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Hydrology and Earth System Sciences Discussions

Interactive comment on "Use of soil moisture dynamics and patterns for the investigation of runoff generation processes with emphasis on preferential flow" *by* T. Blume et al.

T. Blume et al.

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Thank you very much for your constructive review of our manuscript. The specific and detailed comments are very helpful for the improvement of the article. The revision of the manuscript will be carried out based on your recommendations. Following below you will find a detailed response to each of your comments.

In summary, the paper presents valuable experimental data on the water dynamics into such volcanic ash soils. However there is very little evidence that this data, collected only in a small area close to the catchment outlet, could explain "the entire system-catchment"; response, which is one of the main research

questions stated in the introduction. No quantitative investigation has been carried out to explore the relation between the observed soil moisture spatial and temporal variability and the runoff observed at the catchment scale.
RESPONSE: The relation between soil moisture states and catchment runoff behaviour was investigated by analysing and comparing the response times of soil moisture, groundwater tables and discharge. This was done for winter and summer (wet and dry catchment state). In the new manuscript this analysis is described in more detail and for each of the continuously monitoring sensors separately.

It is also not clear the role of the groundwater observed at one of the wells.
RESPONSE: The groundwater data as a descriptor of catchment response was used within the color maps, to show groundwater reaction to the three events. It was furthermore used for the analysis/comparison of response times.

A description of the potential runoff generation processes across the entire catchment is missing.
RESPONSE: This description will be included in the revised manuscript.

I found therefore the title of the paper and the introduction misleading with respect to the actual contents of the paper.
RESPONSE: We will change the title of the manuscript to: "Use of soil moisture dynamics and patterns at different spatio-temporal scales for the investigation of subsurface flow processes".

I also found difficult to follow the discussion throughout the paper, since it is fragmented by several details and considerations, with little integration between the several sections. In some sections it is difficult to distinguish the experimental evidences from subjective considerations or results cited in other refereed papers. The discussion on the analysis of the experimental data is interrupted by details on the performed experiments or collected data, already introduced in previous sections.

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RESPONSE: In the revised manuscript more effort will be put into the separation of experimental evidence and subjective conclusions or assumptions as well as citations. Repetitive information on experimental methods in the discussions part will be removed.

A section of the paper should be dedicated to the description of the soil properties (including hydrophobicity) in the investigated area: a clear picture of the variability of soil properties along the vertical profiles would make easier to understand the considerations on the observed soil moisture data and dye tracer experiments. This section should include a description of the soil profile in the locations where soil moisture probes are installed or at least where dye tracer experiments are performed. Also the experimental effort in characterizing the soil properties should be more clearly illustrated. Soil textural data, soil water retention and soil hydraulic properties measured at the various depths should be clearly listed in separate tables, as it has been done for the hydrophobicity. A better description of the method followed for estimating the soil hydraulic conductivity curve should be provided, since section 3.7 is too generic.

RESPONSE: We agree with the reviewer that the characterisation of the soil profiles is a little short in the current manuscript. The soil physical characteristics of the several commonly found horizons are now shown in more detail and are summarized in a table. This includes porosities, hydraulic conductivities, grain size distributions, bulk densities, field capacity and permanent wilting point. A short summary of the experimental methods used in their determination will also be added. However, these characteristics were not determined specifically for the location of each of the sensors, but on the basis of commonly found soil horizons. We furthermore do not want to put too much emphasis on the determination of the unsaturated conductivities, as these results were only used for the rough estimation of flow path persistency.

A second section should be focused on the description of the criteria followed in the selection of the experimental sites and in the installation of the soil moisture

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probes. The results of the FDR profile probe calibration should be also illustrated. In which horizons have been collected the soil samples employed for the calibration? What is the range of soil content values has been investigated? Does the measurement error of 3% apply to the measurements in volcanic ash soils?
RESPONSE: The selection of the experimental sites will be described in the revised manuscript. Furthermore more details on the calibration of the profile probes will be given. The measurement error of 3% is the one given by the manual and does not specifically apply to volcanic ash soils. We do not know how different the error is for this type of soil. It is also likely to be different from horizon to horizon. Therefore we focus mainly on the dynamics of soil moisture and less on the absolute values in this investigation.

It would be more useful to read the analysis at seasonal and annual scale before the discussion at the event scale, in order to get a preliminary picture of the local climatic characteristics and of the antecedent and boundary conditions during the rainfall events examined in the following sections.
RESPONSE: The seasonal and annual time scale will be addressed before the event time scale in the revised manuscript.

Statistics of the observed rainfall and soil moisture variability in all measurement locations should be provided. Also a diagram describing the timing of the episodic soil moisture measurements and of the selected rainfall events with respect to the seasonal pattern of rainfall and soil moisture should be provided.
RESPONSE: The statistics of soil moisture variability for all depths of the continuously measuring probes will be given in Fig. 5. Rainfall amounts were not determined specifically for the locations of the moisture probes. We feel that a diagram of the timing of the measurements and the selected events is not necessary as this information is already given in the text.

The analysis at seasonal and annual scale should be extended to the runoff and

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the groundwater, if the relations between the local soil moisture observations, stream discharge and groundwater are to be explored.
RESPONSE: Groundwater dynamics and discharge time series will be included in Fig. 6 of the revised manuscript.

Since the soil moisture dynamics at the event scale has been analyzed for 34 rainfall events, it maybe worth to summarize the characteristics of these rainfall events and the outcomes of the observed soil moisture dynamics by quantitative indicators or qualitative attributes, beside the impressive color maps for just three events.
RESPONSE: It is difficult to condense the vast information contained in the soil moisture colour plots into quantitative indicators. Statistics in terms of timing and magnitude of soil moisture reactions in various depths is not straight forward and is unlikely to convey additional information. Adding a section on this topic would increase the length of the manuscript considerably without increasing the information content.

The "small scale variability" of the soil moisture should be presented in the form of tables or diagrams evidencing the variation of the local soil water content relative to a reference direction, in order to better appreciate the local differences in soil water content.
RESPONSE: The small scale variability is already given in relation to a reference direction: measurement 1 on Fig.8 is carried out with the sensor directed upslope, measurement 2 and 3 are angled downslope to the right and left, respectively. This information will be included in the revised manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 2587, 2007.

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Interactive Comment