

## ***Interactive comment on “Strong increases in flood frequency and discharge of the River Meuse over the late Holocene: impacts of long-term anthropogenic land use change and climate variability” by P. J. Ward et al.***

**P. J. Ward et al.**

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We thank David Labat for his comments on our paper and are pleased with his compliments regarding the originality of the research.

A general comment was that the description of the (input) database should be shortened. We agree that the 'Methods and approach' section is fairly lengthy, but this is in part due to the fact that we have chosen to discuss the climate and land use input data here, rather than in the 'Results' section. Of course, since the climate input data are actually climate model outcomes, and the maps used for the description of land

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use changes were also developed as part of our study, these could be discussed in the 'Results' section. However, we have chosen to discuss these in the 'Methods and approaches' section so as not to cause confusion between the actual results of our hydrological modelling experiments (i.e. the discharge results) with the model input. Hence, we feel that it is necessary that the database description is fairly lengthy. However, we will shorten the 'Methods and approach' section where possible in the revised manuscript, especially the section on soil water holding capacity.

We now address the more specific comments raised in the review:

1. It is stated that the hydrological model is not understandable in itself and that Fig. 2 is very poor. We agree that the description of the STREAM model in the paper is short. We chose to keep the description short as a detailed description of the model is available elsewhere, e.g. Aerts et al., 1999. Nevertheless, the description in our paper should provide enough detail to allow readers to understand the general principles of the model. Hence, we will expand the description of the STREAM model (section 3.1). We feel that Fig. 2 gives a succinct and accurate representation of the model, and have therefore chosen to retain this figure. However, we will improve and expand the caption to the figure, so that it is more understandable as a stand-alone entity; we feel that this concurrently improves the understandability of the figure.

2. The reviewer states that the land use database constitution should be clarified. We agree, and will add a graph to the new manuscript summarising the changes in land use over the time-slices studied.

3. The reviewer states that we have not given the reasons for using the STREAM model. A detailed reasoning for this decision is available in the report by Ward (2007, p. 5-10, [http://ivm5.ivm.vu.nl/adaptation/project/files/File/Documents/Report\\_Meusepalaeo\\_Methods.pdf](http://ivm5.ivm.vu.nl/adaptation/project/files/File/Documents/Report_Meusepalaeo_Methods.pdf)). However, in the revised manuscript we will also provide a succinct summary of the most important reasons for the selection of STREAM (in section 3.1).

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4. The reviewer states that the bibliography should be in one paragraph, and not disseminated throughout the text. We assume that the reviewer hereby refers to the referencing to datasets used in the study. For example, we have mentioned that climate data were taken from the ECA&D website in section 3.2.1, land use data from the CORINE website in section 3.2.2, discharge data from various sources in 3.3 etc. We feel that the only way in which these data sources could be removed from their current positions would be through the use of footnotes. However, the use of footnotes is discouraged by the journal. Hence, we refer to data sources in the text at the same point as the use of the dataset is described. In certain cases this can indeed lead to fairly lengthy references to the datasets, but this is sometimes unavoidable since numerous data providers state the manner in which the data must be cited in the terms and conditions of use (e.g. CORINE dataset).

5. We are pleased that the reviewer found section 5.3 interesting, and agree that it would be useful to delineate the uncertainties into those associated with database uncertainty and physical process uncertainty; we will make such a distinction in the revised manuscript. We also acknowledge that it would be even more powerful if we could quantify the uncertainties. However, given the application of the model to palaeodischarge (for which no observed time-series is available), the size of the uncertainties are themselves unknown. For this reason we suggest that the absolute values of our discharge results should not be treated as precise retrodictions of discharge at specific times, but indicative of the major trends over the long-time scale, and of relative changes in discharge and flood frequency between the time-slices studied (section 5.3). Related to this point, we will improve and expand the sensitivity analysis in the revised manuscript.

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