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Comment on hess-2021-462

Rolf Hut (Referee)

Referee comment on "Influence of drop size distribution and kinetic energy in precipitation modelling for laboratory rainfall simulators" by Harris Ramli et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-462-RC1>, 2021

Review of HESS-2021-462: 'Influence of drop size distribution and kinetic energy in precipitation modelling for laboratory rainfall simulators', by Ramli et. al.

Review by Rolf Hut.

The authors present the results of a series of experiments to test a newly build laboratory rainfall simulator. Rainfall simulators are an important tool in the bag of tools of (experimental) hydrologist and therefore a new rainfall simulator that has (potential) benefits over those already available is of interest and use to the readership of HESS. However, the article as presented does not allow, in its current form the readers of HESS to use the results / the rainfall simulator discussed in this work. Major revision and/or rewriting of the article is needed to clear up parts that are unclear and to add information that is currently missing.

Major issues

- The authors claim that in their article 'A rainfall simulator was designed, calibrated and tested' (page 11, line 260, opening sentence of the Conclusion). However, the design as mentioned in paragraph 2 is not enough for a trained hydrologist to reproduce the system.
 - A photo of the system needs to be added.
 - The text mentions that every lateral contains 10 drip emitter at 0.8 meter, which would make the system 8 meters long. I'm assuming that this is 0.08m, as per the drawing in figure 1b.
 - The system seems to be 80 x 80 cm of nozzles. The text says that the flour pallet method is used to determine drop sizes. This is the main measurement presented in the paper. This method uses a 1m x 1x board (as the authors report). Rainfall simulators based on nozzles have notorious 'edge effects' where the rainfall characteristics are noticeably different at the edges of the simulator compared to the center. The authors make no mention of this at all. Open questions include:
 - Did all the rain fall within the 1 square meter of the board? Of so: was it uniform? Their reporting of EU seems to suggest that it is, but it is unclear how EU was determined (see below).
 - How was the calculation from water flow to mm/hour done? This is unclear from the text and has major impacts on the results and the conclusions.
 - Figure 1a suggest that the 'soil' is uneven and thus that different heights are possible in this system. If this is true it needs to be made explicit. If it is not, figure 1a needs to be corrected.
- The literature contains many examples of rainfall simulators and the authors cite a fair few of these. These simulators cover a wide range of both surface areas and rainfall intensities targeted. This ranges from simulators of single drops, lab setups of the meter-scale and full multi-acre setups to be used on fields. The intensity ranges from drizzles to monsoons. The authors do not mention in their introduction what range their new simulator targets, nor for which applications it is build. Making this clear would help the readership with understanding the design choices.
- Paragraph 3 contains a mix of theory and experimental setup that is hard to disentangle. The choices made in how to conduct the experiment are mentioned in between citations to literature. I strongly recommend separating paragraph 3 in a 'theory' and a 'experimental setup' paragraph. As I understand it (but I could be wrong) the following experiments are done:
 - To check the amount of water coming out of the system the flow meter is read for different settings of the pump pressure. It is not mentioned how this experiment was conducted: for how long was the valve opened? Was the flow allowed to settled before starting the measurement? Or was it the same 1 to 4 seconds mentioned in paragraph 3.2?
 - To check the drop sizes generated with this system, the flour pallet method was used with the flow opened for 1 to 4 seconds (how much? How was this determined? Was the idea to only have a few drops? How many?) Subsequently the flour drops were collected. From line 158 I conclude that 100 drops per intensity rate were collected. Table 1 shows that the system generates 113 drops per minute (at 40 mm/hour) so collecting would require just less than a minute. This does not rime with the 1 to 4 seconds. This needs clearing up on what was done and how it relates to what is reported. Related to this: table 1 says that the system generated 6.44 ml/minute at 40 mm/hour. 6.44 ml/minute is 386.4 ml/hour. On a 1 square meter plate, this would be 0.386 mm/hour. I can not combine all these numbers and make sense of them and the authors need to clarify this by clearly stating what experiments they did and how they processed the measurement results into their findings reported.
- The authors use Foote & Du Toit (1969), their equation 3, to relate the drop sizes that they measure to terminal velocity. They use this terminal velocity to determine the maximum kinetic energy of the drops. They compare this to the actual kinetic energy but I do not understand how they calculate kinetic energy from their measured drop

sizes. If they use one of the equations they mention, they are in a circular reasoning because all these relations are based on terminal velocity assumptions. If it is not, then the authors have to make clear how they calculate terminal velocity.

- The drop size reported in the results and in figure 4 are concluded to be similar to natural rainfall (line 264). However, given my understanding of real rainfall, drop size distribution follow a Poisson distribution (by approximation) and the reported results do not. I suggest the authors look at the work of Remko Uijlenhoet on the relation between rain intensity and drop size distribution. The authors can add the expected drop size distribution for the given rain rate in their resulting figures. Based on the fit between these they can substantiate their claim that their rainfall simulator
- One of the critical parameters for rainfall simulators is how uniform they rain over their area and in time. The authors report on EU, but as I understand it, they look at EU per nozzle and not distributed. For their simulator it is important to know if every nozzle has the same output (with regard to drop size distribution and flow rate). Given issues like pressure drop over the length of the laterals this might not be the case. Also the stability in time is an issue: the authors indicate they open and close the valve for 1 to 4 seconds. Is this how it will always be operated? Or will it be opened fully when used in practice? Because there might be start and stop issues in that case with the pressure fluctuating thus creating different sized drops. The authors would need to clarify this.

Given the issues above, I suggest a major re-write of the article with the additional information requested above added to it.

Rolf Hut