85-264-J

Wind erosion effects on soil texture and organic matter

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ABSTRACT: Ten soil sites in western Kansas sampled in 1948 were resampled in 1984 to compare the particle size distribution (texture) and organic matter content in the top 10 cm. Except at one site, the sand fraction increased; this increase ranged from 0.9 to 23.3 percentage points. The greatest changes occurred in the moderately coarse and coarse textured (sandy) soils. Overall changes in particle distribution were +6.5, −7.2, and +0.7 percentage points for sand, silt, and clay, respectively, indicating that silt was removed through sorting by wind. Organic matter declined at 8 of the 10 sites, averaging about 19% overall or about 0.01 percentage points per year. Erosion or other factors are causing a slow decline in silt content and organic matter in these soils, with potentially detrimental effects on soil structure, nutrient availability, and water-holding capacity.

OVER time wind erosion sorts soil, removing the particles and aggregates finer than about 50-100 μm in diameter. Soil particles and aggregates of 100 to 500 μm hop along the soil surface until they reach a sheltered area. During that movement, particles abrade other aggregates or break down themselves, creating additional fine particles that can be removed by the wind.

Due to this sorting, the surface soil texture becomes more coarse and organic matter decreases over time. Limited data indicate that these changes occur slowly (5), requiring years to show clearly their magnitude, especially on cropland where tillage mixes the upper soil layer.

In 1948, shortly after establishment of the wind erosion research project at Manhattan, Kansas, W. S. Chepil, project leader, and Claude Fly, state soil scientist for the Soil Conservation Service, sampled 10 soil sites on cropland in western Kansas. They sought to document the physical and chemical properties of these soils that would be subject to wind erosion and that were representative of the central and southern Great Plains. Data on organic matter content and mechanical composition (texture) were recorded in the 1948 annual report of the wind erosion project. We resampled the 10 sites in June 1984 to determine the extent of changes in organic matter and surface soil texture over the 36-year period.

Study methods

Based on Chepil's descriptions, the 1984 samples at seven sites were taken within 3 m (10 feet) of the original sampling points. Two others (C-33 and C-42) probably were within 15 m (50 feet). The remaining site (C-16) may have been as much as 664 m (0.4 mile) from the original point.

We collected five to six soil samples within a 1-m² area to a depth of 10 cm (4 inches) using a 2.0-cm-diameter split tube. Samples were composited, air-dried, and crushed to pass a 2-mm sieve.

We followed Chepil's textural analysis

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Reprinted from the Journal of Soil and Water Conservation
May-June 1986, Volume 41, Number 3

procedures by determining percent clay less than 2 μm in diameter with a hydrometer, sand by weighing the amount of dispersed soil retained on a 50 μm sieve, and silt by difference. Chepil used sodium silicate and sodium oxalate to disperse the soil. We used sodium phosphate. The samples were not pretreated with hydrogen peroxide. Sand, silt, and clay also were determined by the pipette method. Organic matter determinations were made at the SCS National Soil Survey Laboratory, Lincoln, Nebraska, using the Walkley-Black titration method (6). For possible future comparisons, the samples were analyzed for organic matter, available P, and exchangeable Ca at the Kansas State University Soil Testing Laboratory.

Table 1. Comparison of sand, silt, and clay contents in 1948 to 1984 in the upper 10 cm of soil at 10 sites in western Kansas.

Site Number/ County	Sand		Silt		Clay		Soil Series and Texture	
	1948	1984	1948	1984	1948	1984	1948*	1984
	%							
C-14/Lane	8.9	9.8	72.4	67.0	18.7	23.2	Keith SiL	SiL
C-16/Grant	23.8	27.1	60.4	55.6	15.8	17.3	Ulysses SiL	SiL
C-18/Morton	13.0	15.6	60.9	59.7	26.1	24.8	Baca SiL	SiL
C-21/Morton	61.7	80.5	30.2	11.3	8.1	8.2	Springer FSL	LS
C-25/Morton	49.7	49.4	35.9	33.1	14.4	17.5	Dalhart FSL	L
C-30/Ellis	5.8	8.5	69.1	69.3	25.1	22.2	Hastings SiL	SiL
C-33/Ford	8.6	11.2	71.9	65.7	19.5	23.1	Richfield SiL	SiL
C-36/Stafford	56.9	80.2	31.6	14.7	11.5	5.2	Larned SL	LS
C-39/Stafford	85.0	93.5	12.0	2.8	3.0	3.7	Pratt LS	S
C-42/Stafford	76.4	78.8	18.2	11.4	5.4	9.8	Pratt SL	SL
Overall change		+6.5		−7.2		+0.7		

*Soil Conservation Service Soil Survey Classification; Chepil's textural names are given even though C-25 was also a loam in 1948.

Table 2. Organic matter concentrations in the upper 10 cm of soil in 1948 and 1984 at 10 sites in western Kansas.

