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Hydrology and Earth System Sciences Discussions

Interactive comment on "Modeling impacts of climate and land use changes on catchment hydrology: Meki River, Ethiopia" *by* D. Legesse et al.

D. Legesse et al.

dagnachewl@yahoo.com

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We truly appreciate the constructive and detailed comments and suggestions given by this reviewer. It has helped us to look into the manuscript from a different perspective. We have tried to address most of the comments, questions and suggestions as below. Although some of the suggestions and comments are of global/general nature in modeling, we have made an effort to address some of them. We can not pretend that it is a 'new' contribution. However, it is one contribution towards improving the modeling tool as well as in applying it to address a timely and scientifically important issue.

1.It is true that we did not run the model using combined scenarios. The main reason for this is that the various parameters have different response time making it very difficult to differentiate between the respective impacts on the outputs. For example, to combine land cover change scenarios with climate ones it is more appropriate to use tightly-coupled vegetation models with hydrological models. This is something we want to address in the near future using Dynamic Global Vegetation Models (DGVM) coupled with PRMS.

2.It is also true that there are conceptual similarities between this manuscript and the one published in J. Hydrology on an adjacent catchment. The major difference is the fact that the Meki catchment (studied in this work) has a vast wetland that modifies its hydrology. The basic PRMS model does not have the ability to consider wetlands. We, therefore, modified the soil water balance module of the model in such a way that wetlands are separately considered.

3.We have incorporated some of the comments on the language and would still appreciate any additional comments

4.PP4 LL 27: we replaced variability with change wherever appropriate

5.MMS is described better

6.Lake Ziway is indeed the lowest point and it is clearly shown in Fig. 1

7.We agree that the phrase 'linear regression method was used to fill in missing climatic data values." is misleading. In fact, what we did was we analyzed the climatic data for any possible outliers and missing periods. We found that there were less than 5% of the time series data (rainfall, minimum and maximum temperature) were missing. We then estimated the coefficients of correlation between adjacent stations and determined loading factors. Statistical regression using the loading factors was then applied to fill the missing values.

8.We have moved Section 4.3 to Section 2.1

9.Sensitivity analysis were carried out on all the parameters with initial values and incrementation values. Those parameters with the most impact on the output were then selected for calibration. This avoids the effor of calibrating the model on many parameters, which is very time taking computationally without necessarily improving the final result.

10.One of the most difficult issues in model calibration is in deed in identifying uncertainties attached to model parameters, which themselves are often adjusted through iteration. We agree and believe that this issue needs to be addressed. However, this requires monitoring and field data measurements of at least some of the parameters in order to be able to asses uncertainties. This requires an experimental hydrological site which we may setup in the future. 11.The auto-calibration technique called the 'Rosenbrock optimization technique (Leavesley et al., 1996)' that is implemented in MMS/PRMS was used in this work

12.The objective function is a 'root mean square error' as implemented in the model. Based on the given comments, we have incorporated other 'goodness of fit' measurement results in the manuscript'.

13.We have rephrased 'limited in capturing peaks. . .good for dry seasons' more appropriately so as to reflect the results more understandably

14.Figures are improved whenever possible 15.One way of validating the separate contribution from baseflow, interflow and surface runoff is by comparing the total flow with the observed ones during low, high and intermediate flow periods where the respective contributions of the three components are known (dry period is mainy baseflow, wet period is surface and interflow while intermediate periods are dominated by interflow).

16.Page 4548, line 1-3: how do we know the parameters fit for the stationary (present) conditions apply to non-stationary conditions or a different climate state? This at least warrants some discussion.

This may be true. But the entire process of model formulation, calibration and validation is to see that the model functions 'correcly' for the periods where we have data and then apply it for periods where we have no data or where conditions change. This is a known limitation of a modeling approach.

17.The nine scenarios were selected more or less arbitrarily but within range of anticipated or known values (ICPP or past changes). It is possible to have more scenarios but we have limited them in the interest of simplicity. 18.A statistical summary of results is included 19.The compounding effects as suggested is something very 'realistic'. It would be difficult to address it with this model and we would suggest a coupled Dynamic Vegetation Model with hydrologic model for this purpose. 20.It is true that model uncertainty may overshadow some of the scenario analysis. However, the model calibration and validation exercise is meant to make sure that the model is 'usable' for scenario analysis, although it may still suffer from several uncertainties. This is a fundamental comment addressing a fundamental issue in modeling. 21.GCM outputs may not have the necessary spatial resolution but proper 'downscaling' may yield better capacity in terms of scenario analysis than the more simplistic arbitrary values. This, too, requires further work in downscaling GCM outputs to a catchment scale. 22.The 'Conclusions' section is modified as per the suggestions

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/7/C2312/2010/hessd-7-C2312-2010-supplement.zip

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