

Interactive comment on “Coupling scenarios of urban growth and flood hazard along the Emilia-Romagna coast (Italy)” by I. Sekovski et al.

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Dear Editor,

We are thankful to have a chance to resubmit the revision of our original manuscript nhess-2015-25 entitled "Coupling scenarios of urban growth and flood hazard along the Emilia-Romagna coast (Italy)" to the NHESS journal. We are also grateful for all the guidance and advice from the Editor and the reviewers in order to improve the quality of this manuscript.

All changes made to the original document can be seen as comments in this submission (pdf file). This includes the referee's comments but also comments from the Discussion board. As for the more detailed response to 3rd reviewer's specific con-

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cerns, it can be found below. In order to follow our responses more easily, each remark from reviewer is followed by our answer.

Referee:

This is a good, well-written and interesting paper that is appropriate for this NHESS Special Issue. It describes modelling of changes in coastal flood risk and hazard, with emphasis upon population growth scenarios. The case study is a highly populated region of the Adriatic coast. The authors aim to provide insights into historical growth, scenarios for future growth – and also produce coastal flood extent & hazard maps. I have some fairly minor suggestions & queries.

Specific comments & technical corrections/queries Some suggested adjustments.

• In the Abstract: From: "The extent of coastline urbanization reduces their resilience to flooding, especially in" To: "The extent of a coastline's urbanization reduces its resilience to flooding, especially in" From: "is compact-like" To: "progresses compactly" From: "can be useful for identify" To: "can be useful to identify" or "can be useful for the identification of" From: "Although projecting future is often" To: "Although projecting the future is often"

Adjustments were made according to majority of suggestions...

• P2153, line 26: you write: "High degree of coastal urbanization also caused the flattening of dunes for construction purposes, therefore nowadays dunes are present only in 28% of the 130 km of coastline" – I suggest changing this to: "A high degree of urbanization has meant that as of XXXX [insert year of the source of your statistic from Armoroli et al 2012], dunes are present along only 28% of the 130 km of coastline".

This sentence was changed according to the comment.

• P2154: You switch between metres and cm –perhaps for consistency use one or the other.

Centimetres are now changed to metres.

“Storm surge levels are significant.” – This statement isn’t informative – I’d suggest removing it & just explaining in the subsequent narrative exactly what you mean by significant; where it is stated: “Even low return period surges (e.g. a 1-in-10 year event) can reach elevations close to 1 m above MSL (Masina and Ciavola, 2011).” Is the ‘1 m above MSL’ the storm-induced elevation of the water level (caused purely by the low pressure and wind stress), or is this an extreme water surface elevation (with some surge + tide) above a datum (i.e. MSL)?

We have reformulated the sentence in order to be more clear and now it says “As for the storm surges, even the low return period events (e.g. a 1-in-10 year event) can lead to water level elevations of close to 1m above MSL (Masina and Ciavola, 2011).”

P2161: “Run-up levels, land subsidence and scenarios of sea level rise were not included into the computation” – I appreciate a fast method is desirable, and you acknowledge that run-up can be critical for estimating flooded areas, and also that part of your focus here is upon a fast, practical method. However these variables could be (briefly) addressed separately/more systematically with regard for the implications upon your results; or with more specifics about how they would be integrated into future application of your modelling approach. Do you think that the hazard assessment (or forcing) component of this paper is secondary to (and primarily allows you to demonstrate an example application of) your analysis of the receptor dynamics using SLEUTH?

The drawbacks of the adopted methodology to define the flood-prone areas are listed and discussed in details in the paper by Perini et al. (2015). We therefore refer to the above cited work for further information. The reference to the paper was added on page 2160, line 25 and on page 2168, line 2. We believe that both analyses have the same importance, but of course the paper “allows demonstrating an example application of the analysis of the receptor dynamics using SLEUTH”. Therefore we believe that the

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discussion and conclusion sections should mainly focus on SLEUTH results.

