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Quantification of soil carbon fluxes under different land use types in the juaben municipality, ghana

BISMARCK OWUSU

*CSIR – College of Science and Technology, Box UP 63, Kumasi, Ghana, Natural resource management,
Ghana*

Abstract

Soil CO₂ flux is a major pathway of carbon release from soil to the atmosphere, influenced by temperature and land use. This study quantified soil CO₂ fluxes under three land use types (natural forest, fallow, and cropland) in Juaben Municipality, Ghana, and examined how environmental factors (e.g., soil temperature, moisture, bulk density, humidity) and topography (upland vs. lowland) influence these fluxes. A dynamic closed-chamber system was used to measure soil CO₂ efflux biweekly for seven months. Field plots were established in each land use type and topographic zone, and corresponding soil and microclimate data (soil temperature, moisture, humidity) were collected. Repeated measures ANOVA tested the effects of land use and topography on flux over time, and multiple regression identified significant environmental predictors. The study found that CO₂ flux differed significantly among land uses ($p < 0.01$): fallow land had the highest emissions and cropland the lowest. Topography had no significant effect on flux, though a land use-topography interaction was observed. Fluxes were generally higher in the wet season. Regression analysis showed that soil, air temperature, and humidity positively influenced CO₂ flux, while higher soil bulk density reduced it, explaining 14% of flux variability. The study concludes that land use strongly influences soil CO₂ flux in Juaben, with land disturbance (fallow, cropland) leading to higher emissions than forest cover. The study recommends adopting sustainable land management practices to improve soil structure and reduce CO₂ emissions in croplands. Land use planning should incorporate soil moisture conservation and seasonal considerations to mitigate peak fluxes. Further research on soil microbial processes and long-term flux monitoring is advised to inform climate-smart land-use policies.

Keywords: Environmental factors, keywords: Carbon dioxide flux measurements, land use type, seasonal variations, semideciduous forest, topography