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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "An integrated hydrological and hydraulic modelling approach for the flood risk assessment over Po river basin" *by* Rita Nogherotto et al.

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The manuscript "An integrated hydrological and hydraulic modelling approach for the flood risk assessment over Po river basin" presents a chain of models for producing flood hazard maps in northern Italy. The paper is interesting and touches an important topic, but has many issues in terms of writing, analysis and underlying modelling work. Firstly, I will list my major concerns in the order of appearance in the paper. Then, I will list some minor comments and suggestions to improve the text.

Introduction: the introduction gives little information on the research gaps that exist and which the authors are trying to address. No research goals are stated, and no clue is

given what innovation or contribution to the field is introduced by the paper. Most of the introduction is a general overview of history of flood modelling, though interesting by itself, is mostly not too relevant for the study, and it barely cites any literature from the past 10 years. A revised introduction should clearly state what the study contributes and which research gaps it addresses, and the literature overview should be focused on those aspects, and cite more recent papers given the enormous developments in the field in the past decade. Also, it should be explained what is the existing flood hazard map availability for Italy and why new maps are needed (especially since, as described later in the paper, national maps are already available!).

Methods (2.1): the main innovations here, i.e. the use of a new precipitation dataset and a new implementation with a high-resolution DEM, are very briefly described. The resolution of the DEM and precipitation data should be clearly written, as should the information about other necessary inputs for hydrological modelling (evapotranspiration, snowmelt, infiltration etc.), model set-up (e.g. timestep) and model calibration.

Methods (2.3): from the text it seems that the only change in the hydraulic model is the parallelization. This should be clearly written, and more details should be provided as this is an important addition. It would be particularly useful to describe to what simulation set-up Fig. 3 pertains to. If other changes were made to the model they need to be described.

Methods (2.4): most of all, the method "digging" the channel in the DEM is not well described. Was the bankfull depth used directly for the lowering grid cells in the 3" resolution DEM, or the resolution of the DEM (which is coarser than width of most rivers in the study area) was accounted for by reducing the depth accordingly to achieve the same wetted perimeter? If the former, then the conveyance of the rivers will be vastly overestimated and needs to be corrected. If the latter, then it needs to be properly described. Also, what does the "ad hoc" re-shaping of HydroSHEDS in the abstract actually refer to? Further, there is too little information about the simulation set-up, such as timestep, spin-up time, simulation time, calibration procedure (if there was

any) or roughness coefficient selection (was it spatially-variable? was it adjusted by calibration?).

Validation (3.1): the validation mentions “tuning” the model (line 264), but no information about calibration procedure were provided. Also, the text mentions “Due to the relatively small size of the simulated domains, the duration of all flood simulations was set to 240 h” (line 266). Does this refer to simulation domains from Figure 1? Or the sub-domains mentioned in the previous section? (line 259). This should be clarified to avoid confusion. Still, if the simulation was done over the whole Po river, isn’t 240 hours far too low to capture the response of the catchment (I made a quick check with an empirical equation, which suggests so)?

Validation (3.2): the validation here is only visual, but as Figure 7 shows flooded areas extracted already from the satellite images, it would be possible to apply the method of comparing flood maps from section 3.3 to compute the different indices. Also, the impression of good match between the modelled and observed flood extents partially stems from showing a 500-year flood map for comparison, instead of only 100-year flood. Finally, given that the hydrological simulation made by the authors cover the time of the event, wouldn’t it be a better comparison by running the hydraulic model specifically for the 2016 event?

Validation (3.3): official hazard maps are used here for comparison, but no information how they were produced are provided. This is important in order to assess the source of differences with the authors maps. Also, the authors only show the results for a 500-year flood map, while discussing other return periods as well. Those results should be shown. Especially as authors claim there maps being better than JRC’s , but the results for the 500-year maps are actually worse. Also, it is well possible that the authors’ models underestimate flood hazard severely – but that could be made clearer by information how the reference Italian maps were made. Also, the JRC maps might not include channel geometry, but account for this by removing mean discharge from the design hydrographs, as I did in my pan-European flood modelling work, too (Paprotny

et al. 2017, cited by authors). Other researchers (Ward et al., 2013; Sampson et al., 2015) accounted for this by removing 2-year discharge.

Finally, there is no discussion section in the paper, hence missing many important aspects. Uncertainties and limitations are not discussed (e.g. related to the channel “digging” or design hydrographs). Ways to further improve the work and next steps are not discussed too, and neither is relevance of the work for making projections of flood hazard under climate change. But most importantly, the issue of flood protection is ignored. Though the authors write that the channel “digging” accounts for “man-made” banks, but a return period of 1.5 years is below even the most meagre flood defences. In practice of flood hazard modelling, assumptions about the level of flood protection has very strong influence on the results, as I show in Paprotny et al. (2017). Without this, any improvements to the hydrological or hydraulic modelling are mostly lost. If this is not addressed by the authors in their model, it needs to be at least extensively discussed.

Minor comments:

Title: the authors write “integrated hydrological and hydraulic modelling” but in reality the two are run entirely separately. Also, the work relates to flood hazard mapping in the Po river basin and not “flood risk assessment” (risk is not addressed by the paper) “over” Po river basin. The authors should propose a new title that includes only items that are covered by the paper.

L14: typo “90m”

L26: should be “are” not “and”

L37: “Flood Risk Management Directive” is not an official name, hence it should be refer to as “Floods Directive” in parentheses.

L52: “For limited area gauged basins” is not understandable, probably should be “For small, gauged basins”

L110-111: a large-scale map, in geography, covers a small area (large amplification). Mixing “scale” as in maps, and “scale” as in process is commonplace and should be corrected to “. . .assumes that flood hazard maps over a large domain can be derived from an ensemble of smaller sub-simulations. . .”

L122: “D8” should be explained.

Figure 1: the map lacks legend, grid or scale. Also, the source of the underlying map should be identified in the caption.

Section 2.2: throughout, authors use multiple letters for a single variable. A single letter should be used e.g. S instead of SDH. Subscripts could be also used instead to differentiate.

L172 and subseq.: it should be clearly marged that eq. 3-5 are directly taken from Maione et al. (2003).

179-L180: the authors mention and show equation for the falling limb, but shouldn’t there be also an equation for the rising limb of the hydrograph?

L186: what method was used for fitting?

L191: write specifically which station.

Figure 3 and others: the size of figures, their labels and general appearance should be synchronized throughout the paper, as at the moment that give a very messy appearance together.

L232: “for larger domains” not “on large scales”.

L247-L249: this is the part where it is particularly unclear how the “digging” was made.

L274: the results referred to by authors were actually presented in [Paprotny D., Morales Nápoles O. (2017) Estimating extreme river discharges in Europe through a Bayesian Network. Hydrology and Earth System Sciences 21, 2615–2636.] rather

than in Paprotny et al. (2017) cited here.

Figure 6: a 1:1 line should be added to the graph.

Figure 7: “meters” is missing in the lower legend.

Section 3.3: again, a single letter (with possible subscript) should be used per variable.

L321: Alfieri et al. (2014, 2015) should be cited here regarding the methodology of the JRC maps.

L338: typo “STRT”.

L351-352: rather due to lack of flood defences in the model

L361: as noted above, the authors do not really account for “man-made banks”, if those are formed by flood defences.

L363-364: authors write that “[t]he evaluation of the produced flood maps was performed through some case studies of observed flood extent”, but actually only one case study is shown (Nov. 2016).

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