

Interactive comment on “Evaluating the impacts of land use changes on hydrologic responses in the agricultural regions of Michigan and Wisconsin” by A. P. Nejadhashemi et al.

Anonymous Referee #3

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General Comments

This paper uses a modelling approach to attempt to evaluate the changes in hydrology that have resulted from historic changes in land use, including deforestation, increased arable production and urbanisation, in the Great Lakes region of the US. The broader aim of the paper is to improve understanding of the underlying mechanisms determining hydrological change in order to support sustainable management of water resources. The paper relies heavily on the SWAT model and the physical basis of the processes coded within it in undertaking the assessment. Unfortunately, the valid-

C1712

ity of the internal processing of the model is never evaluated for this study area with a validation procedure based on a single objective (simulation of stream flow at the watershed outlet) and an optimisation procedure that selects a single optimal solution. This method fails to acknowledge the uncertainty in the model structure, input data and validation data. Results from a sensitivity analysis are presented but are impossible to interpret, as insufficient explanation of the procedure is included. In general, the paper is very difficult to understand as the structure is poor, with confusion between presentation of methodology and results. Insufficient detail of the methodology is included with regard to application of the model and sensitivity analysis, the meaning of parameters and identification of their values for the study area. Overall, there are too many unexplained aspects of the modelling and processes in the paper to generate a belief in the reader in the validity of the results from the model application.

Specific Comments

P3426 - please explain what is meant by “6 digit” and “8 digit” watersheds for an international readership

- why are 2 of the watersheds combined in Table 1 ?
- provide an inset of the location in the USA in Figure 1
- refer to Figure 2 for land use
- define somewhere what you mean by sub-basin, watershed and river basin (the latter two mean the same thing to me) and what sort of catchment areas each define (e.g. 10s km², 100s km², or 1000s km²)
- occasional words are missing from sentences throughout the paper (e.g. p3426, l25 should read “the” water budget)

P3427 - the overview of processes in the SWAT model is not very helpful as it is very simplistic and leaves more open questions than answered ones (e.g. why was the SCS method chosen in this application?, which ET calculation method was chosen

C1713

and why?, how is the soil profile defined ? etc.). It would be more useful to include a discussion of processes occurring within the study area, how these relate to the SWAT model structure, and especially how the parameterisation is undertaken.

P3429 - I 21-23: don't understand these statistics on elevation or their relevance in the context of the modelling

- I 24: what kinds of impacts on stream flow – rates of runoff, peak flows, or total runoff volumes (driven by differences in the overall water balance)?

P3431 - no explanation is given for the sensitivity analysis methodology. This is important.

- L4-5: "Sensitivity analysis...calibration" I don't understand the meaning of this sentence. It suggests a sequential parameter calibration approach but this fails to acknowledge the effect of interactions between model parameters.

- I3: Shouldn't refer to the results until the results section. This section should be about the method.

- I20-21: Why were sensitive parameters not altered ? What were their values based on? Why were other parameters altered instead ? You need to explain the rationale for the method.

- I23: isn't this an a priori requirement for all modelling exercises to assess suitable values for parameters to represent the catchment processes? Otherwise you are liable to end up with the "right" answer for the "wrong" reason, the internal functioning of the model will be "wrong" and the model is therefore liable to give the "wrong" answer when scenarios such as land use change are applied.

P3432 - I 9-10: this is totally dependent on the parameters representing different land uses being correctly parameterised and differentiated within the model. Single objective validation of a model on watersheds with mixed land use will be inadequate to validate the differences in land use parameters, due to the multiple degrees of freedom

C1714

of a complex model such as this.

- L14-19: I don't understand these statements.

- I23: yes – exactly! Yet these processes are totally essential to understanding the impacts of land use change on hydrology, so one wonders what value can be expected to come out of the study.

P3433 - need to define what you mean by "regional" and "local" scales.

- L 7-9 what is the difference between (1) and (2) ?

- was the sensitivity analysis done parameter by parameter, or investigating multiple parameters together ? Must describe the methodology in the previous section

- I 12-13: why and how ?

-I17: how is the sensitivity analysis ranking table derived and what does it tell you ?

P3434 - I2-4: there is a lack of process interpretation of what the model is doing

- unclear what the value is of comparing the ranking analysis for pre- and post settlement situations.

P3437 - I25: A value of NS efficiency of 0.2 seems very low to be deemed as an acceptable simulation

P3438 - If you set acceptable criteria for your objective functions to exceed specific values, then you should end up with multiple sets of simulations which give satisfactory results. Why was only one parameter set selected from these ? What happens to the ranges of parameter values if you look at all acceptable simulations that achieve your performance criteria ? Does this affect the interpretation of results ? Are there any implications for evaluating the effects of land use change ?

- L1-15 Unnecessary detail on reservoir management

- Section on sub-basin land use change – much of this should be presented in the

C1715

methodology section. Results are poorly presented here.

P3440 - Again, confusion between methods and results for the watershed level impacts

P3441 - Decreasing forest leads to a decrease in recharge compared with urban ? This is surprising as I would expect to see higher ET losses from forest leading to an increase in recharge and total runoff when deforestation occurs. Need to be clear about your definitions of "recharge" and "runoff"

P3442 - Define what you mean by "basin-wide"

- l24 – what about the increase in urbanisation ? I would have expected this to be the main cause of an increase in overland runoff rather than agricultural land, which has most probably been drained.

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