Geophysical Research Abstracts
Vol. 16, EGU2014-2084, 2014
EGU General Assembly 2014

The effect of break of runoff connectivity on SOC concentration in loess catchment of the Lublin Upland (Poland)

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Soil erosion processes lead to redistribution of soils and soil organic carbon (SOC) in the landscape. In this study, we aimed to evaluate the effect of runoff connectivity on horizontal and vertical SOC concentration in the catchment.
SOC concentration was examined in a small agricultural catchment located in deep loess area of the Lublin Upland, Poland (51019'55"N, 22023'16"E). The catchment area of 5.6 ha is divided into 11 parcels. Conventional tillage is performed on each of the parcel and plow includes of 1-2 moldboard and 1 cultivator operations per year. Tillage is performed along the longest side of parcels. Crop rotation includes wheat, barley, sugar beets, potatoes and maize. Connectivity of temporal overland flow in the catchment is disturbed by grassed borders of the parcels. SOC concentration was studied in 151 sampling points in a grid 20 by 20 m. Structure of soil profile was studied in each of the sampling points, and soil cores were taken from two soil layers of 0-25 and 25-50 cm, and from 7 profiles located within the closed depression and the areas where line of temporary overland flow cross the grassed parcel borders. SOC concentration in soil samples was determined by wet combustion with dichromate solution.
Depositional soils represented 57 profiles in the catchment. The thickness of accumulated soil layer varied from 20 to 151 cm with a mean of 55 cm. SOC concentration ranged from 8.4 to 15.0 g kg-1 (with a mean of 11.0 g kg-1) in the upper and from 2.9 to 14.5 g kg-1 (7.5) in the deeper soil layer. Coefficient of variation was 12.9% in the layer 0-25 cm, and 44.5% in the layer 25-50 cm. To find the reasons of high variability of SOC concentration in deeper soil layer, the location of depositional soils in the catchment was analyzed. The analysis enabled to distinguish two groups of depositional soils of different SOC concentration at the depth of 25-50 cm. Depositional soils located in the zones of temporal stagnation of overland flow (i.e. closed depressions and the areas where the lines of concentrated flow cross the parcel borders) characterized higher SOC concentration with a mean of 10.10 g kg-1, and depositional soils located on slopes - lower (4.10 g kg-1). The first group represented 33 profiles, the second 24. Coefficient of variation in each group of soil was 19%.
Vertical SOC concentration showed a large variation in profiles of depositional soils, with layers of higher and smaller SOC concentration at different depth. Soils located in the zones where lines of concentrated temporary flow cross the field borders showed a high SOC enrichment in buried Ab horizons (at the depth >80 cm) in comparison to soils located in closed depressions. The difference could be a result of larger area that contributes to overland flow in the case of sites located at lines of flow in comparison to the contribution area of closed depressions. The exception is a profile SP6, where the SOC concentration in Ab is similar to the Ab horizon in depressions. The SP6 profile is located in the lower part of the catchment at the end of a parcel of the length of 110 m. The other profiles (SP2, and SP5) are in the areas were distance between the parcel borders is 40-60 m, and SP7 is at the catchment outlet. It seems that the difference in SOC concentration in Ab between SP6 and SP2-SP5 is a result of more effective decrease of velocity of overland flow by closely located grassed borders of the parcels. The studies showed that grassed parcel borders fill an effective role in an increase of soil carbon stock in the areas where lines of temporary overland flow cross the parcel border. The effectiveness of SOC accumulation was larger in the past, as it is proved by high SOC concentration in buried Ab horizon, and was dependent on the distance between the grassed borders.