Relational Analysis of Aggregate Size Distributions and Soil Organic Carbons of the Eroded Sediments

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In terms of soil erodibility assessment, studies on relationship between disintegration of soil aggregates and soil organic carbon have been limited under erosive conditions. In order to investigate these relationships, interrill erosion processes of rain-splash transport (RST) and raindrop impacted flow transport (RIFT) were simulated in laboratory conditions.

The rainfall simulations were conducted with the soils of three different land uses (agricultural land, grassland and forest, taken from a semi arid catchment, located in Ankara, Turkey) under three slope gradients (9, 15 and 20%) and two rainfall intensities (80 and 120 mm h^{-1}) with three replicates for saturated conditions. In total, 18 different sub-group simulations were performed under laboratory conditions (Figure 1).

Figure 1. Rainfall simulator (left) and experimental setup in laboratory (right).

The eroded sediments by both RST and RIFT were collected every 5 min during 60 min in each sub-group of rainfall simulation. The 1143 sediment samples collected from 18 different sub-groups were dried to measure Aggregate Size Distributions (ASD). Mean Weight Diameter (MWD, mm) values, the most widely used index for relating aggregate size to stability, were calculated from the ASD. According to the obtained MWD values for each simulated condition, Organic Carbon (OC, %) content of the eroded sediments corresponding to the dominant aggregate size class were measured for the 1143 samples.

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Results indicated that the values of MWD and OC in the eroded sediments by RST and RIFT changed significantly ($P < 0.01$) with the interaction term of rainfall intensity x slope gradient x land use. The highest MWD values and OC contents obtained from all sub-group of simulations (Table 1) were measured for forest soils ($*P < 0.05$). Agricultural land and grassland soils produced similar MWD values (Table 1). Based upon the initial soil conditions before rainfall simulation, agricultural land soils had initially higher clay contents than grassland; however, grassland soils had initially higher OC contents (Table 1).

For the RST sediments, variation in slope gradient had significant effects on MWD values, except for grassland soils. But, the variation in slope gradients had no statistically significant effect on the OC contents of these sediments ($P > 0.05$) (Table 1). More intensive rainfall conditions for all land uses and slope gradients led to lower MWD values of the eroded sediments (Table 1). The OC contents of these sediments were also affected by the intensity variations for the soils of agricultural land and grassland. Land use had more significant interactions with MWD values and OC contents of the eroded sediments than did intensity and slope gradient for the RST and RIFT processes.

Table 1. Comparison of MWD values (mm) and OC contents (%) for RST sediments ($*P<0.01$).

Slope Gradient (%)	Rainfall Intensity (I) (mm/h)	MWD Values Land use (LU)			Organic Carbon Contents Land use (LU)		
		Cropland	Grassland	Forest	Cropland	Grassland	Forest
9	80	0.36 C **b** ^{B*}	0.39 A **b** ^{B}	0.87 B **b** ^{A}	0.96A **a** ^{B}	1.06 A **a** ^{B}	2.20 A **b** ^{A}
	120	0.45 B **a** ^{B}	0.46 A **a** ^{B}	0.93 A **a** ^{A}	0.29A **b** ^{C}	0.81 A **b** ^{B}	2.47 A **a** ^{A}
15	80	0.45 A **b** ^{B}	0.40A **b** ^{C}	0.90 B **a** ^{A}	0.51 B **a** ^{C}	1.13 A **a** ^{B}	2.31 A **a** ^{A}
	120	0.49 A **a** ^{B}	0.48 A **a** ^{B}	0.75 B **b** ^{A}	0.27 A **b** ^{C}	0.87 A **b** ^{B}	2.37 A **a** ^{A}
20	80	0.41B **b** ^{B}	0.41 A **b** ^{B}	1.00A **a** ^{A}	0.49 B **a** ^{C}	1.01 A **a** ^{B}	2.28 A **a** ^{A}
	120	0.48 AB **a** ^{B}	0.48 A **a** ^{B}	0.63 C **b** ^{A}	0.30 A **a** ^{C}	0.94 A **a** ^{B}	2.18 B **a** ^{A}

*Capital letters was used for comparison of slope steepness; bold lower case letters for comparison of rainfall intensities; superscript letters for comparsion of land use types.

Observed main differences between the RST and RIFT processes were:

- increases in the rainfall intensity led to significant variations in the MWD values of the RST sediments more than those of RIFT,
- the effect of variations in the slope gradient were not statistically significant ($P > 0.05$) on MWD and OC values of the RST sediments compared to those of RIFT sediments for most of the controlled conditions of the experimental design.

In the light of these results, the MWD values of the eroded sediments by the RST and RIFT processes were, to a great extent, similar and statistically the same, showing no changes with land use, slope gradient or rainfall intensity. However, the variations in the OC contents of these aggregates were statistically significant ($*P < 0.05$) with effects of land use, slope gradient and rainfall intensity evident. Increases in MWD values of incoming sediments, especially from undisturbed land uses (i.e. forest and grassland) gave rise to considerable transport of soil organic carbon.