

Interactive comment on “Assessment of extreme flood events in changing climate for a long-term planning of socio-economic infrastructure in the Russian Arctic” by E. Shevnina et al.

Anonymous Referee #1

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General comments

This paper presents an approach to estimate spring flood depth of runoff in a future climate using a stochastic modeling framework. The main focus of the paper is an application of this method to evaluate changes for the Russian Arctic. The method builds on statistical properties of historical data in combination with estimates of expected changes that are derived from climate model simulations of several generations. The authors conclude that increases in spring flood depths but decreases in its variability are expected for much of the Russian Arctic. They also conclude that a main advantage of their approach is that it requires relatively little data and can be used in areas where detailed observations are not available.

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The problem of estimating changing flood depths (or similarly, changing return periods of floods of a given magnitude) is certainly a challenge to engineering in many parts of the world. Stochastic approaches are quite common in engineering so the approach taken here could be possible to apply to infrastructure planning decisions. In general, the authors have used appropriate data for their climate projections, but in terms of the statistical and hydrological parameters, the data are drawn from Russian textbooks and reference material, which make them difficult to evaluate. The authors acknowledge this shortcoming, but I think it is a fundamental problem with the paper that also limits its applicability. Furthermore, it is not clear to me the degree of advance this method provides, in comparison with other methods.

Presently, the paper comes across as mainly a regional assessment of changing flood risks, which, although useful, I am not certain merits publication in HESS. The paper would be substantially improved (and more relevant to cite for other researchers) if the authors could show more clearly a) how their method compares with other stochastic approaches to evaluate change in flood risks, and b) how the method could be applied using other data sources than the reference tables available for the Russian basins they studied here.

Specific comments

P5 L1-17 The authors state that “[t]he stochastic approach was first proposed by Kovalenko (1993) and Kovalenko et al. (2010) simplified the basic stochastic model for applications of hydrological engineering”. This is all the background we are given on stochastic approaches to river engineering under climate change. Surely there must be many other relevant contributions to research on stochastic hydrological modeling. The authors must here put their method in the context of the field, the state of the art, and how their method contributes to advancing the research frontier (if it does).

P5 L18-19 The authors state that “[t]he aim of this study is to perform a regional-scale assessment of the future extreme flood events based on climate projections for the

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Russian Arctic". This is fine, but as mentioned above, I am not sure HESS is an ideal outlet for a study with such an aim.

P10 L8 It is not clear what the authors mean here. From the text it reads as if the model's prediction scores should be shown in Table 1, but I think the authors mean that the whole dataset is shown in Table 1. It must be clear why the authors refer the reader to look at Table 1 here.

P11 L17 It is not explained why there needed to be a statistically significant shift in the historical time series in order to consider it.

P11 L25 I am not too fond of personal communication when it comes to data references. Could these data not be obtained elsewhere? It means then that this study quite difficult for others to reproduce. Also, what reference is meant by "the multi-year catalogues of climatology (e.g. 1989)"?

P12 L28-29 It is not clear which statistical moments are meant here. The two moments shown in the table are explicitly not the same, so I am not sure what the authors mean by saying that they are assumed to be constant. Reading further, I assume this refers to a case or scenario where the authors used this assumption ("no model" case), but it is not clear from the text.

P12 L7-9 It is not correct to say that these are "5-10%" higher. Rather, the results are 5-10 percentage points higher.

P12 L20 Was there any reason for selecting these models? Previous research shows that the choice of climate model greatly influences the results of any hydrological model simulation that uses the GCM results. I strongly suggest the authors motivate why these models were selected. Are they representative of the whole ensemble, or is the sample perhaps biased in terms of key model aspects (climate sensitivity, hydrological response to temperature increase, etc)? To be clear, I do not think it necessary that the models be representative, but the reader should know why the models were selected

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and if there are any aspects of these particular models that could influence the result. For instance, if the models all are in the low end of the climate sensitivity range, the results obtained in this study could be overly conservative (or vice versa of course in the case of very sensitive models). This is important information for the interpretation of the results, not to say any practical application of them.

P12 L25 What periods?

P13 L5 The procedure of extraction from maps should be described much clearer.

