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Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "Subsurface lateral flow from hillslope and its contribution to nitrate loading in the streams during typical storm events in an agricultural catchment" *by* J. Tang et al.

J. Tang et al.

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Dear Dr. Weiler,

Many thanks to you and other three reviewers for reviewing this manuscript and making the constructive and helpful comments.

There are two reviewers (Dr. Burns and an anonymous one) who suggested improving the abstract and introduction. This is clear and important and we will take it seriously during the next revision of the manuscript. In the abstract, we will add some more information on the methodology and key results as suggested, making it more concise and sound for better readability. In the introduction, we will cover the literatures on subsurface lateral through drainage tiles ubiquitously seen in Europe and America, in order to differentiate the system we studied. Thanks for offering a list of references provided by Dr. Zehe and the anonymous reviewer. We will have an insight look through the literatures. In addition, we will have an English speaker, either native or having long-stay in English country to improve the English. All of the typos will be corrected in the next version.

The specific responses to each of the reviewers are as follows.

To the anonymous reviewer:

Following the suggestion, we will work out on the description of the generation of subsurface lateral flow in terms of old water and new water runoff. “Old water” is often characterized by the average soil water chemistry prior to the event concerned, while “new water”, the infiltrated water during the event, has often different water chemistry from the old water (Sklash and Farvolden, 1979; Chandler and Bisogni, 1999; Petry et al., 2002), and we will discuss the mixing processes in the context of EC dynamics in this manuscript.

We will present the objectives in a clearer way during the following revision.

The data of potential evaporation is derived from the meteorological station in the Research Station and it was measured using E60 evaporation pan. Soil hydraulic properties was from the soil water retention curves that were determined by measuring evaporation from the surface of soil core on an electronic balance and soil water potential at different depth of the soil core using microtensiometers equipped with transducers (Wessolek et al., 1994, Geoderma. 64: 93-110; Jing et al., Pedosphere 18(3): 353-362). This information will be added to the text during the following revision.

Due to the management and cost concerns, the tensiometers were installed on only two slopes to compare the two adjacent land uses within the catchment. We assumed that the soil water movement and soil chemistry was similar on the hillslope under peanut cropping in different places within the catchment as the land form, the soil profile structure and the fertilization schedule are similar. All these information was recorded. In addition, soil water chemistry was determined at the sites by using ceramic cup and it shows no distinction between the sites under the same land use. We will state the supports in the revised manuscript.

The short description about the ANOVA statistics can be seen on Page 10 Line 23-25 and the relevant data are presented in Table 2.

pH is the minus logarithms of H^+ concentration. pH is used to compare water chemistry among the water sources and H^+ is used for the mixing model. We cannot substitute pH with H+ concentration or vice versa in the whole text.

The reasons for the lower EC in rainfall than in overland flow were because the soil was an Ultisol, being poor in base ions in surface layer (Xu et al., 2003) and the EC was mainly influenced by nitrate as indicated by the significant correlations between EC and nitrate concentration in the overland flow, soil water, stream flow, well water and spring water.

The reviewer is right in terms of a delay of particulate N concentration behind the stream flow at Station No. 4 (Catchment outlet). This has been noticed in the Result section, but more generalized in the Discussion. The delay means that the stream flow is high enough to transport particulate nitrogen after the peak rainfall from the source area to the catchment outlet. This point can be added to the Discussion, but in the Discussion we focused the subcatchment (slope), e.g. on the data from the Station No. 5 and 6.

The scales of the Figs 4 and 5 are different because the rainfall intensity is strongly different although the total amount of rainfall is not that different. Using the same scales would shadow off the impressive dynamics in the storm with lower intensity (Fig. 5). We agree that the reaction of NO_3^--N to the rainfall existed in Fig 5, particularly during

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the span of low rainfall intensity or low overland flow. This may gives a time for the interaction between overland flow and soil, resulting in a higher nitrate concentration. In addition, the antecedent soil condition was different between the two storms. It was drier in the 12 May 2004 (Fig. 5) and this may promote the loss of fertilizer applied about three weeks ago before this event, which may cause reaction of nitrate to the reduced rainfall intensity.

To Dr. Burns,

Page 12, Line 8-9. The sentence “NO- 3 -N concentration from subsurface lateral flow was estimated by multiplying fraction of subsurface lateral flow estimated in time series with actual NO-3 -N concentration in stream flow” was a wrong statement. The correct one is “NO3-N concentration in the subsurface lateral flow was the measured value in the soil water source before the event”. This will be corrected during the revision.

Page 18, Line 1. It is true that rainfall penetrated through the vertical macropores rather than through the soil matrix by uniform wetting front. This is supported by the positive readings of soil water potential appearing earlier at the deeper soil than at the surface soil after the starting of rainstorm.

Page 23, Line 14-15. Nitrate accumulation is deep soil is a common phenomena in the study region due to the very low denitrification potential. This is often attributed to the low biogeochemical processes in soil with low organic carbon and variable charged characteristics of the Ultisol (Xu and Cai, 2007).

Page 23, Line 23. The reviewer is right. The change in EC in this study catchment is related to nitrate dynamics and it could be related to other solutes in other catchment.

To Dr. Zehe,

The mixing model has considered the mass balance of flow and chemical conservation. Similar work can be found from since 1970s (e.g. Nakamura, 1971; Pilgrim et al., 1979; O’Brien and Hendershot, 1993; Durand et al., 1996). The mixing model has been used to identify the components of stream flow, rather than the components of subsurface lateral flow from different soil depths. We have no evidences of influences of soil electrical charges by soil depth on EC during such short time of storms observed. We found EC was very significantly correlated with nitrate concentration, suggesting that the chemistry of subsurface flow is mainly attributed to nitrate status, rather than other ions. In this study, our assumption is that subsurface lateral flow, as whole, is mixed completely by sources from different soil compartments during a short time, representing the fast response of soil water to the precipitation. During such a short time of rainstorm, we assume nitrate can be conservative and EC was influenced mainly by nitrate from different soil compartments, rather than electric charges. Therefore, Q and EC were independent and EC was used in the mixing model.

We agree that the statement about the hillslope units in a landscape and the Gaussian Error Propagation method will be cited correctly in the following version. It is true that the vertical macropores is the reason for the anisotropy of Ks. We agree subsurface low is not slow flow as shown in our study. But in some literature it was considered to be slow. It is good to compare the work from Wienhoefer et al. (2009) with ours and others. We will try to add a third level of heading while revising the manuscript.

We add some references to support our argument.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 4151, 2011.