Site	Soil Series	Organic Matter (%) 1948	1984	Change
C-14	Keith SiL	2.77	3.21	+0.44
C-16	Ulysses SiL	2.34	1.88	−0.46
C-18	Baca SiL	2.18	1.76	−0.42
C-21	Springer FSL	1.26	0.74	−0.52
C-25	Dalhart FSL	1.08	0.95	−0.13
C-30	Hastings SiL	3.25	2.02	−1.23
C-33	Richfield SiL	2.48	1.60	−0.88
C-36	Larned SL	2.50	1.81	−0.69
C-39	Pratt LS	0.85	0.52	−0.33
C-42	Pratt SL	0.96	1.22	+0.26
Average		−0.40		

Results and discussion

Except for one site (C-25), the sand content in the sampled layer was higher in 1984 than in 1948. The greatest changes, on the average, occurred in the more erodible sandy soil textures (Table 1). For example, the average change in sites with 0 to 45% sand content in 1948 was +2.4 percentage points. This compared with a +10.5 change for sites with 46 to 90% sand content. The reverse was true for silt. Sites with 0 to 40% silt content in 1948 lost 10.9 percentage points over the 36 years. This compared with a −3.5 percentage-point change for the sites with 41 to 80% silt in 1948. Corresponding values for clay were +0.4 percentage points for soils with 0 to 15% clay content and +1.1 percentage points for soils with 16 to 30% clay content. Overall, the percentages of sand, silt, and clay changed +6.5, −7.2, and +0.7 percentage points, respectively, over the 36 years.

Surface texture changes over the period thus occurred at the expense of silt, which was removed from the sites through sorting by wind and perhaps to some extent by water. The landowner at the C-25 site believed his moderately deep chiseling (20 to 25 cm) every spring of the fallow period (a wheat-fallow rotation has been followed since 1959) could have kept the surface texture stable over the years.

Sand-size particles are generally too large to be suspended and transported long distances by wind. Because primary clay particles are smaller than silt, one might expect winds to suspend and remove clay more so than silt. But clay particles frequently are aggregated into larger sizes. These aggregates resist abrasive breakdown during erosion more so than silty aggregates (3). Worldwide, the large areas of loessial soils with very high silt contents bear witness that silt indeed is the constituent carried long distances by the wind.

Sorting by erosion caused changes in soil textural class. Two soils described as sandy loams in 1948 (C-21, C-36) would now be classified as loamy sands. And the Pratt loamy sand (C-39) would be classified as a sand (Table 1). These coarser textured soils are more susceptible to wind erosion, and they commonly are deficient in plant nutrients because of the sorting and removal of finer particles.

Organic matter declined in 8 of the 10 sites over the 36-year period (Table 2). The C-14 site had been dryland farmed in a wheat-fallow rotation. From 1948 to about 1960 a one-way disk was used for clean tillage during the fallow period. Since 1960 the site has been farmed in stubble-mulch tillage during the fallow period using sweep-type implements. The organic matter increase could be associated with the change from clean tillage to stubble-mulch tillage.

Little management history was available about the C-42 site. From 1978 to about 1983 the site was in dryland alfalfa. Since 1983, it has been in continuous dryland wheat. The increase in organic matter may be due to the alfalfa.

On the average, organic matter reductions were similar between the silty and sandy soils, equaling about 19%. Assuming a linear reduction with time, organic matter declined 0.53% per year. Expressed in percentage points, the reduction would be about 0.01 per year. Such small changes in organic matter could not be detected with annual measurements.

Erosion and/or other unknown factors are causing a slow decline in organic matter in these soils, with potentially detrimental effects on soil structure, nutrient availability, and water-holding capacity.

Table 3 shows the 1984 determinations of available P (1) and exchangeable Ca (2) in the 10 soils. Organic matter also was determined using a color comparison method

Table 3. Organic matter, available P, and exchangeable Ca in the upper 10 cm of soil at 10 sites in western Kansas, June 1984, as measured by soil testing procedures.

Site	Organic Matter (%)	Available P (kg/ha)	Exchangeable Ca (p/m)
C-14	3.1	123	3,200
C-16	2.0	111	3,900
C-18	1.9	61	4,500
C-21	0.8	36	1,200
C-25	0.9	59	1,600
C-30	2.2	160	2,300
C-33	1.7	64	2,500
C-36	2.3	109	700
C-39	0.7	54	100
C-42	1.4	140	700

instead of titration (*4*). These values will serve as a data base for evaluating erosion effects on these same sites in the future.

REFERENCES CITED

1. Bray, R. H., and L. T. Kurtz. 1945. *Determining total organic and available forms of phosphorus in soil.* Soil Sci. 59: 39-45.
2. Carson, P. L. 1980. *Recommended potassium test.* In *Recommended Chemical Soil Test Procedures for the North Central Region.* NCR Publ. No. 221 (revised), Bull. No. 499 (revised). N. Dak. Agr. Exp. Sta., Fargo. pp. 17-18.
3. Chepil, W. S. 1957. *Sedimentary characteristics of dust storms: I. Sorting of wind-eroded soil material.* Am. J. of Sci. 255: 12-22.
4. Graham, E. R. 1948. *Determination of soil organic matter by means of a photoelectric colorimeter.* Soil Sci. 65: 181-183.
5. Lyles, Leon. 1975. *Possible effects of wind erosion on soil productivity.* J. Soil and Water Cons. 30(6): 279-283.
6. Walkley, A., and I. A. Black. 1934. *An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method.* Soil Sci. 37: 29-38. □