EPHEMERAL GULLY EROSION: IMPACTS ON PHYSCIAL SOIL QUALITY AND CROP YIELD

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Extended Abstract Soil erosion by water remains a major problem in many regions of the US. More streams in the US are listed as impaired by sediment than by any other contaminant. Sheet and rill erosion have been historically considered the main cause; however, in many cases the dominant source of sediment is from gully erosion. Estimates by the USDA for 17 States suggest that ephemeral gully erosion ranges from 18 to 73% of the total erosion with a median of 35%. In Mississippi, the number one problem for which conservation funds are allocated is gully erosion, which often includes gully inlets associated with bank failures. Refilling of ephemeral gullies by tillage serves to maintain high erosion rates and degrades the soil adjacent to the gully. There has been a limited amount of work associating reduced crop yield to the reduction in topsoil depth adjacent to ephemeral gullies but no work to date has directly measured the relationship of soil physical quality to gully erosion. There has been much discussion in the literature on what quantifiable property constitutes soil quality. Soil quality indicators are measures of how well a soil functions. Soil properties must be identified that respond to management, correlate with the soil value of interest, and be measurable within certain constraints. There are numerous soil property measurements that have been proposed as indicators of soil physical quality. The water retention curve, i.e. relationship between water content, θ, and matric suction, h, has great potential because it reflects soil texture, soil structure, bulk density, and land management practices. The water retention curve provides measures of soil properties such as porosity (i.e. saturated water content), field capacity, drainable porosity (difference between saturation and field capacity), wilting point and available water capacity (difference between field capacity and wilting point) not to mention the pore size distribution. The slope, S, of the water retention curve at its inflection point, h_i, has been proposed as the best measure of soil physical quality. The slope is defined as

$$S_i = \frac{d\theta}{d(\ln h)} = C_i h_i \qquad (1)$$

where C_i is the specific water capacity.

The objective of this study was to measure soil physical quality indicators as a function of distance from a gully that has been filled in to determine the effect of gully filling on soil quality for the soil value of interest, crop yield.

An ephemeral gully in Topashaw Canal Watershed (TCW) was sampled for physical, chemical, and microbial properties in a field currently in NT corn (*Zea mays*). Soil properties were measured and sampled at 66 locations along six 11 point transects.

Transects 1 through 5 were perpendicular to the gully and spaced 15.2 m apart while transect 6 was 30.5 m upslope of transect 5. Each transect had 11 sampling points spaced 7.6 m apart. Thus each transect was 76.2 m long with position 6 located in the center of the gully. In addition to topographic surveying of the gully and contributing area, and crop yield at all locations, the following soil properties were determined at each location: shear strength, penetrometer resistance, particle size distribution, total organic carbon, water stable aggregates, microbial biomass, enzyme activity and chemical analysis (N, P, K, Ca, Mg, EC, pH). At selected locations, the saturated hydraulic conductivity, bulk density/porosity, water retention curve, soil erodibility and excess shear stress were measured.

Crop yield was significant affected by gully erosion and gully filling. The question is what soil properties make good indicators of the soil quality impacts of gully erosion. The depth of topsoil was significantly lower in the scrapped and gully areas. The surface shear strength was significantly lower in the scrapped areas (38 kPa) than the baseline (45.0 kPa) and the gully area had significantly lower surface shear strength than all other areas. Soil penetration resistance for the scraped area was significantly higher than the non-scrapped areas from the surface down to 0.1 m, which is likely a factor in limiting root growth.

The bulk density in the scrapped areas (1.50 Mg m^{-3}) was only slightly higher than the baseline (1.44 Mg m^{-3}) and non-scrapped (1.47 Mg m^{-3}) areas but not significantly different. Despite the saturated water content and field capacity not being affected by landscape position, the drainable porosity (i.e. difference between these values) did exhibit significant difference. The drainable porosity was highest for the baseline and significantly lower for the non-scrapped. While differences in the Van Genuchten parameters (α and n) describing the water retention curve were not significant, there were significant differences in the inflection point (both h_i and θ_i) values. However, the soil physical quality parameter, Si, proposed by Dexter (2004) did not show any response to landscape position (Table 2).

The best indicators of soil physical quality were determined by their relation to crop yield. Simple linear regression across all landscape positions showed that depth of topsoil was the best individual indicator. It is interesting to note that crop yield was not related to the soil physical quality indicator, S. While S is supposed to provide an integrated representation of water retention properties, the water retention property that did relate to crop yield was the van Genuchten α parameter. S values above 3.5 m^{-1} are believed to represent good soil quality while values below indicated poor soil physical quality. Only two of the 24 S values were below this critical value, which ranged from 3.0 to 6.9 m^{-1}. The overall mean S value was 4.7 m^{-1} with a coefficient of variation of only 19%.