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Discussions

Interactive comment on "True colors – changing perceptions of hydrological processes at a hillslope prone to slide" *by* P. Schneider et al.

Anonymous Referee #2

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This article describes the flow processes on a pre-alpine hillslope in Switzerland, based on a large field rainfall-infiltration experiment. It is an interesting example of a hillslope where hydrological processes were studied in detail. The description of vertical preferential infiltration with limited lateral flow in depth, which result in a pressure increase and are here hypothesized to be the origin of shallow landsliding, clearly changes the perceptions of the authors on the flow processes in this particular hillslope. However I think it is not a really new theory (see for example Krzeminska et al. in HESS where the influence of orientation and connectivity of fissures in a landslide was studied with a modeling exercise), so I think the title should be adapted as it seems to be promising a completely new idea.

I do not agree with the conclusion that lateral subsrface flow in the subsoil does not

exist. The conclusions about the flow processes sometimes confuse me: it seems to me that the initial soil conditions are very near saturation and during the first stages of sprinkling the soil becomes more or less saturated at the different depths of SMC measurements. Based on the dye-stained profiles I would think that the difference between initial SMC and saturation are mainly the macropores through which the water infiltrated preferentially into the greater depths, while the surrounding soil matrix was already almost saturated. Therefore I would not expect much interaction from macropores to matrix, as there is not much place in the soil matrix for the water to go, when the matrix is already almost saturated. The authors say that these preferential flow paths do not drain laterally. It is well known that lateral flow in soils often decreases with depth as is the case here. The drainage of the 0.25-1.0 m layer shows that there must be some lateral rapid drainage of these vertical preferential flow paths: the subsurface flow in this layer reacts quite quickly to the beginning and the end of the rainfall experiment and the measured conductivity of the deeper layers as referred to in the article by Brönnimann et al 2013 (which is probably more representative for the matrix) is far too low to produce such drainage, so it must be connected macropores.

As this is probably outflow of only the connected system of macropores and the matrix holds the water quite strongly, then it is interesting to think about this system a bit more: these deeper macroporous structures generally ensure that even though the matrix conductivities are extremely low, enough water can infiltrate into the soil and gets distributed throughout the soil profile and then when the soil gets almost saturated these connected pores under normal rainfall conditions can drain laterally fast enough to ensure that the pore pressure does not rise too high as it is the macropore system over the first meter of soil depth which drains. Only in the occasion where the initial soil moisture content is already very high and the rainfall intensity and duration is really extreme, then the capacity of these macropores for infiltration and lateral drainage may not be enough and pressure may build up.

P8234 lines7-14: these questions are quite sudden to me, I would expect a sum up like this after a more elaborate introduction to the problem. The mention of preferential flow in the first question for example, which is not at all mentioned in the above paragraph. Maybe you should move this kind of summary of most important questions to a later place in your introduction.

P8234 lines 21-22: in the unsaturated zone a soil macropore network, which indeed is not soil piping, may also cause preferential flow at hillslope scales as shown in: van Schaik NLMB, Schnabel S, Jetten VG. 2008. The influence of preferential flow on hillslope hydrology in a semi-arid watershed (in the Spanish Dehesas). Hydrological Processes 22 (18): 3844-3855.

P8234 lines 25-27: isn't this the same as point 4 of the previously mentioned causes for preferential flow?

P8240 paragraph sprinkling experiments: here I would expect details of how long and with which intensity you sprinkled for the different rainfall? I saw you give them later on, but they should be in methods rather than in results.

P8240 line 5: please give the return period of this August 2005 event P8240 line 7: a return period of 2 to 20 years? This is quite a big range?

P8242-p8243, soil moisture content paragraph: please use a consistent accuracy in your soil moisture contents. P8243, l 12: why is W6 not in figure 4? P8243, l 13: increase instead of increasing P8244, l5: I would delete the sentence: "Rainfall intensities higher than...to... at the Rufiberg." As you show straight away in the next lines, this intensity at which runoff starts is probably dependent on the initial moisture content, so with drier or wetter initial conditions the amount /intensity at which runoff starts may be even higher or lower.

P8244, l 20: Just a very rough calculation: If the smc for the top 70 cm of the profile was raised from approx 0.4 to approx 0.45/47 you would need at least 35-40 mm to saturate the soil profile, considering that in the mean time there may be some water

percolating even deeper into the profile or flowing out laterally. When the overland flow starts after 20 or 25 mm, is the profile really fully saturated?

P8245, l13-17: "Following this theory. . ... (Rohde, 1987)." This is slightly confusing, but I think this is mainly due to the term runoff. The surface overland flow /runoff cannot be a form of subsurface stormflow. Subsurface stormflow is really a rapid lateral flow through the soil.

P8252: point 1: this 20 mm threshold, is not that straightforward: in the first experiment the surface runoff started only after a short period of 23 mm/h. In the second experiment it took almost an hour before surface runoff started.

P8256: first paragraph in the conclusions, I do not really see how the different experiments lead to different ideas: as far as I understood everything they led to the same idea, namely that the main runoff/ lateral flow is in the topsoil until the threshold rainfall amount is exceeded and the surface overland flow dominates.

P8257: first paragraph, this rainfall intensity threshold is variable and depends on the antecedent moisture content and the intensity and duration of rainfall, it should be something like the capacity / volume of the macropore to store fresh rainfall with a little extra for their drainage capacity. Once the macropores fill up then the infiltration capacity to the macropores become equal to their lateral drainage capacity which is not that big and then the surface runoff dominates. In the first experiment it has been raining for 20mm/h for more than two hours before the runoff starts, this means that there was at least 40 mm of cumulative precipitation! In the second experiment you start off with 25 mm/h and it takes almost an hour for surface runoff to start. Also your colleagues had a different value for the precipitation threshold at this site than you do.

P8257: final paragraph is quite hypothetical and not really funded in the article.

Table 1: I am always slightly surprised when seeing single numbers appearing for precipitation thresholds: the cumulative amount of precipitation before surface runoff

starts is variable for each location and depends on the antecedent moisture content and the rainfall intensity, see comment on the conclusions

Figure 5: was the rainfall really quite continuous in intensity or was it applied in pulses? It seems very strange that the overland flow can drop from more or less 11 to 6 mm/h while the rainfall continues. Also the top 25 cm have a slightly larger SSF than the 1 m depth. This is not that surprising; normally the topsoil has a higher conductivity. Here it seems not even to be a factors difference, which means it is not that different. I am not sure what this drainage unit means: mm/h, so is it recalculated to be comparable to the rainfall, that means that 1 mm per hour of rainfall on the top is flowing laterally through the 0.25 to 1 m depth layer, is that per m width of the drainage measurement or for the whole width? The lateral conductivity is in any case really not that bad, knowing that the hydraulic conductivity of the matrix is so low, I would think this is mainly flow through connected preferential flow paths.

Figure 6: this figure also shows that it is important not to get misled by the pattern on the E-profile, as this is completely the opposite of the A-profiles concerning the deeper infiltration. That you do not see lateral connections in the deeper soil does not mean that they are not connected; I know from experience that even with many profiles for one location you can still miss such connections. The top soil is logically completely stained due to vertical infiltration from the soil surface, but it can lead to the idea that the main lateral flow takes place in the top soil, while the drainage in the top soil is not even that much more than in the next 75 cm.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 8233, 2013.