Stability of Soil Organic Carbon Pools Across a Rangeland Agricultural Management Gradient

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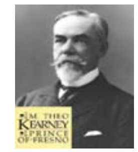

INTRODUCTION

Soil organic carbon (SOC) is a reservoir for plant nutrients as well as a key component in soil aggregation, water holding capacity, and biogeochemical processes. Concerns about atmospheric CO_2 levels and global climate change have focused attention toward understanding SOC dynamics. Range management practices such as livestock grazing and vegetation manipulation that influence the affinity of soils to sequester organic carbon can have a large impact on the terrestrial SOC budget because of the vast area occupied by these systems. SOC is stabilized in three pathways: 1) physical inaccessibility to decomposers; 2) biological recalcitrance of organic material; and, 3) chemical binding between metals and minerals in soil. We hypothesize that different management strategies will result in significantly different pools of protected and available organic carbon, which will be expressed in separate genetic soil horizons.

OBJECTIVES

1.) Investigate the stability of SOC pools (unprotected versus protected) across a gradient of rangeland agricultural management strategies.

2.) Examine SOC stability across the various plant communities, which result from interactions between management, soil, topographic, edaphic, and ecological factors.

METHODS

1.) Soil samples were collected at the Sierra Foothill Research and Extension Center (SFREC) by genetic horizons across a management gradient of non-grazed, non-thinned oak woodland, grazed converted annual grassland, and grazed irrigated pasture.

2.) Physically occluded carbon was assessed by wet sieving soils with a microaggregate isolator into coarse particulate organic matter plus sand (**cPOM** >250um), microaggregates (**m** 250-53um), and silt plus clay (**s+c** <53um) fractions.

3.) Microaggregates were further broken and fractionated to intra-microaggregate particulate organic matter (**imPOM** >53um) and intra-microaggregate silt plus clay (**s+c m** > 53um).

4.) Hot water extractable carbon (**HWC**) and biochemically resistant sodium hypochlorite (NaOCl) extractable carbon were measured on each of the silt plus clay fractions (**s+c X**, **s+c m X**).

5.) All fractions were analyzed for total carbon and total nitrogen by Shimdazu for HWC and Costech for soils.

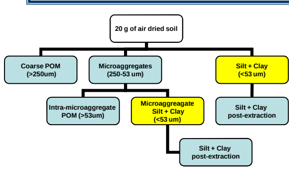

Figure 1. Soil Fractionation and Treatment Scheme. Each group of soils were fractionated by wet sieving. Blue: Total Carbon/Total Nitrogen. Yellow: Total Carbon/Total Nitrogen, Hot water Extraction, and Sodium Hypochlorite Extraction.

Table 1. Generalized concept of carbon pools and protection mechanisms associated with each fraction.

[illegible]	[illegible]	[illegible]	[illegible]		
			physical	biological	chemical
[illegible]	[illegible]	[illegible]			
		cPOM		X	
[illegible]	[illegible]	[illegible]	X		
		[illegible]	X		
		[illegible]	X		X
		[illegible]	X	X	
		[illegible]	X		X
[illegible]	[illegible]	[illegible]		X	X
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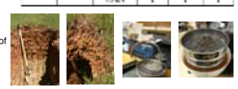

RESULTS

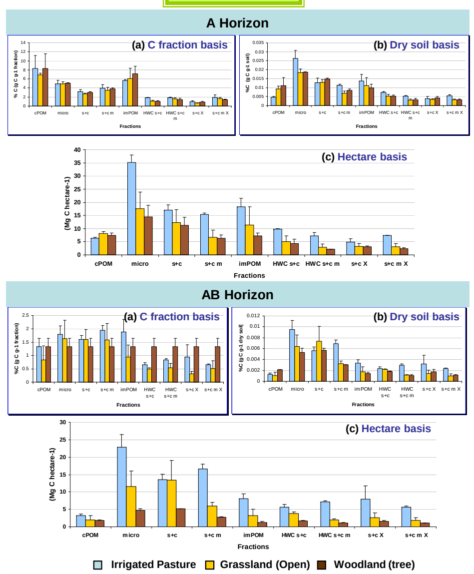

Figure 2. Distribution of C contributed by each fraction at different scales in the A and AB soil horizons. The carbon enrichment throughout different fractions is depicted across three scales: a) C fraction basis-the concentration of C in each fraction (g C g^{-1} fraction); b) Dry soil basis-the concentration of each fraction in a g of dry soil (g C g^{-1} dry soil); and, c) Hectare basis-the concentration of soil on a hectare basis (Mg C $hectare^{-1}$).

DISCUSSION

Different degrees of carbon enrichment were found across three scales in both A and AB horizons (Fig. 2). In the A horizon at the C fraction basis (a), we see that the %C in each fraction was similar across the management gradient. Across fractions, however, cPOM had the highest %C, followed by microaggregates, then the silt plus clay. Yet, the microaggregates and the silt plus clay fractions are considered more stable C pools than the cPOM (Table 1). At the C fraction basis (a) in the AB horizon, the %C in each fraction was almost an order magnitude lower, especially in the POM fractions. Interestingly, there appeared to be no differences in %C in the oak woodland fractions.

Clearer differences were observed between management practices throughout both soil horizons in the dry soil scale (b), where the amount of each fraction is expressed as a concentration in dry soil. The cPOM fraction was highest in woodlands in both horizons, but the irrigated pastures and the open grasslands had more stable pools of carbon (Table 1). This observation may imply that the stability and production of the microaggregates in pasture and grasslands masks the disturbance anticipated by livestock grazing. The close comparison of hot water extractable C in the silt plus clay occluded and excluded in the microaggregates shows the significance of microaggregation to SOC dynamics in the intermediate pool.

As bulk density and rock fragments are considered at the hectare scale, most carbon fractions, both stable and active, are highest in irrigated pastures in both A and AB horizons, especially the intra-microaggregate pools of carbon. However, the irrigated pastures contain more C per hectare consistently in both active and recalcitrant carbon pools.

CONCLUSIONS

Carbon sequestration is one of many ecosystem services provided by the Sierra Foothills. Our results imply that rangeland management practices have profound impacts on the way SOC is stabilized and stored. Previous studies at the SFREC found a higher SOC enrichment by oak trees, when comparing soil total carbon between oak woodlands and adjacent grasslands. Our investigation of protected and unprotected C pools within the total carbon across a whole gradient of management practices found that the most intensively managed system, the irrigated pasture, had more stable C pools than the least intensively managed system, oak woodland.

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