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Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "A modeling approach to determine the impacts of land use and climate change scenarios on the water flux of the upper Mara River" *by* L. M. Mango et al.

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Dear Editor and reviewers:

We thank you for the valuable comments and reviews provided. We have found the comments useful and will help strengthen the manuscript. The reorganization and some technical comments raised are all addressed. We have shown the response below each comment. We have added new tables and figures were added and also redrawn. New simulations on climate change scenarios and the corresponding results were added.

Authors

Interactive comment on “A modeling approach to determine the impacts of land use and climate change scenarios on the water flux of the upper Mara river” by L. M. Mango et al. Anonymous referee #2. The paper deals with an interesting and important research question: what is the impact of land use and climate fluctuation on river discharge? To answer this question, the study focuses on two mesoscale basins in Kenya: the Nyangores and Amala basins, which are tributaries of the Mara basin. For land use detection Landsat imagery was used. Land use and climate change scenarios, the latter derived from the IPCC, are used to study their impact on river discharge, which is modelled with the SWAT model.

The authors use two different rainfall input modes for their SWAT model. One is based on measured daily precipitation, the other is based on the Famine Early Warning System (FEWS) Rainfall Estimation (RFE) imagery, which is a computer-generated product that uses Meteosat infra-red data. The authors demonstrate that discharge in these basins is more sensitive to changes in rainfall as to changes in land use.

There is a major concern on the scientific value of the work. The authors claim that NSE (Nash-Sutcliffe Efficiency) values of 0.622 and 0.586 for their RFE calibrated models are considered good (page 5864, line 16). However, these results are average. The authors have validated their RFE models and obtained NSE values of 0.389 and 0.094 (page 5864, line 22), which they consider as suitable for predicting land use and climate change impacts (page 5864, line 24). Although the authors are right in stating that discharge modelling is in many ways a challenge, the NSE coefficients of the validated models are not really suitable for hydrological modelling at this stage. Impacts of land use and climate change are too important to be calculated with a hydrological model that does not suffice. Furthermore, the authors indicate that the calibration of the rain gauge based models gave disappointing results (NSE of 0.076 and –0.533).

Response; We have included references and table where NSE values in the range we

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found are considered to be good. We have now also rerun the model and got better calibrating parameters which improved the NSE values. The relatively improved model performance indicators are now included in the revised version.

The location of the used rain gauges could be indicated in Fig. 1, which makes a comparison with the 30 artificially generated RFE rain gauges possible.

Response: The location of the rainfall gauges have been added in Figure 1.

A short discussion on the two types of rain data (one measured, one artificially generated), their availability, their shortcomings and how both types influence the modelling would improve the paper. If the calibration of a model is cumbersome due to lack of proper rain data, simulating discharge under different climate change scenarios will become a very tricky job.

Response: We have added the description of the two rainfall data and also compared the model performance under these two different rainfall data sources (Figure 4).

The authors themselves already hint at this in their conclusion. They state that the calibration process my not have been adequately captured variations in the different hydrological years (page 5868, line 20) in both the rain gauge and RFE models.

Response: This is true, however the RFE model was able to give a much better result and in an area with scarce data such as the Mara Basin, it is useful to explore the possibilities of using such data sources to determine whether it is possible to carry out hydrological modeling and scenario analysis and determine the sensitivity/ impact to a certain degree of known accuracy.

Furthermore it is not clear which models are used to calculate the discharge under the different scenarios. In the Figs. 3-8 only the calibrated RFE model discharge is given. Why not use the validated model? It would be of great help when the measured discharge in the Figs. 3-8 is included to analyse model performance.

Response: The validated model was used to calculate the discharge and the statistics

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are given in Tables 7.

In the introduction, changes of the discharge regime due to land cover change are mentioned (page 5853, line 24). Since the NSE is some sort of "end-of -the-day" measure, which means that only over-all performance is assessed, it is important to compare peaks and discharge recession of the models with the measured data in order to assess model performance.

Response: It will be difficult to analyze the behavior of a particular storm on hourly basis. But in this study daily average discharge and rainfall records were examined to determine river response to rainfall events. It in this study we have evaluated the model efficiency on a daily basis. According to the model simulation result there is always a difference between observed and simulated peak flows. In most of the days the model relatively predicts well the rising and recession period.

It would also be of help to the reader to mention which calibration technique has been used (manually or automatic).

Response: This has been addressed. Automatic calibration was used to try and further fit the simulated data to the observed.

Here lies a great opportunity for the authors to examine and discuss the performance of their SWAT model (both after calibration and after validation) under scarce data conditions. The evaluation should incorporate model performance, parameter identifiability and a small uncertainty analysis (e.g. Beven & Binley, 1992; Woolridge et al., 2002; Wagener, 2003; Gupta et al., 2005; Seibert & Beven, 2009). The incorporation of a discussion on rainfall (measured vs. modelled), runoff (measured and modelled), the used (soil) parameters and the scale at which the modelling takes place would improve the paper considerably.

Response: we have now added a section to look into this in the revised manuscript.

Other concerns are: It would be helpful for the reader to explain the parameters that

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are given in table 2, especially for those readers who are not familiar with SWAT.

Response: That is Table 5 now.

It would also be of great help to provide a list of the soils used in the SWAT model and provide a map with their distribution in the basins. Although soils where used (page 5857, line 23) no further information on soils is given. This is an omission, especially since SWAT is a soil and water assessment tool.

Response: this has been addressed (Figure 3 and Table 4)

Please write a caption at tables 3 and 4. Please use r instead of R for Pearsons correlation coefficient.

Response: Addressed. That is Table 7 now.

Please repeat the caption of table 5 in table 6.

Response: Addressed. The header rows in the tables are self-explanatory and there is no need for the captions.

Please check the captions of tables 7-10, they appear to be mixed up.

Response: Addressed

Please remove the lines between the points in Figs. 9 and 10. The percentage of the change of water balance components is given on the vertical axis; therefore, the lines between the dots do not have a meaning.

Response: Addressed

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/7/C4529/2011/hessd-7-C4529-2011-supplement.pdf

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 5851, 2010.