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Projected Uncertainties in Herbaceous Production Result from Unpredictable Rainfall Pattern and Livestock Grazing in a Humid Tropical Savanna Ecosystem

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Abstract : Increased human activities such as grazing, logging, and agriculture alongside unpredictable rainfall patterns have been detrimental to the ecosystem service delivery, therefore compromising its productivity potential. This study aimed at simulating the impact of drought (50%) and enhanced rainfall (150%) on the future herbaceous CO2 uptake, biomass production and soil C:N dynamics in a humid savanna ecosystem influenced by livestock grazing. Rainfall pattern was predicted using manipulation experiments set up to reduce (50%) and increase (150%) ambient (100%) rainfall amounts in grazed and non-grazed plots. The impact of manipulated rainfall regime on herbaceous CO2 fluxes, biomass production and soil C:N dynamics was measured against volumetric soil water content (VWC) logged every 30 minutes using the 5TE (Decagon Devices Inc., Washington, USA) soil moisture sensors installed (at 20 cm soil depth) in every plots. Herbaceous biomass was estimated using destructive method augmented by standardized photographic imaging. CO2 fluxes were measured using the ecosystem chamber method and the gas analysed using LI-820 gas analyzer (USA). C:N ratio was calculated from the soil carbon and Nitrogen contents (analyzed using EA2400CHNS/O and EA2410 N elemental analyzers respectively) of different plots under study. The patterning of VWC was directly influenced by the rainfall amount with lower VWC observed in the grazed compared to the non-grazed plots. Rainfall variability, grazing and their interaction significantly affected changes in VWC ($p < 0.05$) and subsequently total biomass and CO2 fluxes. VWC had a strong influence on CO2 fluxes under 50% rainfall reduction in the grazed ($r2 = 0.91$; $p < 0.05$) and ambient rainfall in the ungrazed ($r2 = 0.77$; $p < 0.05$). The dependence of biomass on VWC across plots was enhanced under grazed ($r2 = 0.78 - 0.87$; $p < 0.05$) condition as compared to ungrazed ($r2 = 0.44 - 0.85$; $p < 0.05$). The C:N ratio was however not correlated to VWC across plots. This study provides insight on how the predicted trends in humid savanna will respond to changes influenced by rainfall variability and livestock grazing and consequently the sustainable management of such ecosystems.

Keywords : CO2 fluxes, rainfall manipulation, soil properties, sustainability
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