Laboratory results of a portable wind and rainfall simulator

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Introduction
Soil degradation and desertification is often caused by wind and water erosion. For many years researchers have been studying both processes separately. Laboratory investigations with wind tunnels that include rainfall simulators have shown the existence of very complex interactions between wind and water erosion. These results were confirmed in recent field research, especially for semi-arid regions. For future quantification and prediction of soil desertification both processes need to be measured together.

Main objectives
General objective of this study is to simultaneously measure erosion rates by wind and water erosion with a combined wind and rainfall simulator operational in the field. To reach this goal following calibration measurements were conducted:

1. Homogeneity of airflow direction
2. Homogeneity of wind speed
3. Drop size distribution and drop fall velocity
4. Spatial distribution of rainfall

Portable wind and rainfall simulator

Methodology

Wind tunnel

- Integrated rainfall simulator
- Concentric pattern of rainfall tunnel sidewall
- Deflection of airflow from parallel by low tunnel height.
- Nearly logarithmical vertical wind profile until 18 cm height
- Wind speed variation between 6.5 and 9 m/s
- Lowest wind speeds near floor and between x = 40-60 cm and y = 10-50 cm
- Nearly logarithmical vertical wind profile until 18 cm height
- Deflection of airflow from parallel by sidewalls (maximum 3°)
- Homogeneous, parallel airflow between y = 20 and y = 50 cm

Integrated rainfall simulator

- woolen wires: air flow direction (1)
- Pietot tube: wind speed (2)
- Collecting pans: spatial distribution (4)
- Guelph-Trent Wedge Trap (GTW)

Combined sediment trap

- passive trap, vertically integrating
- passive trap, horizontally installed
- low cost
- good calibration results

Calibration of wind tunnel

- Complete naturally occurring drop spectra is covered
- Especially larger drops are too slow (max. fall velocity 6 m/s) compared to natural rainfall droplets (green line)

Calibration of rainfall simulator

- Spatial Distribution of rainfall test inside wind tunnel
- Deflection of airflow from parallel by sidewalls (maximum 3°)
- Homogeneous, parallel airflow between y = 20 and y = 50 cm

Spatial distribution of simulated rainfall is rather inhomogeneous

Conclusions

1. Major limiting factors that prevent the development of a "natural" turbulent boundary layer and "natural" drop fall velocities are short tunnel length and low tunnel height. 
2. Due to the properties of full cone nozzles a homogeneous spatial drop distribution can only be created by using more than one nozzle.

Despite the problems to simulate "natural" wind and rainfall conditions we expect to be able to obtain valuable quantitative information regarding the relative impact of wind and water erosion on soil degradation. Especially the high mobility and reproducability make this device suitable for relative in-situ investigations

Literature