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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "FLOPROS: an evolving global database of flood protection standards" *by* P. Scussolini et al.

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Authors: We are very thankful to Dr. Alfieri for his careful work in reviewing our manuscript both at the conceptual level and in the details. We are pleased that he finds the paper to be suitable for publication in NHESS after revision. We acknowledge all points raised and have endeavored to address them to improve the paper. In the following we respond to the individual comments.

Reviewer #1 Lorenzo Alfieri: This article proposes a framework which builds up a database of river and coastal flood protections at global scale. Due to the scarcity of information and the difficulty in retrieving those data, the authors propose a multi-layer approach which gives priority to reported information on existing flood protections, fol-

lowed by policy indications, and ending with a modeling approach to fill the data where missing. This latter appears to be the most populated one, according to Figure 3, hence some questions might arise on the validity of the product. However, a validation study was performed and shown in the article to support the methods. In addition, to my knowledge this work represents the first example of global flood defences published in the scientific literature, hence it is of considerable interest for the scientific and practitioner community dealing with flood risk assessment on large scales. The article is generally well written. The methods are sound and pertinent, though I recommend few additions to clarify parts of the methodology (see specific comments below). Overall the article surely deserves to be published in NHESS, provided that the few comments below are adequately addressed. Specific attention should be given to my last three comments on Figures 4, 5 and 6.

Specific Comments

Reviewer #1: P 7276 L 11-16: I suggest rephrasing this part first defining the content of the three layers and then addressing the use of the Policy and Model layer to increase the spatial coverage.

Authors: We have re-phrased this paragraph accordingly. It now reads: “The Design layer contains empirical information about the actual standard of existing protection already in place; the Policy layer contains information on protection standards from policy regulations; and the Model layer uses a validated modeling approach to calculate protection standards. The Policy layer and the Model layer can be considered adequate proxies for actual protection standards included in the Design layer, and serve to increase the spatial coverage of the database. Based on this first version of FLOPROS...”

Reviewer #1: P 7277 L 15-16: Please note that the approach used at the JRC described by Rojas et al. (2013) has undergone considerable scientific and technological advances. The updated version was recently published in an article by Alfieri et al.

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(2015).

Authors: We have included reference to this more recent and improved approach.

Reviewer #1: P 7279 L 14-21: My suggestion is to keep track of the upgrades (or potential degradation) of flood protections, together with the year of change. In this way different global protection layers could be produced corresponding to different years, thus enabling continuous risk assessment simulations over several years which account for improved protections, commonly occurring after major flood events.

Authors: This is a very pertinent suggestion, and the possibility of tracking past states of protection standards could indeed be valuable in assessments of changes in risk through time. We have taken note, for each database entry, to specify the year of the implementation of protection, when this was available. In the reviewed version of the supplementary information, and in all documents pertaining to FLOPROS, we will therefore include a dedicated field. Moving forward, we indeed hope that the database can be used to monitor changes in protection standards over time. We are currently discussing the possibility of this with key international organizations, such as UNISDR and the World Bank /GFDRR. However, this first version of the database represents a first effort of protection at current time, which can be used as a baseline for such future developments. In any case, we include in the revised version the following explanation of the fact that protection might degrade in time: "... and (3) because flood protection standards are prone to "degrade", in the absence of adequate maintenance, and with effect of climate change on the frequency and magnitude of flood events."

Reviewer #1: P 7282 L 7: Suggested: remove "at least".

Authors: Ok, removed.

Reviewer #1: P 7282 L 15 to P 7283 L 2: I think this text should be shortened or removed as it creates some confusion. While reading, it generates several questions on assumptions and underlying datasets (e.g., the 2 and 1000 years limit, EAD, potential

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flooded area). Then the reader realizes that the same procedure is written with all the details in the following part of the text (p 7283). I suggest describing the procedure just once.

Authors: Thank you for the suggestion. We have now merged the two parts of text that the reviewer is referring to, to provide only one, coherent and concise description of the method. It now reads:

" 1. Global maximum and minimum flood protection standards were set. Here, we assumed the minimum protection standard to be 'no protection'. In the GLOFRIS global flood risk model (Ward et al., 2013; Winsemius et al., 2013) schematisation (Ward et al., 2013; see their step 3), no protection means a protection against flood with a return of 2 years (the natural bank-full discharge, following Dunne and Leopold, 1978), and hence this value was used. For the maximum protection standard, we assumed a return period of 1000 years as per Jongman et al. (2014). 2. Next, as it is known that protection standards vary depending on country wealth (Feyen et al., 2012; Jongman et al., 2015), we estimated a maximum and minimum flood protection standard for each income group of the World Bank classification, namely: high-, upper-middle-, lower-middle-, and low-income . To do this, firstly, GDP per capita (GDPpc) was calculated per income group in USD 2005 at purchasing power parity. This was done using gridded maps of GDP values and of population density from the IMAGE model, the same maps used in Ward et al. (2013), developed with the method described in van Vuuren et al. (2007). Next, the maximum (minimum) protection standard for a given income group was calculated by dividing its GDPpc by the GDPpc of the income group with the highest (lowest) GDPpc, and multiplying the obtained value by the assumed maximum (minimum) protection standard, i.e. 1000 years (2 years). 3. In the next step, the protection standard for each sub-country unit was estimated. The expected annual damage (EAD) that would occur if no flood protection were in place was calculated using the GLOFRIS model, and then normalized to potential flooded area to yield the EAD per unit of area (EADarea). For each World Bank income group, the sub-country

