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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Modelling the socio-economic impact of river floods in Europe" *by* L. Alfieri et al.

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General Comments:

In this manuscript, the authors report a novel methodology to quantitatively assess flood risk in Europe between 1990 and 2013. Using a high resolution observational meteorological dataset and socio-economic datasets, their model integrated a high resolution (100 m) 2D flood inundation model with an impact model focusing on estimating the population affected and the economic damage due to river floods. The authors show the results of flood risk assessment during 1990-2013 using two different approaches, an integral method and an event based method, and present a comparison of the two approaches.

The paper fits into the scope of NHESS very well. I think this paper has academic value

and the results are helpful to governments, international organizations, re-insurance companies and emergency responders, etc. The originality of the method and findings in the paper are up to international standards.

However, my primary concern with the manuscript is this manuscript is really short on discussion. Discussion on the sources of uncertainties of the model cannot be avoided, and more words are needed on how the integral and event based methods can be complementary as shown by their different results. Moreover, the results are not well written to present the pattern of flood risks in Europe. The authors present a combined model composed of five modules, but they did not show any equation or outputs of any intermediate modules to help readers understand how natural and socio-economic factors are linked in flood risk assessment. The figures are not well designed and their captions are not informative; I believe it will be difficult for many readers to understand the figures without reading the full paper very carefully.

Below is a detailed summary of my suggestions and comments. I think this manuscript needs major revisions.

Specific Comments:

1. P2, Line 5 and P11 Figure 1: "The proposed approach follows a modelling framework composed of five different steps (see Figure 1). . .. . ."

As a flow chart for modelling, Figure 1 should show information on what are the outputs of each steps and what methods or control factors are critical to each steps. There are many unexplained abbreviations and asymptotic formulas, such as "PPA & PD = f(T)". Abbreviation should be explained in the caption and the figure should be improved.

2. P2, Line 11: "Streamflow maps at 5 km grid resolution are produced by forcing Lisflood with the EFAS-Meteo dataset (Ntegeka et al., 2013) . . .. . ."

I think the authors can tell readers the total number of the grid points for the sake of showing them the high resolution of the modelling in the beginning of the paper.

3. P2, Line 14: "The current Lisflood version is calibrated at 693 stations across Europe against up to 8 years of daily observed discharge....."

What is the reference for this claim? Add it to the paper.

4. P2, Line 24: "L-moment estimators are nearly unbiased for a wide range of sample sizes and distributions (Vogel and Fennessey, 1993), and are particularly useful for relatively short samples as in this study....."

What is the reference for the claim “are particularly useful for relatively short samples as in this study”? I am very suspicious of using a 24-year series to infer the peak flow of a flood with a return period as large as 500 years.

5. P2, Line 30: "Flood inundation maps for the entire European domain were produced at 100 m resolution using the Lisflood-FP floodplain model (Bates et al., 2010; Neal et al., 2012) forced by the flood hydrographs with specific return period described in the previous section. The full procedure to derive pan-European flood hazard maps is described in details by Alfieri et al. (2014a)....."

The flood depth is a key parameter in the model, so you should tell readers how efficient is the Lisflood-FP floodplain model and did the model ever be validated or not. Some flood inundation map for the entire Europe is need to present the outputs of the Lisflood-FP floodplain model and to show the spatial variability of flood hazards. If the figure cannot be added into the main body of the paper, it should be putted into Supplement Material.

6. P3, Line 6: "For this task we used the country specific depth-damage functions defined by Huizinga (2007) for different land uses, while the spatial variability in exposure is determined according to the refined version of the Corine Land Use provided by Batista e Silva et al. (2012)....."

A representative equation for depth-damage functions must be given to help readers understand how natural and socio-economic factors are linked in the flood risk assess-

ment.

7. P3, Line 26: "This method estimates the damage of each simulated flood, rather than considering the theoretical probability of occurrence. It is based on a selection of all discharge peaks (POT) exceeding the flood protection level (by Jongman et al., 2014) at any location....."

What does “POT” stand for?

8. P3, Line 33: "3 Results"

The current Results section is not meaningful and it is difficult for readers to understand the implications of these results. In flood risk assessment, the biggest advantage of modeling over statistics is the contributions of different factors controlling flood risks (flood hazard, exposure and their vulnerability) can be differentiated. Therefore, the authors should explain in the section the patterns of flood risks for the entire European domain; and for the regions seriously affected by floods, the reasons should be given: whether the risks mainly result from adverse basin meteorology and climate, topography, inadequate flood prevention, or exposure of large amounts of population and assets to floods, etc.

