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Hydrology and Earth System Sciences Discussions

Interactive comment on "Water and nutrient balances in a large tile-drained agricultural catchment: a distributed modeling study" *by* H. Li et al.

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First of all, we greatly appreciate the insightful comments and constructive suggestions from Reviewer #2. Our responses are following.

Major critical points and problems to be solved:

1. There is no overview of other coupled hydrological and biogeochemical process models in the Introduction. It has to be included. Response: Included.

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2. The authors do not present results for suspended sediments due to lack of data. Hence, there is no sense to include the description of this module at all. Just a statement that sediments are considered is sufficient. Response: We agree that the description of sediment module is not as important as other modules. We included a very brief description because the movement of particulate phosphorus and nitrogen is coupled to movement of sediment. This part has been further shortened.

3. The results for dissolved Phosphorus are rather poor (Fig. 5). There should be an explanation or discussion. Response: A possible explanation for this under-estimation is the effluent discharge from the urban areas between Big Ditch and Monticello, including the towns of Mahomet and Monticello. Effluent from the local sewer system and wastewater treatment plants is discharged into the Sangamon River, which introduces non-negligible amounts of nutrients into the river, especially phosphorus. Dissolved phosphorus from effluent discharge, in the form of point-source pollution could make a significant contribution to the in-stream concentrations of phosphorus in the summer and fall seasons.

4. Point sources have to be included. Maybe this would improve the results for DP modeling? Response: We agree that the results for DP modeling will be improved if including point sources from the urban areas. This should not be difficult as long as the observation data are available. However, we have contacted the local agents and they have not been monitoring DP in particular.

5. N and P dynamics are compared only visually. Please add criteria of fit for concentrations or loads. Response: For this study, the purpose of calibration is to capture the inter- and intro-annual variability of water and nutrient mass balances. Specifically, the calibration has been conducted in order to: a) satisfy regional mass balances as indicated by the empirical data from literature (Table 1); b) match the predicted time series (regular hourly interval) to the observed time series (irregular interval, roughly biweekly) as well as possible, in terms of magnitude and seasonal variation. However, as we pointed out, the model inputs of N and P are estimated in a rather coarse way

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due to lack of detailed observation or investigation. Therefore, we had a doubt of the value of R-square or RMSE values here, and didn't feel much sense of reporting them.

6. The calibration and validation periods should be distinguished. Response: The main purpose of the study is to discuss water and nutrient balances in the catchment, not to evaluate the model. So it is important to make sure that the model gives the best performance in the whole modeling period. We divide the whole study period into two parts: a warm-up period, 10/01/1993∼09/30/1994, and a calibration period, 10/01/1994∼09/30/2004.

Minor problems:

1. The paper is too long. Description of sediment and nutrient processes parametrization (on seven pages now) should be shortened or presented as a Table. Formulation of objective in the Results section (p. 19, l. 8-11) should be removed. Description of Fig. 8 (p. 22-23) is too long and could be shortened. The summary could be shortened as well, e.g. first couple of sentences ("in this paper wee have explored: : :") could be excluded. Response: We have shortened the description of sediment. Since this is a modeling study, we owe the readers necessary background about the model itself. The formulation of objective in the Results section has been removed. Fig. 8 is the most important figure in this paper, and we feel that it deserves a longer description than the others. We have also shortened the summary as well.

2. p. 5, l. 1-4: not clearly formulated sentence: was the model extended for this research, or before and now "taken"? Response: both of the extensions are for this work. The corresponding part has been modified for clarity.

3. Please check terminology use: "sub-region" and "sub-zone" should be consistent in the whole paper. Response: "sub-region" was changed to "sub-zone".

4. What is the meaning: p.6, l.l: "specified number of REWs"? Specified by whom? How? Based on what? Response: "specified number of REWs" is the amount of

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the REWs that the watershed is descritized. The number is indirectly controlled by the author in the preprocessing of DEM in ARCGIS through a threshold. The word "specified" has been changed to "certain" for a better clarification.

5. As vegetation zone and unsaturated zone are different zones, it is not clear how the vegetation-related processes (e.g. root zone and root-related water and nutrient uptake) are represented in the model. This should be clarified. Response: As shown in Figure 2, vegetation zone is on top of unsaturated zone, and it is assumed that vegetation root is distributed within the unsaturated zone only. As there are two unsaturated zones (u1-zone and u2-zone), the amount of root located in u1-zone and u2-zone is determined by vegetation type, soil properties and climate conditions. In this work, we assume that 70% of vegetation root is located within u1-zone (top 30cm soil layer), and 30% within u2-zone. Root distribution has significant impacts on transpiration and nutrient uptake. In this manuscript we omit the detailed description of hillslope processes, including vegetation-related processes, firstly due to the limited space, and secondly due to the fact that we are focusing more on the lateral movement of water and nutrient.

6. Formula (1): please explain how the depth of the saturated layer is calculated; is it a state variable in the model? Response: Right, the depth of the saturated layer is a state variable in the model, and is allowed to vary with water stored in the saturated layer. The saturated layer is exchanging water vertically with the unsaturated layer and longitudinally with the channel (via subsurface flow and tile drainage).

7. Fig. 3: please show the modeled part of the catchment. Response: The model has been applied to the whole basin. The part upstream of Monticello station is utilized in the analysis of this work due to the availability of observed data.

8. Fig. 5: really data with hourly time step? Or daily? Response: Yes, the simulated NO3-N and DP concentration series are at hourly scale, not daily.

9. Percent bias is 5%, or 0.05% here (p. 20)? Response: Sorry, it should be 5%.

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10. p. 23, l.17: increasing trend or correlation? Response: It has been modified as “an increasing trend with increasing annual runoff depth”.

11. Fig.10 could be substituted by a long-term average seasonal dynamics. Response: Done.

12. Description of Fig. 10 (p. 25) includes the listing of components, which is not necessary here and should be excluded. Response: Excluded

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 3931, 2010.