

Rainfall simulators in hydrological and geomorphological sciences: benefits, applications and future research directions

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Rainfall simulators are used extensively within the hydrological and geomorphological sciences and provide a useful investigative tool to understand many processes, such as: (i) plot-scale runoff, infiltration and erosion; (ii) irrigation and crop management, and; (iii) investigations into flooding within a laboratory setting. Although natural rainfall is desirable as it represents actual conditions in a given geographic location, data acquisition relying on natural rainfall is often hindered by its unpredictable nature. Furthermore, rainfall characteristics such as the intensity, duration, drop size distribution and kinetic energy cannot be spatially or temporally regulated or repeated between experimentation. Rainfall simulators provide a suitable method to overcome the issues associated with depending on potentially erratic and unpredictable natural rainfall as they allow: (i) multiple measurements to be taken quickly without waiting for suitable natural rainfall conditions; (ii) the simulation of spatially and/or temporally controlled rainfall patterns over a given plot area, and; (iii) the creation of a closed environment, allowing simplified measurement of input and output conditions.

There is no standardisation of rainfall simulation and as such, rainfall simulators differ in their design, rainfall characteristics and research application. Although this impedes drawing meaningful comparisons between studies, this allows researchers to create a bespoke and tailored rainfall simulator for the specific research application. This paper summarises the rainfall simulators used in European research institutions (Universities of Trier, Valencia, Basel, Tuebingen, Wageningen, Loughborough and Ghent) to investigate a number of hydrological and geomorphological issues and includes details on the design specifications (such as the extent and characteristics of simulated rainfall), as well as a discussion of the purpose and application of the rainfall simulator.