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Hydrology and Earth System Sciences Discussions

Interactive comment on "Hydrological responses of a watershed to historical land use evolution and future land use scenarios under climate change conditions" *by* R. Quilbé et al.

R. Quilbé et al.

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First of all, we would like to thank reviewer #2 for these relevant comments. Our answers are given below :

General comment :

Reviewer #2 : Following other referee comment, more information about calibration and validation of hydrological model and climate scenarios is needed. Indeed, the authors indicate they present it in papers not available yet. This make very difficult for the reader to estimate the quality of the results. The way the results are assessed could maybe be improved as averaging or homogenising the results of all the ombinations

of GES scenarios may lead to unrealistic results (some detail is given in the specific comments).

=> Authors : More information has been given about the components and the calibration of the hydrological model in sections 2 and 3. Also, the methods used to determine the future meteorological series have been shortly described (section 4.2.1). We understand that the companion papers (Quilbé et al., 2007 and Savary et al., 2007) would have facilitated the understanding and the assessment of the results. Some parts of these papers will be joined to the revised manuscript for a better understanding. Note that these papers are currently in the correction phase too and should be published in the same time as the present paper. Regarding the homogenisation of the results, it would be very heavy to present in detail the results for all GCM-GES-M combinations and difficult to get to any conclusion, except that we cannot say anything. Note that the averaging is done on the difference between future and reference period for all GCM-GES-M combinations. We calculate the mean of the differences, and not the difference of the means (future mean vs reference mean), which would not make sense and could, indeed, lead to unrealistic results. In the same way, the statistical tests are paired tests, which means that, for each GCM-GES-M combination, the results for the future period are compared to the results for the reference period. We think that considering all combinations as equiprobable is the best compromise for the compilation of results.

Specific comments:

1) Page 1344, lines 18-19: a more detailed description of the scenario construction and the downscaling methods and results in terms of P and T scenarios is needed (it is given in a submitted paper, the authors claim, not available for this referee). A figure showing for example the mean monthly evolution of P and T and perhaps other variables may help the reader to quickly understand the main differences between scenarios.

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=> A short description of delta and statistical downscaling methods has been added in section 4.2.1. The results regarding T and P would be interesting but we would really like to maintain this article equilibrated between the retrospective approach and the prospective approach and focus rather on the influence of land use than on the effect of climate change. They are further discussed in the companion paper (Quilbé et al., 2007).

2) 1345, lines 14-15: maybe a figure would help to illustrate the uncertainty linked to relations between pig production and land use.

=> We have added the correlation coefficient values which give an idea of the relationship between pig production and each land use class. We prefer not to make the paper heavier with a new figure.

3) Page 1346, line 1: provide the meaning of the SSU acronym

=> It is given on page 5, line 16 : spatial simulation unit

4) Page 1346, lines 19-20: some details could be provided on the interest of assessing such particular critical streamflow sequences regarding the hydrological processes or water management (why these return periods and number of consecutive days)

=> Right. This has been added.

5) Page 1347, lines 18-20: It seems that there could be a contradiction here, as it is stated in Page 1340, line 19 that the model is sensitive to Manning coefficient. Water balance do not depend on evapotranspiration only so, does the kind of soil/vegetation may not have at least an influence on the runoff/infiltration partitioning? Moreover, low flows are controlled by aquifer drainage and groundwater recharge should be at least slightly influenced by land use. So maybe Gibsi is more sensitive to ETR than to runoff simulation or maybe the more important effect stated is due to the land use effect on the groundwater recharge? Some additional discussion would certainly improve this section and provide some needed details about the hydrological modelling results.

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=> Yes, land use has a great influence on water balance (this is confirmed by our results), but what we say in this sentence is that this influence is effective only during the vegetative period, not in winter and early spring when there is no evapotranspiration. This is why our results (not shown in the paper) show that, during this period (winter and early spring), the land use configuration does not affect water discharge. We have specified it in the end of the sentence to make it clearer.

6) Page 1348, lines 14-15: again, a more detailed description of the scenario construction and the downscaling methods and results in terms of P and T scenarios would help the reader to analyze such results.

