AN EXPERIMENTAL INVESTIGATION ON SOIL EROSION USING A SMALL PORTABLE WIND TUNNEL

W. Fister[1] ; J. B. Ries[1] ; J.-F. Wagner[2]

[1] University of Trier, Department of Physical Geography, Behringstr., 54286 Trier, Germany
[2] University of Trier, Department of Geology, Behringstr., 54286 Trier, Germany

Abstract. A small portable wind tunnel has been developed to achieve a better understanding of the relationship between water and wind erosion. With this wind tunnel several test runs both on fallow and arable land have been conducted at Marìa de Huerva, Spain. To better represent the typically applied dry farming system, the soil surface treatments ploughing, harrowing and rolling were chosen. Additional tests were carried out on undisturbed crusted soil and on soil which had been disturbed by sheep trampling. The results of these tests show, that it is possible to gain verifiable data with this fairly simple device.

INTRODUCTION

Water and wind erosion are the main driving factors for soil degradation and desertification in semi-arid landscapes. Although, in most areas, soil erosion by water is assumed to be more important than by wind, the exact ratio between both is mostly unknown. With different soil surface conditions, for example physical soil crusts, trampling by grazing flocks, ploughing, harrowing, and rolling, this ratio can change significantly. To achieve a better understanding of the relationship between both factors, a small and portable wind tunnel has been developed during this project. The main objectives of the work are:

- Determination of the wind erosion risk of different soil surface conditions on silty soils in the Central Ebro Basin, Spain.
- Registration of the ratio change between wind and water erosion due to the different soil surface conditions

METHODOLOGY

1. Wind tunnel

The wind is generated by a fan with 5.5 hp, 163 cm³ and a two wing propeller. Its wings can be variably adjusted to different angles to change both the wind power and wind speed. The turbulent rotating air stream is caught by a 2 meter long transition section (*figure 1*) which is made of strong PVC-foil (thickness = 1 mm). This section should be long enough to reduce the largest turbulences from the air stream.

To further straighten the air stream a 15 cm long air-straighter follows (*figure 2*). Its honeycomb structure is made of 289 PVC-tubes each 4 cm in diameter.

The 3 m long tunnel itself is made of three separate (1 m long) sections of aluminium and perspex sheets which can be folded up for transport (*figure 3*). The sheets are stabilized and connected by three aluminium frames. The bottom of the tunnel is open and creates a 2 m² test area.

The sediment output from the test area is caught by the Sediment catching area which is made of usual canvas cover (tarpaulin) with a base of 3 x 5 meters (*figure 4*). For stabilization of the vertical boundary wood poles (1 m side and 1.5 m back) were wired together. An overview of the built-on tunnel is shown in *photo 1*.

