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 meso-scale 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). 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. 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.

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.

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

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.

Other concerns are:

It would be helpful for the reader to explain the parameters that are given in table 2, especially for those readers who are not familiar with SWAT.

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.

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

Please repeat the caption of table 5 in table 6.

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

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.

References:

Beven, K. & Binley, A. M. (1992). The future of distributed models: Model calibration and predictive uncertainty. Hydrological Processes, 6, 279-298.

Gupta, H. V., Beven, K. J., Wagener, T. (2005). Model calibration and uncertainty estimation. Encyclopedia of Hydrological Sciences.

Seibert, J. & Beven, K. (2009). Gauging the ungauged basin: how many discharge measurements are needed? Hydrology and Earth System Sciences, 13, 883-892.

Wagener, T. (2003). Evaluation of catchment models. Hydrological Processes, 17, 3375-3378.

Wooldridge, S. A., Kalma, J. D., Franks, S. W., Kuczera, G. (2002). Model identification by space-time disaggregation: a case study from eastern Australia. Hydrological Processes, 16, 459-477.