Impact of Tillage Management on Aeolian Sediment Transport: A Multi-Source Regression Analysis Using Effective Plant Cover (EPC) Factor

A. Nouri¹, G. Erpul², F. Youssef³, M. Basaran⁴, J. Lee⁵

Wind erosion is a common environmental problem in most of the arid and semi-arid regions of the world. Although anthropogenic soil disturbance has always been an influential factor intensifying the natural process of aeolian land form evolution and dust emissions around the world (Xu, 2006; Okin et al., 2001) and in inland drift-sand areas of Turkey (Buyuk et al., 2011), comprehensive understanding on this subject is still missing. Tegen and Fung (1995) estimated that 20–50% of the global dust load is initiated from human-disturbed soils. The objective of this study was to examine the impact of two tillage practices, reduced tillage (RT) and conventional tillage (CT), at the beginning of the windy season on sediment transport on a sandy-loam soil surface in Karapinar, Turkey. Employing the conventional tillage system combined with fallow periods in wheat cultivation in semi-arid regions of central Anatolia has been identified as a suitable practice to restore the soil moisture content. During the fallow phase of the cropping system multiple moldboard or disk plowings are usually performed to increase the soil percolation and water storage capacity. Conventional tillage buries residues and stalks, and likewise removes the natural plant cover that has been emerged on the surface after the last tillage application. The coincidence of the spring tillage and severe spring winds in fallow periods has been determined to be the major reason for soil losses from these croplands.

A new plant factor was tested for assessment of the spatial efficiency of vegetation cover accounting for both the physical characteristics and spatial distribution of individual plant units. This plant factor assumes that for a known number of plant units the best distribution pattern is acquired whenever they are located in regular grids. Any deviation from this pattern and accumulation of plant cover causes erodible areas between plants which is quantified by this new factor. The Effective Plant Cover (EPC) factor could successfully explain the spatial sediment losses in the presence of natural vegetation cover.

During the first wind event, in the absence of the effective plant cover, the RT plot had 57% greater sediment losses than the CT plot. However, sediment losses from the second, third and fourth wind events were 93%, 4%, and 6% greater from the CT treatment compared to the RT, respectively. Multi-source regression analysis revealed a relatively sharp linear reduction in sediment collections at the lower heights of the catcher bars (20, 40 and 60 cm) with the unit increase in EPC. However, in sediment collectors at the 80 and 100 cm heights where notably smaller values of sediment were collected, inconsistent relationships were occasionally observed. The Coefficient of Determination ($R^2$), Mallows’ CP, and AIC (Akaike's Information Criterion) techniques were used to select the best mass flux prediction model. Taking into account the intercept, our selected model has 5 model terms comprising wind duration, soil moisture content, average EPC and maximum wind speed. This model with $Cp=4.6$ and $AIC=76.3$ explained 91% of the variability in the sediment mass flux. Despite the spatial effect of the natural plant cover reducing the aeolian sediment transport, the magnitude of the sediment losses in the temporal manner was still mainly controlled by wind characteristics and soil moisture content (Figure 1).

¹Amin Nouri, Ph.D. candidate, University of Tennessee, Knoxville, Tennessee, USA; ²Gunay Erpul, Professor, Ankara University, Ankara, Turkey; ³Feras Youssef, Ph.D., The Ministry of State for Environmental Affairs, Damascus, Syria; ⁴Mustafa Basaran, Associate Professor, Erciyes University, Kayseri, Turkey; ⁵Jaehoon Lee, Associate Professor, University of Tennessee, Knoxville, Tennessee, USA. Corresponding author: G. Erpul, email: gunay.erpul@ankara.edu.tr.
Figure 1. Mass flux of aeolian sediment (g m⁻¹ s⁻¹) for all events, for four events of conventional tillage (CT) plot and four events of reduced tillage (RT) plot. Average wind speed (WS_avg) and maximum wind speed (WS_max) observed at each plot also plotted.

References


