REVIEW of the paper

Importance of hydrological uncertainty assessment methods in climate change impact studies

Authors: M. Honti, A. Scheidegger and C. Stamm
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This paper assesses the uncertainty of flow prediction by hydrological model forced with different climate change scenarios. Hydrological model uncertainty is quantified by two different methods within a Bayesian framework - calibrating discharge time series and calibrating the discharge quantile directly. The results are presented to the relatively small catchments from the same region. I have a few comments which I think need to be addressed.

General comments:

A wide range of uncertainty analysis methods exists involving different levels of mathematical complexity and data requirements. The appropriate method to be used depends upon the nature of the problem at hand including the availability of information, model complexity, and type and accuracy of the results desired. As expected, the uncertainty results varies with the method used to estimate them, this is nothing new (see, e.g., Pappenberger et al., 2006). Different uncertainty analysis methods have their limitations and assumptions. Hence it is important is to test whether these assumptions are valid or realistic under the given modelling situation and problem at a hand and whether the results are realistic and consistent with the observation. However in climate change studies, it is impossible to get the “truth” observation of the future. This raised the important question of what method is the best for the uncertainty assessment in climate change studies, which is not properly addressed in the paper. I think one should be able to choose an uncertainty analysis method under given assumptions and limitations; and to test whether these assumptions are valid or realistic under the available information he\she had.

The author claimed that the source, structure and composition of uncertainty depended strongly on the uncertainty analysis methods. But what I found missing is that these aspects of uncertainty are not explicitly defined or mentioned in the paper. The authors have used different terms for different sources of uncertainty inconsistently throughout the paper, for example, hydrological, climatic, predictive, future climate, meteorological, total, final, future weather, weather generation, future climate uncertainty etc. Describe how these sources of uncertainty are represented in each stage of their experiments. In the current form all these sources are mixed up and confusing. Does uncertainty in each stage represent single source or accumulated source, for example does uncertainty in stage 2 represent uncertainty in stage 1 + uncertainty in stage 2 or does uncertainty in final stage

4 represent all sources of uncertainty? In this paper this is very important to understand what these terms refer to and how they are estimated. Note that it is often difficult to disaggregate total uncertainty into their source components because of their interaction and non-linearity of the model. Not to confuse, I think it is better to use only three terminologies, e.g. climatic, hydrologic and total uncertainty. Climate uncertainty is represented by 10 GCM-RCM scenarios, hydrologic uncertainty by Bayesian methods and total uncertainty is the combination of both. I strongly suggest to use the consistent terms throughout the paper including in the tables and figures.

Specific comments:

P502, L23-L24: This sentence is completely wrong. The uncertainty assessment method depends on the source of uncertainty to be analysed, but not vice versa.

P503, L16: …. in the **near** future.

P503, L22-P5043: Do not describe the methods in the Introduction section; can be moved to method section.

P505, L20: What is predictive uncertainty of hydrological models? If I understood correctly in this paper it is uncertainly of hydrological models given that forecasts are perfect (no uncertainty), but need to define explicitly (see general comments).

P505, L28: the most popular formal and informal likelihood calculation methods in **uncertainty analysis** ….

P506, L1: hydrological predictive uncertainty due **to** invalid statistical assumptions…

P506, L17-L19: I do not agree with this statement. In the time series approach quantile Q5, Q50 and Q95 have already computed from the model realizations.

P507, L20: Show rainfall stations in Fig. 1.

P508, L5: It is not clear why stochastic weather generator is used? I suggest to have a small paragraph after section 2.2 to explain the context of three climate data used in this study.

P509, L5: Number tables or figures based on their first citation in the text, i.e. the first mention of Table should be Table 1.

P511, L24 - L26: What period was used to compute these flow qantiles?

P512, L10: Is total uncertainty the combination of hydrological and climate uncertainty? Define these terms explicitly before they are used (see general comments). What does mean by a hybrid approach?

P513, L2-L9: This sentence is not complete, rephrase the sentence e.g. then the flow quantiles were selected for each ….

P513, L2-L9: Use same terminology throughout the text and figure. For example, weather data in the text vs climate in the Fig. 3. From the Fig. 3 it seems climate data refers to all weather data except precipitation.

P513, L15-L16: What are flow indices? Are these referring to flow quantiles?

P513, L15-L16: In general 10% of the observed flow data should be outside the Q95 and Q5 interval. In stage 3, the observed flow data in not known. However in stage 1 and in stage 2, it is possible to compute the actual percentage of observed flow data inside the Q95 and Q5 interval (percentage coverage). Did you compute the percentage coverage in these stages?

P514, L7: The details of the approximate quantile likelihood function are described in Appendix B **and C.** (Appendix C is not referred to the text).

P515, L20-L22: Stage 3 GCM-RCM chain is better than Stage 2 weather generation. I do not see significant uncertainty in the figure 4, indeed quantiles are matching very well.

P517, L15: Given that the paper is a bit long, section 3.2 and section 3.1 can be merged.

Tables and Figures

Fig 3: I understand what WG, CC means, but it is never defined in the text.
This is confusing text - *White stars indicate stages of calibration.* Does it mean that calibration of hydrological parameters is done only in stage 1?

Fig 4: To be consistent with Fig 3, use stage 0, 1, 2, 3 and 4 in the legends if these refer to observation, hydrological model, weather generator and GCM-RCM chain.

Fig 4:9: What does Box and whisker diagram represent, how these are calculated?

Fig 5: I think figure 5 contains too much information.

Fig6 – Fig10: Use Stages in either y axis or x axis in both panels. Use the consistent notations (e.g., Stage 0, not St 0). Table 7 also presents the relative change, so no need to repeat in figure, I strongly suggest to remove the bottom panels. Then Fig 6, 7 and 8 can be combined together to compare TS, K1 and K2 approach in a single plot.

Table 1: Define all affected storage symbols.

Table 2-4: Endnote symbols a and b need to be swapped.

Table 2: Table 2 does not present parameters for paves area.

I think Table1-4 can be removed or moved to the appendix.

References

Pappenberger, F., Harvey, H., Beven, K., Hall, J., Meadowcroft, I., 2006. Decision tree for choosing an uncertainty analysis methodology: a wiki experiment http://www.floodrisknet.org.uk/methods http://www.floodrisk.net. Hydrol. Processes, 20: 3793-3798.