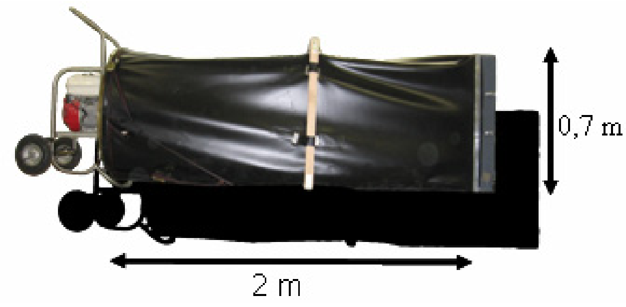

Figure 1: Fan & Transition Section

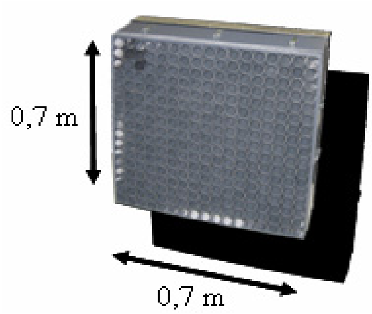

Figure 2:Air Straighter

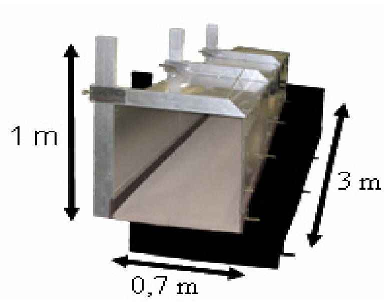

Figure 3: Wind Tunnel

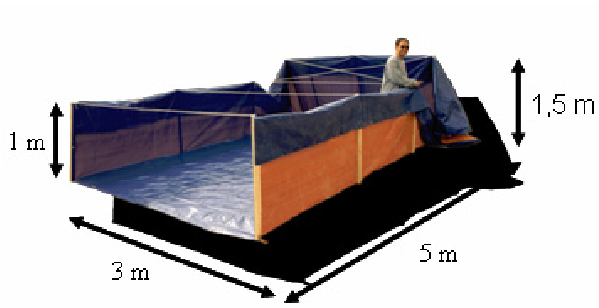

Figure 4: Sediment Catching Area

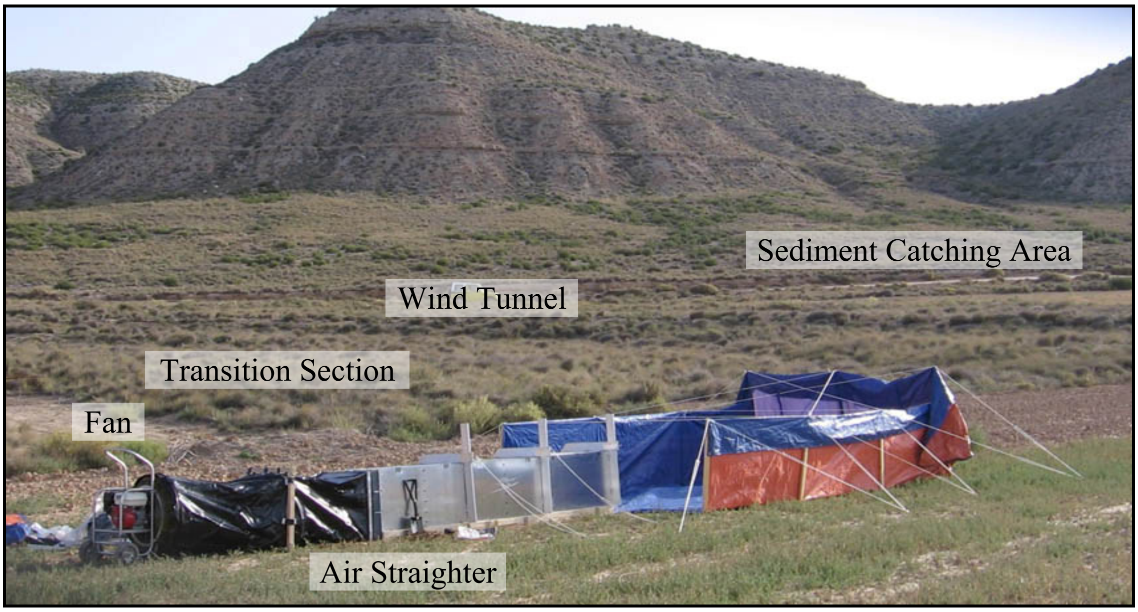

Photo 1: Wind tunnel in María de Huerva, Spain

2. Soil surface treatments

Soils within the Ebro Basin generally have very high silt contents (> 50 % [1]). Therefore soil sealing and crusting occur frequently on abandoned fields. To store more water in the soil for the growing season, farmers use a special dry farming system. During the fallow stage, they first plough and harrow their fields to increase the infiltration of rainwater, before rolling their fields to seal the soil surface against evaporation loss. The applied soil surface treatments in the test runs are chosen to represent this typically applied dry farming system. An overview of the soil surface treatments is given in *figure 5*.

