Erosion by wind, windless rain, and wind-driven rain. Experimental in situ measurements with a portable simulator.

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Natural rain events often occur as rainstorms, adding a driving component to falling raindrops. Laboratory investigations in wind tunnels with the ability of simultaneous rainfall production showed that wind significantly alters drop sizes, drop fall velocities and impact angles of falling raindrops. Leading to higher kinetic energies and increased soil detachment in comparison to falling drops with no wind influence. Unfortunately, in most in situ soil erosion studies this combined effect of wind and water is either not taken into account or deliberately excluded from the system, because of increasing complexity of processes involved. Therefore a portable combined wind and rainfall simulator for in-situ soil erosion studies was developed and used in Spain (Aragón, Andalusia). The main objective was to get first results to compare erosion rates caused by wind, windless rain and wind-driven rain on plot scale.

The working section of the simulator is 4 m long, 0.7 m high, 0.7 m wide and rectangular in shape. A bounded plot of 2.2 m² can be irrigated by four pressure nozzles (Lechler type 460.608) with an intensity of about 90 mm h^{-1}. The spatial drop distribution is very well reproducible and the drop sizes resemble natural rainfall quite well, when compared to Marshal-Palmer distributions of same rainfall intensities. The pre-shaped boundary layer varies from 15-20 cm in height. The airflow within the lower 30 cm of the tunnel is sufficiently homogenous across the tunnel (deviation from mean 0.4-0.55 m s^{-1}) for in situ measurements. The duration of wind simulations is 10 min and 30 min for rainfall simulations. The simulations are performed in four consecutive test runs with following order: (1) Single wind, (2) single rainfall on dry soil conditions, (3) single rainfall on moist soil conditions, and (4) simultaneous wind and rainfall. The interval of runoff collection is 2.5 min and emptying of samplers for wind material takes place at the end of each test run.

The results indicate that wind erosion in Aragón is more or less negligible on undisturbed, crusted soil surfaces, but it can reach high amounts of up to 50 g m^{-2} on rolled and grazed fields. The expected increase of runoff erosion rates from windless rain to wind-driven rain, due to the combined force of wind and water, can be seen in most simulations. The increase varied from 1.5 % up to 226 %.

The results show that this combined wind and rainfall simulator is a valuable tool for soil erosion studies in the field. The good transportability ensures the investigation of diversified research questions even in remote areas.