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Experimental setup for precise investigation of raindrop impacted thin water flows

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Experimental setups with rainfall simulators over soil flumes are a widely-used method to study laboratory-based erosion processes. Small scale processes, such as splash, sheet, and interrill erosion mechanisms, can be studied with a very high degree of precision and accuracy. However, a major problem when performing investigations on raindrop impacted thin water flows is that accurate measurements of key erosion variables are difficult to obtain. In many investigations, important values are, therefore, not directly measured, but inferred from easier to determine parameters. For example rainfall intensity, plot dimension, and flow discharge are recorded during an experiment to rather crudely estimate velocity and depth of flow. Since water depth and flow velocity vary spatially and temporally during experiments with non-controlled flow conditions, this lack of measurement accuracy clearly reduces the explanatory power of the experimental data. Another example for this imprecision is the use of pressure nozzles for this kind of high accuracy experiments. The main problem associated with spray-type nozzles is that they produce a wide spectrum of drop sizes. In order to characterise simulated rainfall from nozzles, certain parameters, such as mean volumetric drop diameter (d50), are generally used. Knowing that different drop sizes have different effects on particle detachment when impacting on thin water layers of certain depth, it is apparent that this parameter of average drop size is not suitable for the detection of precise relations of, for instance, drop size, flow depth, and particle detachment. Although simulated rainfall from nozzles has a more natural drop size distribution, this use of roughly calculated metadata, instead of accurately measured parameters, is one of the main reasons why it is still not possible to deduce exact physical formulas to precisely model soil erosion mechanisms.

In order to be able to control and manipulate the key factors of the processes of raindrop impacted thin surface flows, an experimental setup and measurement protocol was designed. The main aims of this study are to present the setup of this newly-developed equipment and to explore the difficulties in designing specific parts of this instrumentation, and to provide guidance for other investigations on this topic. In addition, preliminary results using this experimental configuration are presented.