

## ***Interactive comment on “Anomaly in the rainfall-runoff behaviour of the Meuse catchment. Climate, land use, or land use management?” by F. Fenicia et al.***

**F. Fenicia et al.**

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We thank the Reviewer for his extensive comments on our manuscript. We address the important issues raised on his commentary in our reply given below.

*Reviewer comment: My main major concern is with regards to the method used in the hydrological modelling. Firstly, the model is evaluated based on the GLUE framework of Beven and Binley (1992) but using a moving time window rather than evaluation simultaneously over the entire observation period. The authors find that by allowing the model parameters to vary over time, the performance of the model can*

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*be improved, and state that time varying parameters can correct most of the modelling error (pg. 1801, lines 8-9). However, is this not logical since the best parameter set is chosen for each 4-yr time-window, the aim of which is to improve performance for each time-window? An assumption is then made as to which parameters should be allowed to vary over time, one of which is alpha, a calibration parameter which accounts for the fact that forest transpiration may vary with forest age. It is found that by varying this parameter over time the model performs better over the entire period, and it is suggested that this provides evidence that the change in the water balance (as identified by the rainfall-runoff anomaly) may be the result of the change in forest age. However, the use of the model does not prove this, as it seems logical that by allowing this parameter to vary over time that the model performance can be improved. If the model is sensitive to changes in this parameter then by allowing it to vary will consequently lead to large changes in the results. Given these points it seems very optimistic to state that land use and land management provide a more likely explanation (page 1804, line 1) than climate change for the observed changes in runoff. At the least these issues need to be discussed, and I would suggest presenting results of the sensitivity analyses so that the reader can assess the sensitivity of the model to the various parameters.*

Authors reply: We thank the referee for this constructive comment and we shall provide a sensitivity analysis of model parameters. The reviewer finds it obvious that by varying model parameters the model performance can be improved. We agree with this point. However, our objective was not just to improve model performance, but to identify trends in model parameters that could be related to variations in catchment characteristics. May be we did not stress this point enough in our paper. In the revised version, we shall include a final simulation with an imposed temporal variation of model parameters, so that the catchment dynamics can be described by a single representation of reality. We hope that this way our objective becomes clearer and this criticism can be partially answered.

*Reviewer comment: The description of the model set up is unclear. For example, what are the spatial and temporal resolutions? Also, the description of the model parameters needs improving. For example, why were the interception thresholds all multiplied by the same calibration parameter ( $C_i$ )? This may allow the interception of the various land use classes to vary proportionally, but what is the reason for doing this? A discussion of such issues is needed. Please expand on the model description and make the parameter descriptions clearer.*

Authors reply: We shall explain this point in further detail. We vary the thresholds proportionally to try to avoid unrealistic parameter combinations in the calibration phase, such as an interception threshold for urban area that is larger than that of forest. Moreover, calibrating one interception threshold for each different land use would result in too many parameters, so we try to condense the interception properties of different land uses in one parameter.

*Reviewer comment: The authors use climate data for De Bilt in The Netherlands to calculate evapo-transpiration (ET) over the entire Meuse basin. This seems to be one of the major weaknesses of the study. On page 1795 (lines 3-6) it is stated that these provide an acceptable agreement with observations within the catchment area. However, which observations are being referred to here? And moreover, what is meant by a reasonable agreement? Please show this evidence, for example some graphs and/or statistical tests showing the agreement between the estimates and the observed data. Also, have any measures been taken to account for the spatial variability in ET within the basin? If so, which? If not, please discuss the implications of this.*

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Authors reply: this point has been mentioned by other reviewers as well. The choice of using this station was made in the study of Ashagrie et al. (2005) on which our work is based. The choice was motivated by the fact that this station was the closest to the area that could cover the entire observation period. We shall introduce a comparison between the De Bilt station and other stations within the catchment for the latest years in order to assess the uncertainty associated with the use of these data.

*Reviewer comment: It is stated that a similar anomaly was found in the Moselle catchment, and that this provides evidence that the anomaly cannot be attributed to data errors. However, can you be sure that this is the case? Perhaps changes in the measuring method were implemented in both stations at the same time? It may be useful to examine the metadata of both stations to check this.*

Authors reply: clearly we cannot exclude that data errors could not be the cause of the anomaly. However, the fact that in the neighboring catchment, with different data, the same anomaly appears suggests that data errors are not a likely reason. Clearly it is a hypothesis, but we have good arguments to support it.

*Reviewer comment: In a number of places in the text the authors make substantive statements without providing evidence or references. For example: pg. 1789 (5-7), pg. 1794 (20-21), pg. 1795 (21-22), and pg. 1804 (6-9). Please ensure that such statements are supported.*

Authors reply: we shall provide additional references on these issues.

*Reviewer comment: The authors refer to the work of Ward et al. (2008) on page 1790 (line 27), saying that they found a negligible effect of land use change on Meuse*

*discharge. In fact, they found that land use change had a huge effect on Meuse discharge over the last millennium, but that the climate signal was more important over the last century. This should be addressed more carefully.*

Authors reply: We shall rephrase this more carefully.

*Reviewer comment: The paper would benefit greatly from a discussion of the limitations of the method and the results, and what implications these could have for the results and conclusions. At the moment this is lacking, and the conclusions seem to be given with too much certainty.*

Authors reply: this point has been underlined also by other reviewers. We shall extend the discussion and be more modest in the conclusions.

We also thank the reviewer for his minor comments, which we shall take into account in the reformulation of the revised manuscript.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 1787, 2008.

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