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units with the highest and lowest EADarea were assigned the income group-specific maximum and minimum protection standards (see step 2), respectively, and protection standards for the remaining sub-country units in the income group were linearly interpolated. GLOFRIS only simulates floods on rivers of a Strahler order 6 and higher (Winsemius et al., 2013). Hence, it was not possible to derive a modelled protection standard for catchments with lower Strahler order rivers, corresponding to ca. 2% of the Earth's land surface (excluding Antarctica)."

Reviewer #1: P 7284 L 7-8: I suggest adding a short description mentioning the key points of the return period and of the annual exceedance probability method. I currently cannot find it in the text.

Authors: This sentence indeed needs clarification. We changed it and expanded to: "Further, we performed interpolation between protection standard values (step 2 and 3), whereby the interpolation was carried out based on both the return period (e.g. 50 years) and the annual exceedance probability (the inverse of the return period; e.g. 0.02)."

Reviewer #1: P 7284 L 11: Table 5 do not exist. Do you mean Table S1 of the Supplement?

Authors: Sorry for the confusion and thanks for pointing this out. We have corrected this to "Table 4".

Reviewer #1: Figure 3: If I understand well, the model layer should be able to fill any gap of data which is not already provided by the Design and Policy layers. Yet, I still see in Fig.3 some empty area (e.g., in Denmark, Italy, Bulgaria, northern Africa). Why were those areas left without a protection value?

Authors: This is explained in the Methods at P 7283, which we slightly re-phrased to accommodate the reviewer's comment: "GLOFRIS only simulates floods on rivers of a Strahler order 6 and higher (Winsemius et al., 2013). Hence, it was not possible to

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derive a modelled protection standard for catchments with lower Strahler order rivers, corresponding to ca. 2% of the Earth's land surface (excluding Antarctica)."

Reviewer #1: P 7285 L 6: "out of"

Authors: Ok, amended.

Reviewer #1: P 7288 L 26: Suggested: remove "there". Please check the entire sentence, currently not easily readable.

Authors: We changed to "therefore".

Reviewer #1: P 7293 L 6: "on" or similar preposition is missing at the start of the line.

Authors: We added "on".

Reviewer #1: Table 4: Footnote #1 states 9 comparisons, while the table itself and Fig. 4 only show 8. Please check.

Authors: Thanks for the careful reading. We have corrected this to "eight".

Reviewer #1: Figure 4 and Figure S1: I don't understand why these figures show log(1/PS) instead of simply log(PS). In case of the latter option the y-axis would be upside down as compared to the current version, with the advantage that larger numbers would mean higher protection standards. Absolute values would be the same as now, given that log(1/PS)= -log(PS). Same comment for Figures 5 and 6. In addition, in the legend it's difficult to see any difference between the max and min value, hence these two could be grouped into just one item.

Authors: We thank the reviewer for the very good suggestion. We follow it and in the revised version we plot these figures using the log(return period), with the same visual result, but with no need to reverse the axis to show higher flood protection on the upper side.

Reviewer #1: Figure 5 and P 7289 L 1-18: Besides testing the linear correlation be-

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tween the two sets of samples, it would be interesting to test the overall skill of the two layers in terms of multiplicative bias, such as with the Root Mean Square Factor (RMSF). This would also address the issue of poor statistical significance mentioned on P 7289 L 13, due to a small sample.

Authors: We thank the reviewer for the interesting suggestion. We included the root mean square deviation (assuming this is what the reviewer intended) in the box of fig. 5, and changed the text in section 4.2 to report on this analysis of the predictive capacity of the Policy and Model layer datasets.

Reviewer #1: Figure 6 and its discussion on P 7293 takes an almost negligible portion of the article. I suggest expanding this part with some additional detail to understand better the variables analyzed. Also, a more in-depth discussion of the results would improve the interpretation of the data.

Authors: Following the suggestion, we added further elaboration on the preliminary results included in this part of the discussion, explaining the indices, and reporting more explicitly on the implications of the correlations we found. It now reads: "Our preliminary results indicate that at the country-scale significant correlations appear to exist between protection standard in the Design and Policy layers and certain economic and governance indicators. For instance, the "Government Spending" index accounts for the total expenditure of governments as a proportion of the country's GDP, while the "Freedom from corruption" index reflects experts' opinion on local perception of corruption in most countries (using Transparency International's Corruption Perceptions Index) (The Heritage Foundation, 2014 ; and references therein) (Fig. 6). The significant correlations suggest that countries with higher public spending, and countries where corruption is less widespread, tend to have higher flood protection standards, as included in the country-scale entries of our Design and Policy layers. Future research could focus on further examining such relationships in greater detail." However, because we consider these results indeed preliminary, aimed mainly at illustrating one of the possible uses of the new datasets, we would prefer to keep this section short and

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focused.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 7275, 2015.