" *by* M. Boettle et al.

Anonymous Referee #1

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General comments

The authors present a comprehensive framework for studying the economic impact of sea level rise. The method combines analytic expressions for the probability of extreme high water events and for the damage caused by flood events to produce an expression for the expected annual damage. Water levels are modelled by a Generalised Pareto distribution, based on a peak-over-threshold analysis using a point process approach, and damage by a power law, based on two case studies.

The method allows the relationship of the mean damage to a number of parameters to be investigated. Asymptotic expressions, valid for high parameter values, have simple forms and are shown to give a reasonable approximation to present-day conditions in the two case studies. These expressions provide useful insights into the relative importance of different parameters.

The method is unusual in combining estimates of sea level rise and estimates of flood damage, which are often considered separately. It is also able to encompass change in both the severity and frequency of events. It could be applied to any location where sea level estimates and damage estimates are both available.

This analytic, damage-focussed approach is a useful addition to the literature and I recommend publication after a few minor changes, listed below.

Specific comments

1. Abstract: the statement "a doubling of losses can be expected from a mean sea level increase of only 11 cm" derives from a modelling study described only briefly and not from the analytical approach taken in most of the paper - this is not clear from reading the abstract. On the other hand, as noted below, it would be good to see the modelling linked more strongly to the rest of the work.

2. Abstract: I would avoid the use of the word "error" when describing stochastic uncertainty. Perhaps the last sentence can be expressed as something like "While the absolute value of the uncertainty in the flood damage increases with rising sea levels, we find that the uncertainty decreases as a fraction of the expected damage."

3. It would help the reader if a table of the main parameter symbols and meanings were included: $\mu, \xi, \sigma, \mu, \Lambda, \gamma$.

4. The paper uses a mixture of currencies, EUR and DKK. The results would be easier to interpret if one currency was used consistently.

5. p.6238, l.2: "divided by the provided expression". For clarity, I suggest including a reference to the equations, e.g. "E_D divided by the expressions given in equations 11-13 converges...".

6. p.6240, l.17 "the mean excesses show a linear behaviour". I don't find the choice of threshold obvious from the plots in Figure 3, especially for Copenhagen. Please include a little more discussion.

7. p.6240, l.24 The threshold for Kalundborg has been moved a long way, almost to the highest levels observed. Can we be confident that the GPD estimated using the 80 cm threshold will still apply, even with the adjustment to σ?

8. p.6240, l.22-27: I get σ=18.05 and x_{max}=212.79, but this may just be due to rounding errors.

9. p.6241, final paragraph: I agree that the asymptotic behaviours provide good estimates for Kalundborg, but this needs more discussion for Copenhagen, where the values of E_D and STD_D at the current 1-year event are considerably higher than the asymptotic values and the slopes are noticeably lower.

10. p.6242 first paragraph: This introduction of results from a widely used model is welcome, but it would be helpful if it was tied more closely to Fig. 4 and to the previous paragraph.

11. p. 6244 final paragraph: As in my previous comment, I think the claim that the analytical relations approximate the numerical results "very well" needs more discussion.

12. p.6245 Final paragraph: Storm surges can last 2-3 days, so would it be appropriate to consider events repeating in that time as just one event?

13. Appendix B2: there is slight inconsistency in the use of the terms m_k (p.6250 l.10), m_n (p.6251 l.13) and m_k (p.6254 l.1). One expression would seem to be enough for all three cases.

14. p.6255, l.15: The equation is missing the term $2\gamma^2\omega^{2\gamma-2}\xi^2\Delta\omega^2 m_2$; this has a knock-on effect to the next equation (but does not affect the conclusion).

15. Figure 1: This is a very nice representation of the methods described in the paper.

Technical corrections

1. p.6231, l.14: "For estimating" instead of "Estimating"

2. p.6232, l.13: "Finally" would be better than "Eventually"

3. p.6234, l.1-2: I suggest the following alternative, for clarity "which is strictly valid for independent water levels, and is commonly assumed in practice"

4. p.6236, l.17: "investigations to" instead of "investigations on"

5. p.6241, l.1: Missing s on "parameters"

6. p.6246, l.5: "means that the" instead of "means, the"

7. p.6246, l.14: "i.e." is not normally used at the start of a sentence

8. p.6246, final paragraph. Make it clear that this is referring to the Appendix.

9. p.6247, l.6: There is a word missing after "behind", or this could be rephrased as "underlying mechanism"

10. p.6252, l.14: Eq. (4) should be Eq. (5)

11. p.6253, l12: In the second part of the equation for Var, $2\omega^{\gamma-}$ should be $2\omega^{\gamma-2}$