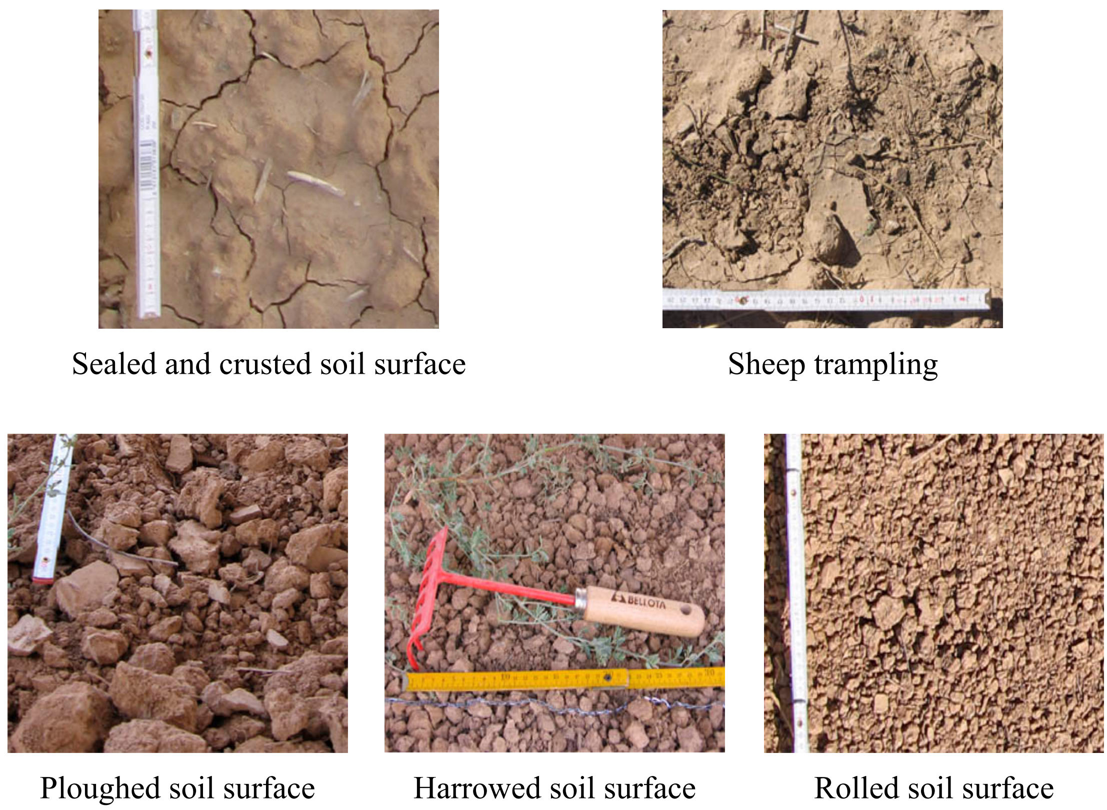

Figure 5: Soil surface treatments

Another cause of the destruction of the crusted soil surface on abandoned fields is grazing flock *(photo 2)*. Tests were carried out with simulated sheep trampling to represent this common process. For further differentiation on the effects to wind erosion, the sheep trampling was simulated both before and during the wind erosion tests.

Photo 2: Wind erosion by grazing sheep in María de Huerva, Spain

RESULTS AND DISCUSSION

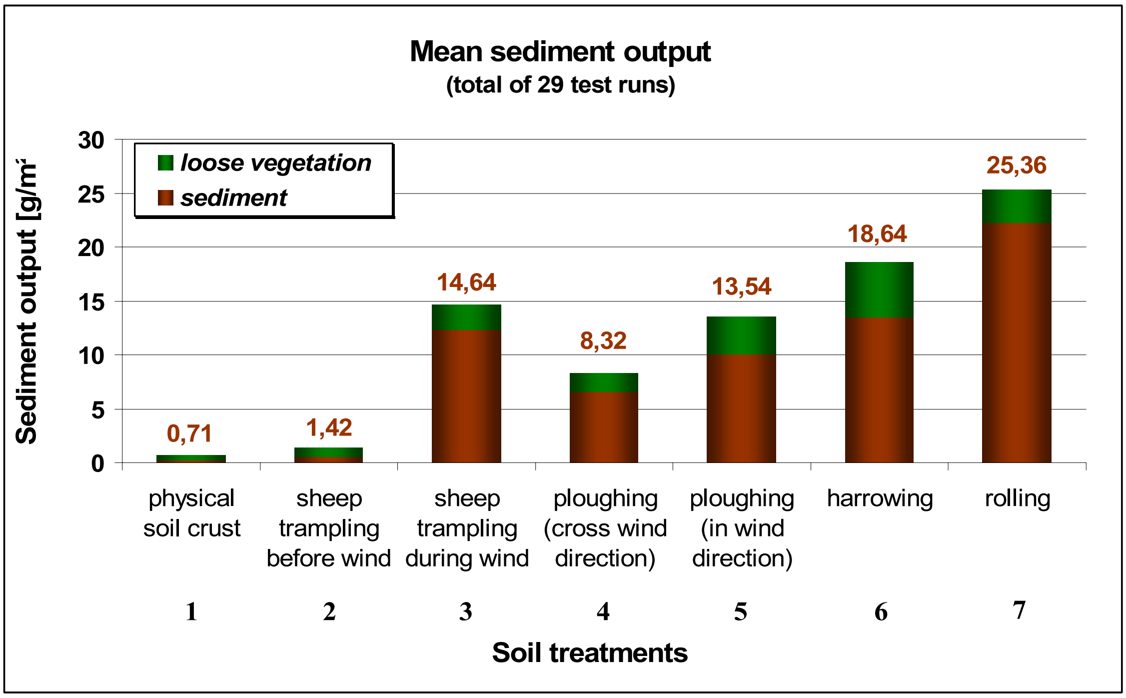

Figure 6: Mean results of 29 test runs with the small, portable wind tunnel (according to REHBERG [2])

Column 1 of *figure 3* shows that the sediment output by wind erosion on crusted soil surfaces is almost negligible. Due to the soil sealing and the fixing of fine soil particles, this result corresponds with our expectations and the results from previous studies of HUPY [3] and RAJOT, ALFARO, GOMES & GAUDICHET [4]. Remarkably, although the soil crusts were clearly destroyed by sheep trampling, the increase of sediment output in calm wind conditions cannot be interpreted as significant *(column 2)*. If trampling is simulated during wind erosion events, the sediment output increases significantly by more than 10 times the particle deflation of crusted soils *(column 3)*. The average output amount of about 15 g/m² is comparable to the average output on arable land *(columns 4 to 7)*. The increase in sediment output from ploughing to harrowing and rolling is corresponding to the reduction of soil surface roughness. It reaches quantities similar to the amount of particle output through water erosion on crusted soils in the Ebro Basin [5, 6].

CONCLUSION

Even if this fairly simple device is not able to simulate all of the aerodynamic parameters which are necessary to represent exactly the natural wind conditions, the mobility together with the capability to produce verifiable data from different surface conditions recommend its utilisation. Due to the probability of mistakes in the experimental design, only results which are statistically significant should be interpreted. Therefore farmers have to decide whether they want to minimize their hazard of water erosion through ploughing and increase wind erosion or vice versa.

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