Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-473-AC1, 2018


Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Climate change will increase potential hydropower production in six Arctic Council member countries based on probabilistic hydrological projections" *by* Elena Shevnina et al.

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Received and published: 7 December 2018

The Referee #1 recommends to reject the manuscript due to "the following reasons:

1. Various methodological problems, including: - Very confusing method, with no validation to demonstrate correct capture of annual flow or hydropower variability. There are country-level annual hydropower generation data available through EIA that ought to be used to check for correct representation of generation." Answer: In this particular manuscript we did not pay much attention to the method itself since there are



more papers to describe the details (Shevnina and Silaev, 2018; Shevnina et al., 2017; Kovalenko, 2014; Viktorova and Gromova, 2008; Kovalenko, 1993). This method is suggested more than 20 years ago, and it is included to the course "Hydrological modeling" for Ms. and PhD students of the Russian State Hydrometeorological University. Most studies in the Fokker-Plank-Kolmogorov approach in hydrological modelling are published in Russian and there are also the manuscripts in English listed in the section of References. The discussion about the validation of the method is given further. As for the hydropower generation data, we think there is a typo, and the Referee #1 refers to IEA (https://www.iea.org/) instead of EIA (U.S. Energy Information Administration). Nevertheless, the IEA has data of hydropower generation per county, but we are not sure if that is freely available, and we do not estimate the potential hydropower production on an absolute value.

"- No proof offered to show that the MARCS model simulates statistical moments of annual runoff correctly. Answer: The model cross-validation procedure is described by Shevnina et al., (2017) in English and by Kovalenko (1993) in Russian. It includes several steps: to define the sub-periods in the observed yearly time series of river discharges; to set-up the model for the first sub-period; to simulate the exceedance probability curve (EPC) for the second sub-period and to compare with the EPC constructed from observations in the second sub-period (Kovalenko, 1993). The results on the cross-validation procedure for the annual runoff are already published by Kovalenko (1993) based on the historical observations on the catchments located in the North of Russia. In this study, we relay on these results and this circumstance was mentioned on the page 7 lines 210-211.

"- No apparent filtering for catchments or reaches of river that are actually developed for hydropower already or are suitable for hydropower plants." Answer: The data on the observed yearly time series of river discharges was filtered by applying the statistical tests to reveal non-homogeneity/trends in the time series according to Dahmen and Hall (1990), and to calculate the length of the reference period. In this case, the current

regulation rules can affect on the projected statistical moments of the annual runoff for the catchments with present hydropower network. To answer to the questions How? or How much?, a new study is needed.

"- No analysis or discussion as to whether the climate models used are able to provide any useful information on extreme precipitation conditions." Answer: In this study, we did not discuss the ability of the climate models to provide the projected values of the extreme precipitation conditions because the basic parameterization scheme by Kovalenko (1883) was applied. It means that the projected variance of precipitation was not accounted in the calculations, and the statistical moments of annual runoff were simulated only based on the mean of annual precipitation. To account the projected extremes of precipitation the method should be modified, and this is the next step further. This step can be done as soon as the simplest version of the AFA method (https://www.geosci-model-dev-discuss.net/gmd-2018-108/) will be discussed and published.

2. The study is behind the curve. A study published six years ago is taken to be "state-of-the-art" (line 83). In fact, there are now dozens of studies in the literature that examine hydropower production under future climate conditions, including monthly simulations of individual plants at global and regional scales. You need to build from the most up-to-date work in the field to demonstrate your contribution. If your method offers something that can't be achieved with the existing tools, then you need to demonstrate the advantages and performance. Answer: We can update the "state of the art" hydropower production literature, but it would indeed be nice to get clarification if the problem is with the method or with the lack of references to recent studies. We are not sure that the method itself is clear for the hydrological modeling community, where physically-based hydrological models are most common. These physically-based hydrological models are well developed tools to serve a short-term forecasting, and in many studies they are used to simulate "climate based" projections of streamflow runoff.



3. Very little in the way of new knowledge in the conclusions. There are various published studies that show wetter climate and increased hydropower generation in northern latitudes. Answer: Yes, we agree that more discussion should be given to the novelty of the study in terms of usefulness of the presented method to planning of hydropower production. In the revised version, we can expand the discussion section based on the papers like this: https://www.hydrol-earth-syst-sci.net/21/133/2017/hess-21-133-2017.html.

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