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Hydrology and Earth System Sciences Discussions

Interactive comment on "Modelling subsurface storm flow with the Representative Elementary Watershed (REW) approach: application to the Alzette River Basin" *by* G. P. Zhang et al.

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SUMMARY

The authors present an extended version of the REW approach by introducing a new macropore domain to account for fast preferential flow of water both in the vertical and horizontal direction. To this end the authors introduce a new domain, named the macropore domain, by formulating the respective mass balance equation for the macropore domain. The key assumption underlying their approach is that a) exchange terms between the unsaturated zone and the macropore domain is can be neglected, b) flow is driven by gravity and does not depend on the water content in the macropore domain i.e. it is sufficient to specify a conductivity of the macropore domain c) horizontal

macropores/pipes are parallel to the average slope of the surface i.e. it is sufficient to specify a single average slope for a REW.

The authors apply the REWASH with the new macropore domain to the Alzette catchment in Luxembourg which is discretized into 12 REW, whose parameters are automatically calibrated. The optimal parameter sets yields a Nash Sutcliffe Efficiency of 0.73. For internal validation the authors use furthermore discharge observations where the model produces partly very nice results, is partly also not too good. They use furthermore observations of groundwater levels from 4 locations, where the fluctuations of the saturated zone depth is general too large when compared to the observations.

EVALUATION

The presented study is of high relevance for hydrological modellers as it addresses the very important effects of representing preferential flow within a mesoscale physically based model, partly, in a very successful manor. The study is therefore highly suitable for the audience of HESS and for the special issue “Towards a new generation of hydrological process models for the meso-scale”. However, the authors should address/explain the following major and minor critical points to optimise the benefit for the reader and to better underpin/justify their key assumptions.

KEY POINTS TO BE ADDRESSED

A key assumption of the presented approach is that the authors neglect exchange between the macropore and the unsaturated zone domain. While this might be reasonable in the soils/sub surface in the Alzette River, in general this is a crude simplification. Exchange between the soil matrix and the macropore system is a key process in many landscapes with cohesive soils and biogenic macropores. Especially it is of major importance for predicting the persistence of herbicides in the subsurface. The authors should better justify their assumption by discussing the soils and the features in their catchment

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The closure relation for infiltration into the macropore domains (Eq. 10) is designed in such a way, that any amount of rainfall water, that does not infiltrate into the u-zone or is stored within the interception store infiltrates into the macropore domain. Thus, no infiltration excess runoff is produced at all. While this might be a reasonable assumption in the Alzette basin, this is in general again strong assumption that does not hold in many Hortonian landscapes, even if macropore infiltration is of importance their (e.g. Zehe and Blöschl, 2004 WRR). Again the authors should better justify this assumption by the typical properties of the soil in the basin and come up with a critical remark.

Simulated fluctuations of the saturated zone depth is general too large when compared to the observations are in general too large. This can be partly due to the fact, that too much water infiltrates into the macropore domain or, that the water flow in the macropore domain should decrease as function of the water saturation. Again some discussion is needed here.

DETAILED COMMENTS OF MINOR IMPORTANCE

In their introduction the authors should also acknowledge the Work of Niehoff and Bronstert 2003, JoH, who studied the impact of macropore flow on catchment scale flood response using the WASIM-ETH model

In general the author should name all the variables after the equations, even if they are named in a previous paper. The paper has to be understandable as it stands alone, which is not the case in the present form!

The authors should consider not to start with an equation directly after the subheading

Page 9: The authors define the fraction of lateral macropore flow by multiplying the conductivity with the sine of the slope angle, which is correct if the macropores are parallel to the surface. However, the term with the cosine is not, as they claim the vertical component parallel to the gravity gradient, but the component normal to the

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average slope angle!

Page 10: Outflow to the channel conceptualised simply as driven by gravity. The authors should explain this assumption and explain why they do not use a leakage approach.

Page 11: Comment, if the clay soils are fast draining it can only be due to macropore flow!

Page 11: The authors should give the ranges of their parameter values selected for the automated calibration and explain their choice.

Page 15: The overestimation of the runoff during dry periods might be due to neglecting exchange between the macropore and the matrix domain

References Please change reference Lee, Sivapalan, Zehe (2006) to Lee, Zehe, Sivapalan (2006)

Interactive comment on Hydrology and Earth System Sciences Discussions, 3, 229, 2006.