A portable wind and rainfall simulator for in situ soil erosion measurements

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Laboratory research in wind tunnels with the capability of simulating rainfall highlighted the importance of considering the complex interactions between wind and rainfall in the analysis of soil erosion processes. In order to overcome the inherent limitations of laboratory research and to further investigate these interactions under comparable conditions in the field, a Portable Wind and Rainfall Simulator (PWRS) has been developed. The aim of this study was to specify the wind and rainfall characteristics of the PWRS and to evaluate if its simulation quality and reproducibility is adequate for comparative soil erosion studies in the field. Wind velocitymeasurements showthat a pre-shaped logarithmic boundary layerwith a thickness of about 0.2 m exists. The uniformity of airflow across the tunnel is acceptable within the lower 0.3 m of the tunnel with maximum standard deviations below 0.7 ms−1. Maximum variability of wind velocities between three consecutive repetitions of themeasurements is lower than 15%. The spatial rainfall distribution for windless rain show rather poor uniformity (Christiansen Uniformity (CU) coefficient=60%), but very good reproducibility inbetween five consecutive replications. About 90% of the test plot experiences a variability of rainfall below 5%. Simulated drop size distributions correspond very well with calculated Marshal–Palmer Distributions (MPD) of equal rainfall intensities(mean deviation of 2.1%). Forwind-driven rain both abovementioned parameters clearly improve (CU=76%,mean deviation=1.7%). Themean rainfall intensities showalso very lowvariability between the five replications with standard deviations of 0.31mm h−1 forwindless rain (mean intensity 96mm h−1) and 0.69mm h−1 for wind-driven rain (mean intensity 88mm h−1). In conclusion, test results of the PWRS are very satisfactory, especially considering the physical constraints, which have to be taken into account to reach desired portability. The analysis presented in this study suggests in particular very good reproducibility of wind and rain conditions. The PWRS should therefore be a useful device for comparative in situ soil erosion measurements in the field and support the gathering of quantitative data on the relative importance of soil detachment rates betweenwind and water erosion, aswell aswindless and winddriven rainfall.
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