9. P3, Line 38 and P12 Figure 2: "Values plotted in Figure 2 are expressed as ratios of the respective country GDP and country population, while absolute values are shown as labels aside each color bar....."

Figure 2 can be more informative if the authors sort the countries from top to bottom according to the lengths of blue or green bars. With this design readers will have a quick and clear idea which countries sufferred from largest relative damages and whose populations were most affected. In addition, a webpage link on ISO country code should be given in the caption as many readers are not familiar with country codes.

10. P5, Line 1 and P14: "3.2.1 Case study - Central Europe floods in 2013 The catas-

trophic floods hitting the Central Europe in June 2013 was selected as case study to test the performance of the event based method for rapid risk mapping. Figure 5 shows maps of damage and population affected in Central Europe, based on the simulated discharge maps from 25 May to 10 June 2013....."

A few sentences are needed to tell reader the overall hazard magnitude of the 2013 floods.

The meanings of two elements in Figure 5, one is the gray circles, the other is the gray areas (close to the “Rhine” and “Danube” River), are not explained either in its legend or in its caption.

11. P5, Line 24: "4 Discussion and Conclusions"

In my opinion, the Discussion section may include a more meaningful discussion on how the integral and event based methods can be complementary as hinted by their different results shown in Figure 2. For some countries, the results given by the integral method are smaller than those given by the event based; for another countries, the results turned out to be the very reverse. The authors should find out the reasons for these differences and the implications for the “adaptation effect” (Di Baldassarre et al., 2015). If a larger damage is given by the event based method than by the integral method, does it mean that the overall magnitude of floods risks during 1990-2013 is larger than that in the long term? If so, does it further mean in the future fewer flood hazards might occur in these countries and they might been more adapted to and better prepared of future flood hazards?

I agree that at present it is very difficult to quantify the uncertainty range of the model. But a detail discussion on the sources of uncertainties of the model cannot be avoided. “4.1 The influence of flood protections” is actually a source of model uncertainty. The authors can easily find out more sources of uncertainties by checking very steps of their modeling. For example, in the first step “Continuous hydrological simulation”, as shown in the supplement materials, the uncertainties of hydrological simulation change

with the upstream basin area.

The following two parts in the Results section could be moved to Discussion and modified as the points for the sources of model uncertainties:

P4, Line 20: "It is worth noting that the presented approach is focused on rivers with upstream area larger than 500 km2. Hence, the flood risk is likely to be underestimated in regions where the hydrography is dominated by smaller streams (e.g., coastal regions of Greece, South of Italy, Croatia, Norway, UK, Denmark, as well as some mountainous regions in the Alps) where local storms and flash floods are major components of the overall impact of floods. Similarly, the impact of coastal floods is not modeled in the 25 results shown."

P4, Line 29: "A report by Fenn et al. (2014), prepared for the 30 European Commission Directorate-General for the Environment (DG Env), includes an assessment of financial, economic and social impacts of river floods in the countries of the European Union between 2002 and 2013. Fenn et al. (2014) addressed the scarcity of flood impact data by extrapolating the cost of major floods in the European countries on the basis of the available data, so that the overall estimated flood impact is given by the sum of extrapolated and quantified data. Figure 4 compares annual flood damage aggregated over the European Union of the event based method from 1990 to 2013 and data by DG Env for the available years. Data from the two datasets are in good qualitative agreement. "

The authors should also tell readers the method of Fenn et al. (2014); they must be different from the methods of this paper. As for the claim “data from the two datasets are in good qualitative agreement”, some statistics should be shown to support the claim. As shown in Figure 4, for the year when major flood hazards occurred (2002, 2010, and 2013), estimates of flood damage using the event based method and the method of Fenn et al. (2014) have large differences. Why? Which source of model uncertainty is hinted in these differences?

12. A separate “Conclusions” section is needed to present readers some important take-home messages.

13. After a major revision, I think the abstract of the paper should be rewritten.

Technical corrections:

P2, Line 5: "The proposed approach follows a modelling framework composed of five different steps (see Figure 1). . .. . ."

“five different steps” can be changed to “five steps”; “different” is a redundant word.

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