Purpose

The effect of uncontrolled grazing and unpredictable rainfall pattern on future changes in soil properties and processes of savanna ecosystems is poorly understood. This study investigated how rainfall amount at a gradient of 50%, 100%, and 150% would influence soil bulk density (ρ), volumetric water content (ϑ_v), carbon (C), and nitrogen (N) contents in grazed (G) and ungrazed (U) areas.

Materials and methods

Rainfall was manipulated by 50% reduction (simulating drought—50%) and 50% increase (simulating abundance—150%) from the ambient (100%) in both G and U areas. Plots were named by combining the first letter of the area followed by rainfall amount, i.e., G150%. Samples for soil ρ, C, and N analysis were extracted using soil corer (8 cm diameter and 10 cm height). Real-time ϑ_v was measured using 5TE soil probes (20 cm depth). The EA2400CHNS/O and EA2410 analyzers were used to estimate soil C and N contents respectively.

Results and discussion

The interaction between grazing and rainfall manipulation increased ϑ_v and C but decreased N with no effect on ρ and C:N ratio. Rainfall reduction (50%) strongly affected most soil properties compared to an increase (150%). The highest (1.241 ± 0.10 g cm^{-3}) and lowest (1.099 ± 0.05 g cm^{-3}) ρ were in the G50% and U150% plots respectively. Soil ϑ_v decreased by 34.0% (grazed) and 25.8% (ungrazed) due to drought after rainfall cessation. Soil ρ increased with grazing due to trampling effect, therefore reducing infiltration of rainwater and soil moisture availability. Consequently, soil C content (11.45%) and C:N ratio (24.68%) decreased, whereas N increased (7.8%) in the grazed plots due to reduced C input and decomposition rate.

Conclusions

The combined effect of grazing and rainfall variability will likely increase soil ϑ_v, thereby enhancing C and N input. Grazing during drought will induce water stress that will destabilize soil C and N contents therefore affecting other soil properties. Such changes are important in predicting the response of soil properties to extreme rainfall pattern and uncontrolled livestock grazing that currently characterize most savanna ecosystems.