

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

### **Anonymous Referee #3**

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An integrated hydrological and hydraulic modelling approach for the flood risk assessment over Po river basin, by Nogherotto et al. – submitted to NHESS Overall evaluation: The aim of the manuscript is to provide a combined approach for mapping flood hazard for different return periods, starting from a precipitation dataset and using a statistical procedure to design synthetic hydrographs, to be then used to simulate inundation scenarios in the floodplain.

Although the topic is interesting, the manuscript is well written and structures and the its scope is in line with the journal, I don't find this study innovative enough to be published in NHESS. The methodology, as described in the manuscript, is the one developed in

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Maione et al. (2003) and used to map European flood hazard in Dottori et al. (2006), who also use the identical approach for simulating the flooding dynamics, with the only difference in reducing the flood hydrograph discharges by subtracting the estimated average daily discharge, instead of “digging” the DTM as stated in this manuscript. The main differences declared in this study are the different database and DTM used that just characterize an application of the cited methodologies on different case studies. This is the main reason why I would reject the manuscript in its current form. Some other concerns about the manuscript are listed below. I hope the authors will find them useful and I encourage them to resubmit a thoroughly and carefully revised version of the present study, clearly specifying the innovations made.

Major comments:

Title: I don't think this can be defined an “integrated” approach, because the two models (hydrological and hydraulic), as I understand from the description, run separately. I would relate to a “combined” approach instead. In addition, flood risk in literature is defined as the combination of flood hazard, exposure and vulnerability, while the manuscript refers to hazard only.

Introduction: I would add a part about flood hazard maps, investigating how they are currently designed, which is the situation in Italy (where you focus your study), etc.

Section 2.3: I find this part too short and less detailed, it becomes clearer only after reading the paper of Dottori et al. (2016). Details about boundary conditions, roughness coefficients and other useful details for modelers should be added. In the last part of the section, the reader is expected to find how the following sections are organized, but the list of the steps here stated don't agree with the chapters.

Section 2.4: the main lack here, and in the whole manuscript, is the description of the digging method. Being one of the few modifications of the cited methodologies, it needs to be clearly described (included the motivation of this choice instead of following Dottori's methodology), in order to justify the application of this approach. Again, details

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need to be added, such as how the model works in the external areas, how the different flood maps of the virtual stations are merged, levees breaching mechanisms (if any), etc.

Case studies and study areas: They need to be better described and motivated, included the choice to refer to three different studies areas. “Upper Po basin”, “the area in the south of Turin”, “the area of Alessandria” are too general, please specify where they are (also with Figures), how big they are, etc. Is the area in Figures 8 and 9 the same as in Figures 4 and 5? If yes, why is it cut in the northern and southern part? If not, why not?

Section 3.1: Please pay more attention in the terminology used: the SDHs cannot be validated using observations from the gauging stations for Tr 50, 100 and 500 years. . . there are not observations for 500 years return period!!! These values are extrapolated from statistical studies starting from observation, but it needs to be clarified. In addition, I would not say “tuning” the model, because the model was already developed by Maione et al. (2003), maybe it was applied to the new data. If there are substantial modifications instead, please clarify it, because it is not evident up to now.

Section 3.2: Why do authors refer also to  $Tr = 500$ , when they write that the November 2016 event was catalogued as a 100years return period event? In addition, I think that the sentence “We can see that the observed event, associated to a return period of 100 years, is fairly good represented by the model (Fig. 7 (b) and (d)) as the maps include the particular events observed” cannot be accepted in a scientific manuscript as a valid result of a study. The judgment of the validity of the approach cannot be based on the impression of the reader that looks at the two maps and conclude that they are similar! Why authors didn’t use the same indices as in Section 3.3? I would provide a initial Section in Chapter 3 where describing the indices used, and then perform all the comparisons using this indices.

Section 3.3: In order to better understand and discuss the results of the study, an expla-

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nation on why authors chose River Po Basin Authority and JRC maps as comparison must be added, and also how they are derived. Why authors say that it is possible to calculate indices only for  $Tr = 500$  years but then show and comment results also for  $Tr = 50$  and  $100$ ? It is not clear, in addition and related to this comment, which models consider the embankment system. Po river has an important levee system, which has a very important influence on the results of hydraulic simulations (see, e.g., Wing et al. (2019)\*). This issue must be considered at least in the discussion result. In addition, there are no reference at water depth results in the study, that's why the sentence at P. 15 L. 352-354 is not correct.

In general, results in Section 3 have to be deeper investigated (e.g. in Figure 9, the explanation of the differences between CA2D and JRC maps are not taken into consideration at all).

Figures 8 and 9: I find the way to visualize results in Fig. 8 very unrepresentative. I would, instead, represent maps in Figure 8 as in Figure 9, in terms of comparison of CA2D and JRC maps, respectively, with AdB maps, following the representation of results in Table 1. The same for Figure. 4.

Minor comments:

P. 1 L. 26: results ARE less satisfactory. . .

P. 2 L. 36: the development of flood hazard maps is only one of the mandates of the European Flood Directive (better than "European Union Flood Risk Management Directive")

Among 2d models, I would mention also the 2d version of Hec-Ras, very used in the last years.

Figure 1: this is unnecessary, it doesn't add anything interesting to the study.

P. 6 L. 163: the right reference is Alfieri et al. (2014) instead of 2013, if I understand what authors refer to.

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P. 7 L. 211 – P. 9 L. 213: Please rephrase, it is not clear.

P. 9 L. 213-214: the following Section is 2.4, but this is not the section in which the results are shown. Please correct.

Figure 4: y-axis label is missing.

Figures 4, 5, 7, 8, 9: scale bar and north arrow are missing.

P. 10 L. 266: add reference

P. 10 L. 267: “small size”: please specify quantitatively.

P. 10 L. 267-268: please explain better, with references.

Please provide reference for “observational data” in the Po River.

Figure 5: Please specify in the caption which model is used to map hazard areas.

Figure 6: a) and b) labels are not shown in the figure.

Figure 7: what does the legends refer to?

P. 13 L. 300: perform a COMPARISON BETWEEN existing. . .

P. 13 L. 314: I would use the terminology “CA2D maps” from the beginning of the manuscript.

P. 13 L. 315: PO RIVER BASIN AUTHORITY instead of River Po Authority.

P. 15 L. 338: the SRTM used. . .

P. 16 L. 362: which hydrographs?

P. 16 L. 365: the comparison is not in the ENTIRE domain, please clarify

\* Wing, O., et al., A New Automated Method for Improved Flood Defense Representation in Large-Scale Hydraulic Models, *Water Resources Research*, 55 (12), 11007-11034, 2019. <https://doi.org/10.1029/2019WR025957>

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2019-356>, 2019.

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