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“Reconcile land system changes
with planetary health”

Using soil health parameters as indicators of sustainable management in semi-arid soils

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Abstract

Land degradation and unsustainable land use management practices in developing countries are affecting terrestrial nutrient cycle, microbial communities, and overall soil health. This study assessed the effect of four land use types (forests, exclosures, grazing lands and intensively cultivated croplands) across four locations (Desa'a, Hugumburda, Geregera and Haikihelet) in semi-arid environment of northern Ethiopia on selected soil health indicators. Microbial biomass carbon (MBC), water extractable organic carbon (WEOC), soil organic carbon (SOC), total nitrogen (TN) concentrations, C:N ratio, soil textural classes and bulk density were quantified and compared across different land use types/conversion gradients and soil depths. The MBC decreased with increasing depth, with values 2–3 fold higher in forest, exclosures and grazing land compared to croplands, demonstrating the C limitation of subsoil microbial communities. The distribution of SOC and TN concentrations across land use types and locations over 90 cm depth recorded a decreasing trend from topsoils to subsoil, with average values ranging from 0.39 % C and 0.04 % N in Hugumburda cropland to 3.12 % C and 0.26 % N in Desa'a forest respectively. Results showed that C:N ratio was affected by land use types, but there was no definite distribution trend. This suggests that the use of C:N ratio as a sole soil quality indicator is limited and might be quite misleading. There was no land use effect on WEOC in Vertisols while Cambisols recorded high WEOC in lower depths. Soil biogeochemical cycles and ecology as shown in this study, can be affected by land-use management, with high impact in sandy than in clayey soils. Minimum tillage or residue retention as sustainable management practices in croplands can ensure increased microbial activity and abundance, contributing to ensuring ecological sustainability.

Keywords: soil processes, clayey soil, land use change, microbial biomass carbon, sandy soils, soil organic carbon