

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 greatly acknowledge the useful comments of the reviewer, who identified some limitations of the current paper and suggested ways for improvement. The reviewer mentions two main concerns on which we elaborate in the following reply.

Reviewer comment: No historical land cover data is used and it is unclear what figures were used to specify the respective surfaces for each land use in the basin. The actual factual evidence on forest management changes in the basin is slim (restricted to some Dutch references). It would be helpful to have some more information on

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historical land cover changes and management practices to support the authors' hypothesis.

Authors reply: We shall provide some more details on the information available to us with respect to the land use change that took place in the area, and provide maps that illustrate the type of changes. Furthermore, we shall try to add additional references to support our hypothesis.

Reviewer comment: Other explanations for decreased runoff are not explored or mentioned. For example, decreased runoff began at the same time when mine works activities developed in the Meuse basin (modifying underground water circulation), canalisation works took place in the French section of the basin and war damage reconstruction came to an end (with increased net water consumption from various heavy industrial plants). These historical factors are not properly discussed, as they seem to imply considerable and complex changes in water circulation and consumption in the basin.

Authors reply: We shall address in further historical detail the type of changes that took place in the area and discuss their potential impact on water resources. We shall mention alternative hypotheses that could potentially explain the anomaly that is displayed in the Meuse catchment.

Reviewer comment: it would be useful to have a native English speaker proof-read the paper.

Authors reply: we shall do so.

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Reviewer comment: The land use/cover changes analyzed by Garcier (2007) concerned the nearby Moselle catchment, not the Meuse. The authors do not state clearly whether similar changes occurred in the Meuse catchment. More generally, it is unclear whether the authors stand by their assumption that land cover changes were negligible over the course of the century

Authors reply: The description of the historical changes in the catchment structure has been based on Garcier (2007). We know that the Meuse and Moselle catchments have similar history. However, we shall perform more research on this. By varying model parameters over time, we relaxed the assumption that catchment properties and particularly land use are constant over time. Some effects of land use change, such as the gradual change from deciduous to coniferous forest are taken into account explicitly, others are considered implicitly by varying model parameters. We shall try to be clearer on this point in the revised version of the paper.

Reviewer comment: p. 1791, l. 13: I don't understand the reference to FAO (1995) and a page reference would be helpful: '90 to 99% of forest in Europe is functional production forest'. Does that mean that forests are actually exploited for wood? That there are artificial plantations? Since the figure is quite high, I suspect it incorporates the forested areas of Scandinavia and doubt it could apply to the Meuse catchment.

Authors reply: We shall do more research on this and try to be more detailed on what type of information is available on the topic. However, the main aim of this paper is to indicate that our hypothesis is plausible from a physical perspective, and that parameters are within physically realistic range. Hence it justifies further research, which should include digging into archives and in the historical literature.

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Reviewer comment: It would be helpful to have a better map that would show the extent of the Meuse basin, the sub-section area (21000 km²) investigated and the location of the meteorological station of de Bilt, the gauging station of Borgharen and the precipitation stations.

Authors reply: we shall include a better map of the area.

Reviewer comment: The spatial proxies used in the study (and notably the use of De Bilt as the sole source of meteorological information) introduce considerable uncertainty in the modeling outcome. It should be clearly stated/discussed.

Authors reply: as replied to Reviewer 4, we shall compare the meteorological data of de Bilt to other stations within the catchment for the years available to evaluate the uncertainty introduced.

Reviewer comment: It is unclear what is in decline: wood production? Forested areas (would contradict l. 17)? l. 26: it is unclear what the "remaining part, used for pasture" is.

Authors reply: We shall formulate this differently. We meant to say that although forest areas did not decrease, wood production did. We considered Farmland as the sum of Agricultural land and Pasture. The "remaining part used for pasture" is the part of Farmland that is not used for agriculture.

Reviewer comment: I don't quite see where the five land use categories fit in the model. Could figure 4 be modified to explain this point more clearly?

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Authors reply: We shall provide a more detailed figure.

Reviewer comment: The role of the C_i factor is not clear

Authors reply: The C_i factor multiplies the interception threshold selected for different land uses (Table 1) in order to let them vary proportionally in the calibration phase. We shall clarify this point in the revised manuscript.

Reviewer comment: What proportions for each land use were selected? Were these proportions allowed to vary with time?

Authors reply: The proportion of deciduous and coniferous forest was allowed to vary with time, while the others remained constant. In the 5th and 6th paragraph of section 2 we give the proportions of land use used in the study.

Reviewer comment: p.1799: what is the sampling rate for discharge measurements?

Authors reply: The sampling rate for discharge measurements is daily (Section 2, paragraph 2).

Reviewer comment: The result section emphasizes the importance of parameters $Nlagf$ and α in explaining much of the variability. However, in the absence of a discussion on land use change assumptions, it is difficult to make much of the significance of α . The discussion section is rightfully careful when it comes to conclusions and it would be useful to indicate what further research could be

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conducted to overcome the hurdles identified in the paper.

Authors reply: We shall discuss in more detail the assumptions on land use change in the catchment. Our main assumption is that model parameters can be related to catchment characteristics, and therefore their variation, such as in the parameter alpha, can be associated with variations in catchment properties, such as the evaporation demand of growing forest. We shall provide more detail on what further research can be done. In the specific case, it is necessary to better investigate the historic development of land use. In general, it is important to better understand the impact of forest age on catchment runoff.

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