In the discussion & conclusions you make the point that yours is a fast and simple method for estimating future flood hazards. If it is not feasible here to explain the specific sensitivities (of a more detailed hazard assessment component, e.g. values for wave run-up, morphological change, sea level rise etc.) can you provide any more insight to some of the practicalities of your model (e.g. run times, set-up time etc.), especially as you indicate this approach could be adopted by a wide range of users / decision-makers?

We have added the following sentences on page 2163, line 17: The model set-up (i.e. model construction) requires few minutes. The model run takes almost 3 hours considering also 30 minutes for input data preparation and independently from the modelled scenario. The model is run along 20-25 Km of coastline at a time (5 sectors). Once the methodology is set, the model itself is quite rapid. The time consuming part of the presented procedure is the collection of historical storm information and the trial-and-error procedure.

P2162: “Resulting hazard maps were more realistic in some areas, if compared to historical storms”. – do you mean that in locations where you were able to calibrate or validate, the results were likely to be more certain?

Yes. We have added the following sentence on page 2162, line 2: (i.e. in locations where it was possible to validate the results)

P2170 line 3-4: “We believe that planners and decision makers should be strongly encouraged to take into account models and scenarios.” – see above comments. A bit more information on what models and scenarios (or types of these) you are specifically referring to would enhance this statement.

The sentence has now been changed in order to be more clear: “We believe that planners and decision makers should be strongly encouraged to take into account prob-

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abilistic models and scenarios - not only ones that consider the dynamics of climate forcing but also spatial dynamic models that project urban growth.”

“More of a generic view / some context as to how your methodology is similar or differs to other research (case studies & methods applied elsewhere), would be beneficial, and strengthen a review of your research’s strengths, and recommendations for future work. For example this Special Issue includes a paper which assesses the population vs sea level in the context of coastal flood hazard: “Stevens et al.: Estimating the long-term historic evolution of exposure to flooding of coastal populations, doi:10.5194/nhess-15-1215-2015, 2015.”

This text is now added in the page 2152: “The only application of using SLEUTH to estimate future exposure to marine floods known to us is the one by Garcia and Loáiciga (2014). In their study the flood-damage quantification module was developed by merging flood maps with SLEUTH urbanization predictions in order to calculate the expected annual flood damage (EAFD) for given scenarios of sea-level rise. In general, the subject of growing population exposure to coastal flooding and sea level rise seem to be more in focus lately (e.g. Jongman et al, 2012; Neumann et al., 2015; Stevens et al., 2015).”

(New) references:

Jongman, B., Ward, P. J. and Aerts, J. C. J. H.: Global exposure to river and coastal flooding: Long term trends and changes, *Glob. Env. Change*, 22, 823-835, 2012.

Neumann B, Vafeidis, A. T, Zimmermann, J. and Nicholls, R. J.: Future coastal population growth and exposure to sea-level rise and coastal flooding - A global assessment, *PLoS ONE*, 10(3): e0118571. doi:10.1371/journal.pone.0118571, 2015.

Perini, L., Calabrese, L., Salerno, G., Ciavola, P., Armaroli, C.: Evaluation of coastal vulnerability to flooding: comparison of two different methodologies adopted by the Emilia-Romagna Region (Italy), *NHESSD*, 3, 4315-4352,

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doi:10.5194/nhessd-3-4315-2015, 2015. Available at: <http://www.nat-hazards-earth-syst-sci-discuss.net/3/4315/2015/nhessd-3-4315-2015.html>, 2015.

Stevens, A. J., Clarke, D., Nicholls, R. J. and Wadey, M. P.: Estimating the long-term historic evolution of exposure to flooding of coastal populations, *Nat. Hazards Earth Syst. Sci. Discuss.*, 3, 1681–1715, 2015.

Interactive comment on *Nat. Hazards Earth Syst. Sci. Discuss.*, 3, 2149, 2015.

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