The influence of wind driven rain on soil detachment rates on homogenous sandy substrate

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Introduction

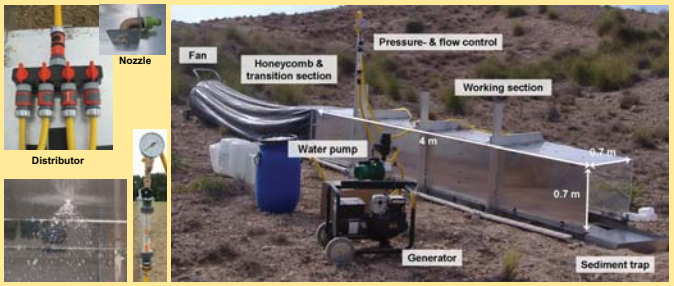
Trier University's portable wind and rainfall simulator is a recently developed device for plot-scale *in situ* assessment of differences in erosion rates with and without the influence of wind on raindrops. Results from laboratory and initial field research showed an influence of wind on drop velocity, impact angle and kinetic energy and a subsequent increase of eroded material.

Main objective

1) Qualitative observation of processes of erosion with wind-driven rain
2) Quantification of erosion of wind driven rain
3) Comparison of erosion of cohesionless soil under windless and wind-driven rain

Method

Portable wind and rainfall simulator



Built up wind- and rainfall simulator at Freila (Andalusia)

Specifications: plot size **2.2 m²**; water discharge per nozzle *(Lechler 460.608)* **60 l/h**; rainfall intensity **88 - 96 mm/h**; pressure **~ 0.2 bar**; wind velocity **Ø 7.5 m/s**

Test procedure

Test runs on plot:

Run 0) single wind
Run 1) windless rain on dry soil
Run 2) windless rain on moist soil
Run 3) wind-driven rain on moist soil

Test duration: 10 min for single wind test run; 30 min for rain test runs

Measurement interval: 2.5 min for rain test runs

Between test runs a 30 min break was included.

For investigation of wind-driven rain, run 2 and run 3 were compared.

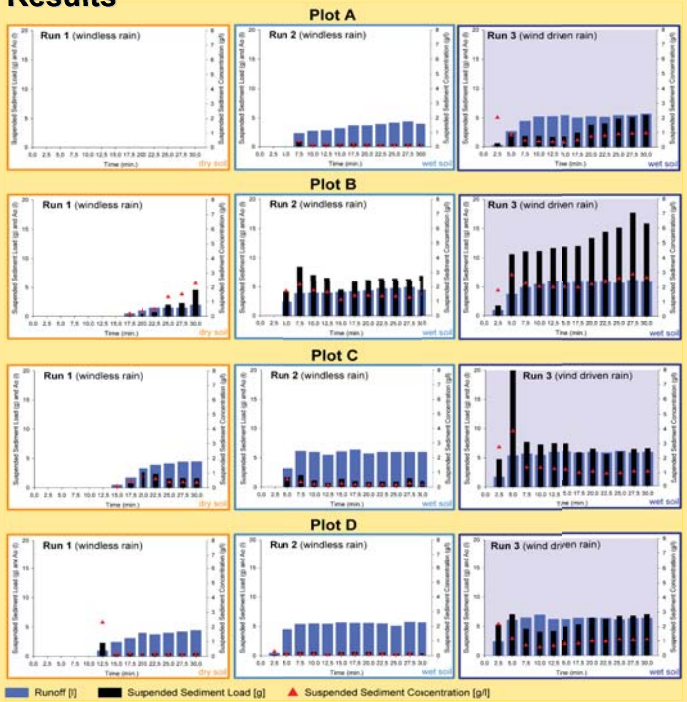
Study site

Wageningen University's Irrigation Tunnel

- Highly standardized, reproducible and controllable "semi-laboratory" conditions
- 7.6 x 60 m with uniform inclination
- Homogeneous sandy substrate
  - D_{50} = 0.16 mm
  - Ploughed and cultivated
  - Compacted layer in -0.15 m

→ *Highest possible reproducibility combined with closest to nature circumstances.*

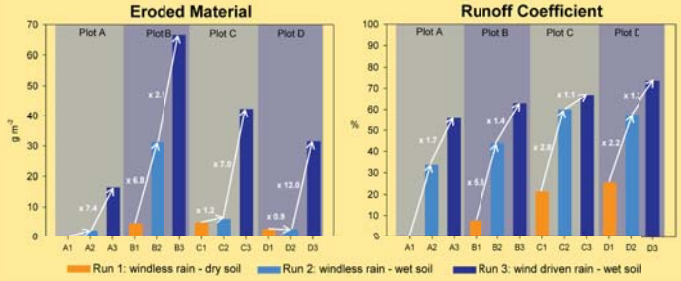
Results



Results

Plot	Run	Runoff Coefficient (%)	Eroded Material (g)	Sediment Concentration (g/l)
A	Run 1 (windless rain)	0	0	0
	Run 2 (windless rain)	34	4.9	0.1
	Run 3 (wind driven rain)	58 (+71%, x 1.7)	36.3 (+640%, x 7.4)	0.6 (+368%, x 4.7)
B	Run 1 (windless rain)	8	10.1	1.3
	Run 2 (windless rain)	44	68.8	1.6
	Run 3 (wind driven rain)	65 (+48%, x 1.4)	146.6 (+113%, x 2.1)	2.3 (+56%, x 1.6)
C	Run 1 (windless rain)	21	10.7	0.5
	Run 2 (windless rain)	60	13.3	0.2
	Run 3 (wind driven rain)	69 (+15%, x 1.1)	93.1 (+602%, x 7.0)	1.4 (+562%, x 6.6)
D	Run 1 (windless rain)	26	5.8	0.2
	Run 2 (windless rain)	57	5.8	0.1
	Run 3 (wind driven rain)	76 (+32%, x 1.3)	69.5 (+1108%, x 12.1)	0.9 (+894%, x 9.9)

- Eroded material increases from 113 % up to 1108 %
- Sediment concentration increases between 56 % to 894 %
- Increase in runoff only 15 % to 71 %



Conclusions

- **Wind-driven rain increases soil erosion on cohesionless soils substantially.**
- **Reason for increase is combined effect of**
  - **fast flowing surface water,**
  - **reduced surface water film,**
  - **directed impact of drops.**
- **Experiments allow quantitative and qualitative observation of runoff and erosion processes.**

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