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Hydrology and Earth System Sciences Discussions

Interactive comment on "Identifying runoff processes on the plot and catchment scale" *by* P. Schmocker-Fackel et al.

P. Schmocker-Fackel et al.

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Final author comment

We want to thank the anonymous referees #1, #3 and #4 for their positive reviews and their constructive criticism. We will include many of the suggestions directly in the revised paper. In the following, we will discuss four topics raised by one or more of the referees in more detail and then continue with some of the referee's specific comments.

1) Transferability and the possibility of upscaling the method

We think that the presented method is transferable and can be used for upscaling to larger catchments. We have, for example, mapped Dominant Runoff Processes (DRP) using the SN decision scheme in more than 40 catchments in Switzerland, Germany and Chile with areas between 1 km2 and 300 km2. If no soil and other maps were available, the necessary data had to be collected in the field. It is obvious that the amount of fieldwork required is largely reduced, if adequate maps and other data are available.

The automatic, GIS based method of mapping DRP requires maps and data in digital form. If such maps are available, DRP maps can be produced rapidly for large catchments. This was done for the whole Canton of Zurich (including the Aabach catchment) with an area of 1730 km2. Detailed soil maps based on the Swiss soil classification also exist in other Cantons of Switzerland. However, for large parts of Switzerland only large-scale soil maps exist. For these areas, as well as for catchments in Germany, the set of rules used by the GIS had to be adapted to the available digital data. In a running project, the consequences of the use of lower quality data are tested and the results of the Canton Zurich DRP map verified. However, the intention of this paper is to present the development of the methodology.

2) Event dependency of runoff generation

As discussed in the paper, it is possible that more than one runoff processes occurs on one site, the one that contributes most to runoff is called dominant. Which process dominates depends on the characteristics of the site and of the rainfall event. The SN decision schemes distinguish between long duration, medium intensity and the short duration, high intensity events. In the test catchments, some areas were identified where HOF2 might occur during high rainfall intensities and a different process during lower intensities. This is handled with the published set of rules. In a follow-up project, other process changes were observed during high intensity sprinkling experiments (described in: Subsurface storm flow formation at different hillslopes and implications for the "old water paradox", Kienzler, P. and Naef, F. (2006), Hydrological Processes, under review). As suggested by referee #3 we will improve the definition of DRP and rainfall characteristics in the revised paper.

3) Active vs. contributing area

The map of DRP as shown in this paper is a map of active areas. Whether these areas actually contribute to runoff or not depends on their connectivity to the river. As mentioned in the paper, these areas coincide in the catchments studied. In other catchments, areas were found that were not well connected to the river network, so that active and contributing areas did not coincide. The effects of these discrepancies can be compensated by reclassifying of the DRP area in question into a slower process.Up to now this has been the proceeding taken by us in such cases. Another and probably better way to deal with this problem is by taking the interactions between process areas and their connectivity to the river network directly into account. However, this is still subject to ongoing research in our group.

4) SSF

Subsurface flow is always a mixture of preferential and matrix flow. When fast subsurface flow is considered, preferential flow might have more weight. We will try to formulate this more clearly.

Detailed comments

In the following we comment selected remarks of the referees. Remarks not commented here are accepted by us and will be directly included in the revised version of this paper.

Referee #1

Comment: "Paragraph on runoff processes is quite weak".

This paragraph is short since it was not our intention to give a detailed review of runoff processes in the paper. However, as suggested by the referee we will include more references to relevant papers on runoff processes.

Comment: "To what extent the small catchments investigated are Representative Elementary Areas that can be used at larger scales."

We do not quite understand, what the referee means with small catchments? Our smallest element is the plot scale, which would be our REA. The reaction of a catchment is determined by the distribution of the processes in a catchment, which can be quite different in neighboring catchments. Therefore it seems difficult to enlarge the REA beyond the plot scale.

Comment: "In summary, a very good paper, but one that needs strengthening by linking it into the wider literature."

We thank referee #1 for his many suggestions of relevant literature and will consider them in the revised paper.

Referee #3

Comment: "Please comment how land-use information is included into the rules."

The rules for agricultural areas in Fig. 5a determine the susceptibility to HOF2 from soil properties only. Whether HOF2 actually occurs during intense precipitation depends on actual land-use. Fig. 5b deals with forested areas only, while Fig. 5c explicitly uses the land-use information for the process determination.

Comment: "How important is it to know the artificially drained areas?"

Agricultural areas on the Swiss plateau are often artificially drained. Drainage alters runoff generation, therefore the existing digital maps of the tile drain systems were included in our set of rule.

Comment: "In the description of the process catena (p 2078), the authors observed return flow at P4. How can return flow happen at this site if there is no SSF above this area (SOF2 was determined)."

The dominant runoff process during a flood event at P5 is SOF2. In a larger time scale, the slope is drained by SSF, leading to return flow at P4.

HESSD

3, S1253–S1257, 2006

Interactive Comment

Comment: "Section 4.2 (and hence Fig 8) does not fit in this paper in my opinion. The information is not used for developing the rules, determining any plot scale processes or validating the mapping. It is a nice observation, but how can this be used to test your approach?"

We included this section to demonstrate that observations during flood events can be used to verify the process evaluations and to determine whether an area is connected to the river or not.

Comment: "Are the runoff volumes in section 5 for the events plotted in Figure 10 and 11 based on total runoff or only direct runoff (minus base flow)? In case of direct runoff, please specify the method of defining base flow."

They are based on direct runoff only. Base flow was defined as the flow before the start of the flood event and was assumed to stay constant throughout the event.

Comment: " I am wondering if the authors could comment how their approach could be transferred to a snow-melt dominated watershed."

We have not used our approach in snowmelt dominated watersheds yet. During snowmelt events in winter or spring, the antecedent wetness and the water table in the soil is usually high. On the other hand, the melt rate is very low compared to the rainfall intensity of an average storm and in addition a snowmelt event covers an extended time period. Therefore, other processes might dominate during snowmelt events, which might require an adaptation of the set of rules.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 2063, 2006.

HESSD

3, S1253–S1257, 2006

Interactive Comment