=> See answer to the first specific comment

7) Page 1348, lines 16-18: the interest of combining all the GES scenarios is questionable here as it makes harder the results assessment (as stated page 1350, line 16). Comparing different GES scenarios using one single GCM for different GES scenarios or one GES scenario with several GCMs should perhaps facilitate the assessment and the comprehension of the results.

=> But on which criteria do you choose a GCM rather than another ? We could be satisfied in presenting only the results for all GCM-GES-M combinations, saying that some of them lead to an increase in water discharge, and some others to a decrease. But would it be useful for a management purpose ? We think that considering all GCM-GES-M combinations as equiprobable is the most objective way to present results and to get to an average effect. We could go further in the analysis and assess the effect of the GCMs, considering one specific GES-M, or inversely. But it would lead to a large number of combinations and would certainly make the paper “indigestible”. Moreover, this is not really the main objective of this paper, but rather of its companion paper (Quilbé et al., 2007). We want to keep this one equilibrate between the retrospective approach and the prospective approach.

8) Page 1348, lines 25: "(not shown)", It is found embarrassing to not provide any

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figure, especially when the results are further discussed in the following sentences.

=> Right. A figure has been added (now Fig. 8) to illustrate this point.

9) Page 1349, lines 1: why is it homogeneous? Due to the delta method used?

=> This is not due to the delta method used as it is used for both water regime and erosion. Moreover, the downscaling method also gives homogeneous effect on annual water discharge among the thirty years of simulation. It is more probably due to the physical processes simulated by the models. On one hand, annual runoff closely depends on annual precipitation in a linear way. On the other hand, annual sediment load depends on several other factors and mainly on what occurs in Spring, in a nonlinear way.

10) Page 1349, lines 6-8: the fact that the B2 scenario has a more severe impact than the A2 scenario is very surprising, as the latter is normally the pessimistic one that may provoke a stronger temperature increase. Further details are necessary to explain these results.

=> Right, this is surprising. Actually, the difference between HadCM2-A2a and HadCM2-B2a is not only linked to the GES but also to different initial conditions in GES simulations. Even T and P results for reference period are different for both GCM-GES-M combinations. This indicates that, at such a short term (2025), the different GES-GCM-M combinations should be seen as different equiprobable simulations rather than as pessimistic or optimistic conditions.

11) Page 1348, lines 11-12: part of this discussion is needed in the present paper.

=> We have removed the sentence “Note that all these results are discussed in details in Quilbé et al. (20072)” and added a short discussion about the difference between GES A2 and B2.

12) Page 1349, line 18: Fig 4 doesn’t seem to illustrate the GCM-GES-M effects. Maybe Fig. 6?

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=> Right. It is Fig. 6. It has been corrected.

13) Page 1350, line 4: Briefly remind the characteristics of both land use scenarios

=> Right but we have preferred to remind these general characteristics on the previous page, together with scenario A.

14) Page 1350, lines 4-7: it not seems as clear as stated, maybe an additional figure would be helpful.

=> We have tried to clarify this sentence based on Fig. 10. The legend of Fig. 10 has also been clarified.

15) Page 1350, lines 8-11: ECHAM4 B2 provokes a discharge decrease while HadCM3 provokes an increase, so is it meaningful to provide a mean value? Maybe sediment load simulated under HadCM3 increases under scenario B2 anyway?

=> Yes, maybe. But would it be enough to say that both GCM-GES-M combinations give contradictory results ? We think that, in a water management point of view, we have to try to extract some synthetic, average information from this huge amount of data and this large uncertainty.

16) Page 1350, lines 16-19: Right but, maybe providing averaged and homogenised results from such a different conditions is less realistic than comparing results depending on GES scenarios at least.

=> Already discussed.

17) Page 1351, lines 7-8: and a further thought about how to present the results of impact studies to water managers could be interesting too.

=> Right. Two sentences have been added.

18) Page 1351, lines 21-23: it is not very clearly demonstrated in the main text as only averaged values are provided and comparisons between both driving forces fail.

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=> We think it is, see previous answer regarding Fig. 10.

19) Fig 8: it is not clear which graph is for which GCM-GES-M combination.

=> Right. It has been clarified.

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