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Hydrology and Earth System Sciences Discussions

Interactive comment on "Catchment modeling and model transferability in upper Blue Nile Basin, Lake Tana, Ethiopia" *by* A. S. Gragne et al.

A. S. Gragne et al.

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Authors’ response to referee # 1 (anonymous)

First of all, we (authors) would like to apologize that it took so long for us to reply to the comments of the referees. The first author suffered from some illnesses (incl. stays in hospital) and was not able to respond to his e-mail in the last weeks since he is back to his home country Ethiopia.

We received many good and detailed comments from a total of 5 reviewers on this paper, which is a good sign for the wide interest of our paper. The reviewers pointed out a number of shortcomings of the paper and gave excellent input into interesting future studies. We would like to significantly revise the paper for possible publication in HESS – if invited to do so by the editor. In the following we will reply to each of

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the reviewers separately.

Referee # 1 had many very valuable comments and we would like to response to his/her main points:

1) The catchment modeling and model transferability study was limited to two sub-catchments because of the limited availability of data in the Lake Tana catchment, which is typical for many developing countries. The studied catchment Gilgel Abay is the main tributary to the lake, thus it can be called the source of the Blue Nile, but around 60% of its area is ungauged in terms of runoff. Only the two main perennial rivers that drain the Gilgel Abay catchment have hydrologic records, consequently, the development of a hydrological model for that region and its transferability is of high importance in this area that has over-regional importance in terms of water resources development. The 3rd gauging station in the study area was established only in June 2005 (location downstream of the confluence of the gauged catchments), but up to today no rating curve was developed. We are aware of the limited ‘generalizeable value’ of the results and we stated that clearly in the manuscript.

2) We do not fully agree that we did not consider the parameter uncertainty; i.e. see the discussion of well-defined/undefined parameters which parameter spaces were analyzed based on $>$1,000,000 Monte Carlo simulations for each catchment representation (CR). No doubt, much more could be done in this field (as demonstrated e.g. by the Lancaster group in a number of recent papers), but this was not the focus of this paper. We also feel because of the limited data quality (cf. discussion of figures 2 and 5), that this study site is the ideal area to study this further. We agree with the reviewer that Pappenberger and Beven (2006) have a point in requesting that every modeling study should consider parameter uncertainty – this is what we did to some extent with the Monte Carlo simulations and the investigation of the suitability of different model structures (various degrees of distributed computations). However, as in this catchment (and very likely many other catchments world-wide) other sources of uncertainty (i.e. input data uncertainty) are significant, but developing catchment models

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and testing their transferability is of crucial importance for water management, we do not agree that such studies should not be published. Actually, if the editors of our best journals would only allow modeling papers to be published if they include an extensive parameter uncertainly – I would propose a complete model uncertainty study including all possible sources of uncertainty in that case – most of the currently published papers (incl. many excellent ones) would have to be rejected.

3) Model calibration: Before manually calibrating the models, the parameter space was explored executing millions Monte Carlos simulations (MCS) and using the Nash-Sutcliffe efficiency (Reff) and the water balance error as guiding objective functions. The parameter value ranges for each model parameter were narrowed down (Table 2) and millions MCS calculations were executed for each catchment representation (CR). Then additional manual adjustments of the parameter values were executed. An automatic calibration procedure was not applied as besides optimizing the mentioned objective functions, meaningful parameterization from a process point of view was important (cf. discussion of different CRs, catchment properties; figures 4 and 5), in particular with the additional objective in mind to test the model transferability. We will explain this procedure better in the revised manuscript.

4) Epot estimation: The only available daily observed meteorological data were rainfall and temperature, while monthly data of relative humidity, sunshine duration, minimum temperature, and maximum temperature were available on monthly basis. Unfortunately, in the study area, like in most parts of Ethiopia, records of radiation are not available. Hence, to compute Epot using the Penman-Monteith approach, calculation of the net radiation was done based on the extraterrestrial radiation which can be estimated based on the geographic position and day of the year. As a result, Epot computations could only be carried out on monthly basis and transferred to daily data using the daily temperature and comparing to the mean monthly temperature. We did not find a better process-based alternative under the given circumstance and would like to add that the monthly –> daily breakdown has been applied successfully

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in a number of studies outside boreal climate conditions. This will be clarified in the revised manuscript.

5) The computation of the lapse rates (p. 818) was done using the long-term mean rainfall and temperature records at the meteorological stations located inside the catchment and altitude of these stations. We agree that values are surprisingly low, but we have to assume that they are caused by the local micro-meteorological conditions in the Lake Tana region.

6) The component of the upper outflow of the upper reservoir was named ‘direct runoff’. We will define this and other terms more carefully in the revised manuscript. Additionally, we will improve the language at the indicated (and several more) locations.

7) Conclusions: We will partly reword them in the revised manuscript and write them sharper. However, we do not agree completely with the referee’s assessment of this part. We learned a lot from the model application about the catchment functioning, in particular from the only partly successful application at daily time step, the limitations of the applied HBV model structures in this environment and the difficulties of model transferability.

Pappenberger F, Beven KJ. 2006. Ignorance is bliss—or 7 reasons not to use uncertainty analysis. Water Resources Research 42(5): W05302. Doi: 10•1029/2005WR004820.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 811, 2008.