An experimental study of drainage network development by surface and subsurface flow in low-gradient landscapes by Brian G. Sockness and Karen B. Gran

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1 General comments

The paper presents a set of experiments of drainage network development performed on a cylindrical drum equipped with a rainfall simulator and a base level control. The objective is to study the progressive development of channel networks on initially flat "lowland" surfaces, and to discuss qualitatively the respective influence and drivers of sapping and overland flow on channelization and network growth. The paper makes interesting claims yet, as it is, clarifications are needed to sustain them.

1. The paper is biased towards overland flow type processes. The definition of Non Contributing Areas (NCA) does not take into account the fact that groundwater divides can extend far into topographically flat areas. Thus much of the discussion on hydrologic connection applies to surface-water connection only and, although this lowers the ambition of the paper, it should be clearly acknowledged or challenged.

2. Experimental conditions and runs have to be more precisely described especially the way infiltration rates were measured.

3. The authors discuss the difference between two channel types but we lack a description and characterization of these channels. We should be shown various examples of these channel types, their characteristics should be discussed, and so for the evolution from one type of channel to the other.

4. Eventually I would suggest a revised version could be more focused on the experiments, their description and analysis in order to provide a useful account of these runs.

2 Specific comments

17 in the abstract you mention that seepage and overland flow channels occur for different infiltration and precipitation rates, then you tell that seepage occurs after overland flow channels had developed. This is a bit confusing

20 What do you mean by surface water contributing area for seepage channels ?

32-35 The notion of NCAs as internally drained areas seems a little bizarre to me. This view seems oriented by some surface flow vision. I can't see how these NCA can't be connected through groundwater flows to the network that is going to incorporate them. Given the setup the entire system has a single groundwater drainage whose boundaries are the cylinder walls.

55-57 Again this claim only applies to surface flows, At least at the beginning of the experiment.

60 I would be curious to know how these spillover events have been recorded in natural settings.

65 Why should hydraulic conductivities be contrasting ?

Table 1 How do you measure the infiltration capacity I ?

Table 2 The "low rainfall" rate is $8\,\mu$m/s $\sim 29\,$mm/h which turns out to be a **very large** rainfall rate. For an experiment of 10 hours this means a rainfall on order of 30 cm... This does not often happen in real life even in equatorial settings. The "high rainfall" rate then corresponds to $\sim$ 60cm for ten hours which is within a factor of two from the world record for a precipitation of that duration.

Table 1 It seems as if no erosion and network growth can occur if there is no continuous uplift. Then, how can you decorrelate the importance of this factor compared to the others ? what if there was no uplift or at least if $U/R << 1$? Did you test this ?

Figure 2 How do you prevent water flow from the tank sides and if you do not prevent it how does it affect the experiment ?

205 What would happen if the system was not saturated before the start ? Given the Infiltration rate you describe I suspect you would have no overland flow and only sapping processes. Did you try ? Did sapping channels form and develop ?

225 The definition of NCA and CA as zones where *surface* waters do or do not contribute is made clear here. It should probably appear earlier.

235 Same comment for the influence of flow on the walls. It should appear earlier in the description of the experiment.

250 Can you show examples of each type of channel head please so we can make up our minds ?

Table 3 What is the rationale behind these choices and again can you show us the channel types you are talking about ?

Figure 6 The Channel type 2 you seem to show here looks more like a mass flow then a sapping channel. Do you have other examples ? Are these channel types always localized on the borders ?

324 You say that type 1 overland flow channels comprise the vast majority of channels during the first half of the experiment but you force this to be so by saturating your media before the start of the experiment. This does not seem to be natural. Then could you show some example pictures of the changes from type 1 to type 2 you describe ? I would really be curious to see how run 3 looks like in the end.

338 what sort of unit is this $m^2 \cdot m^{-2}$? Is that not just the same as a fraction ? Can you explain ?

Figure 8 There are maybe two issues here that are pervasive in the entire manuscript. First you are not clear about the difference you make between CA aka contributing area and CA aka channelized area (sic). is there any and if so can you be more specific. If, as it seems at first, they are the same then a second problem arises as do not know what is the real basin area of seepage channels. You always stick to your surface flow definition of the contributing area. But this has not much meaning for a channel fed by groundwater. You should be clearer on these issues and potential limitations.

420 and discussion thereafter Again because your initial setup favors a specific type of process (overland flow channels) it seems difficult to be able to sort out the influence of the factors you describe with your initial saturation. It really seems important that you discuss this point somewhere.

455 Again if one looks at table 1 the infiltration rates you give should prevent infiltration because they are much higher then your rainfall rates (which are already huge). Thus this discussion seems a bit far-fetched.

465-470 I'd love to be persuaded but clearly you do not disclose the evidences needed to claim this.

499 Again I think that because you saturate your media prior to the start your experiment is biased towards overland flow and therefore conclusions about clay content and rainfall are probably far-fetched.