P14 L5 It needs to be made clear to what degree these results were already published. If the figures used here are directly from some previously published report, they should be part of the methods and data, and not a result of the study. If the authors analysed spatial datasets for new geographical regions, it is ok to have them as new results here. But it is not clear what the authors mean.

P14 Results from Table 4 It is difficult to follow the discussion of the results when they are presented in absolute values in the table, but discussed in terms of percentage increases in the text. I would prefer the authors either discussed also the absolute changes in the text, or that the percentage changes are shown in the table, so that one can follow which figures in the table are discussed in the text.

P14 L22-23 "The strongest increase (over 27 %) of the mean values with a lowest decrease of the coefficients of variation (over 17 %) is predicted by CaESM2 for the RCP2.6 scenario." I can't follow this from the table – which parameter increase of 27% are the authors talking about? Precipitation, temperature, or spring flood depth?

P14 L25-27 Here the authors talk about the "European part of the Arctic", and refer to figure 3, where there is one region referred to as "Northern European Arctica [sic]". There is also another region termed "Kola peninsula and Karelia". Do the authors by "European part of the Arctic" refer to only the "Northern European Arctica", or to both these regions? If so, it would be good to state this, for instance by labeling the panels

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in Fig 3 as a, b, c, d, and then here refer to (Fig 3a-b) or similar. Not everyone knows where the Kola Peninsula and Karelia is. Furthermore, I assume this still only refers to territory within the Russian Federation, and it is therefore technically incorrect to refer to it as the “European part of the Arctic”. Such a region would include parts of Scandinavia as well. I suppose that calling this the “European part of the Russian Arctic” would be more correct. In general, it would be helpful if the authors referred to the sub-regions they define in a consistent way throughout the paper, both in text and figures, and also clearly outlined these on a map.

P15 L16-18 Here it is a bit difficult to follow what Hirabayashi et al found. From the text I assume they found a decrease, but of what magnitude? How do the results really compare?

P16 L17 What Strategy? Please explain.

Table 3 It is not clear what the percentage refers to. All periods? All basins? How many value pairs are compared?

Figure 1 The figure should indicate the critical value of the t-test for the chosen significance level. Is this the dotted line in the figure? Please label this line.

Figure 5 must be improved. It is very difficult to see the patterns, and what pattern that corresponds to which value. I would suggest using grey shading instead for at least some of the categories, so that one does not have to use so many different patterns that are difficult to distinguish on the map.

Figure 6 must also be improved for the same reasons. Also, the ordering of the figures should be the same as the order they are referred to in the text.

References P23 “Government development strategy. . .” I was not able to retrieve this file from the web link provided.

Language and other minor points

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Although the language is generally acceptable, there are quite a number of grammatical errors, and the paper needs editing before it can be accepted for publication. I have not noted all language points but list some issues that I noted here.

P3 L14 Remove “an” before “annual”

P3 L21 Replace “increases” with “increase”

P4 L8 Replace “this studies” with “these studies is”

P4 L9 Replace “calculation” with “calculation of”

P5 L29 Consider the choice of the word “alarm”. I suggest “a warning”, or more neutrally, “a highlight”.

P9 L5 Replace “iterator” with “an iterator”

P10 L9 Replace “The example” with “An example”

P10 L10 Replace “partition of” with “partition”

P10 L13 Replace “1-year incrementing” with “increments of 1 year”

P10 L14 Replace “critical of 0.05 level of the statistical significance” with “t critical value at the 0.05 level of statistical significance”

P11 L13 Replace “average” with “an average”

P11 L14 Remove two occurrences of “the” on this line

P11 L15 Replace “66% cases” with “66% of cases”

P11 L16 Replace “contain the” with “have”

P11 L16 Replace “then” with “than”

P11 L19 Replace “corresponded” with “corresponding”

P11 L21 Replace “per a” with “per”

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P11 L28 Replace “parameters” with “parameter”

P12 L1 Replace “the one” with “one”

P12 L6 and onward Please be consistent with the tense you are using. The discussion here should refer to the past tense and not the present.

P12 L9 Replace “gives the advantage of over 11–22 % in the percentage of the successful nominally predicted PDFs” with “gives an even larger advantage, with values 11–22 percentage points higher in terms of successful nominally predicted PDFs”

P12 L10 Replace “regional-oriented” with “the regional-oriented”

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