Interactive effects of climate and land-use changes on plant biomass production and carbon pool dynamics in the Ghana

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Introduction

In the wake of climate change, insight into the potentials of land management systems in sequestering atmospheric carbon to reduce greenhouse gas concentrations remains vital (Adu-Bredu et al., 2008, Qasim et al., 2016, Dimobe et al., 2019). There is limited understanding about how climate and land use interactively affect C sequestration of different pools. In this regard, this study was conducted in the Moist Semi-Deciduous and Guinea Savanna Agro-ecological Zones of Ghana to assess the carbon sequestration potentials of different land-use types (forest, cropland and rangeland).

Objectives

The specific objectives are to:

- Determine the interactive effects (direct and indirect) of climate and land-use change on carbon pool of the vegetation layer
- To quantify and model carbon sequestration under the different land uses at the local, national and regional scale

Materials and Methods

•**Study sites:** 2 ecological zones with two sites per zone namely:

❖ Moist Semi-Deciduous Forest Zone

- Bobiri Forest Reserve
- Pra Anum Forest Reserve

❖ Guinea Savannah Zone

- Mole National Park
- Gbele Game Reserve and Bird Sanctuary

•**Sampling design:**

❖ Main plots were laid in three land use types (Fig. 2).

❖ In each land use type, two topographic positions were studied (Highland and Lowland)

❖ Five plots each were located in each topographic position

• **Data Collection**:

❖ Tree inventory of adult trees and saplings. We measured:

- Diameter at breast height (dbh)
- Tree height

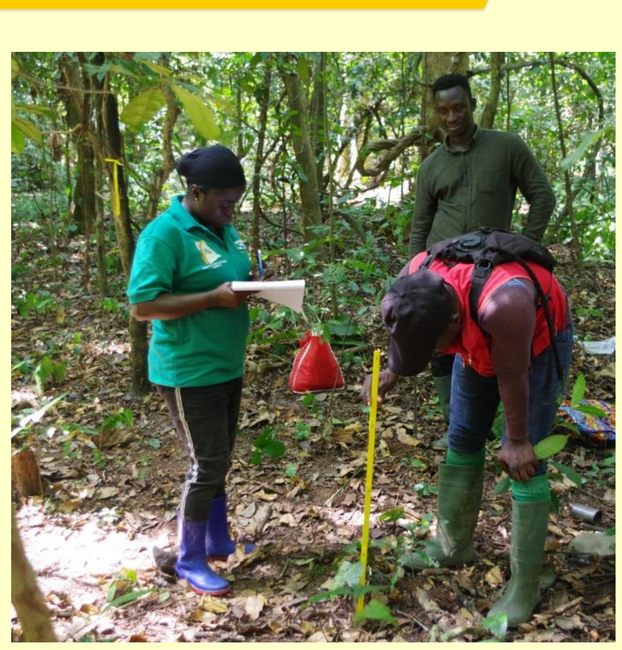

Fig 1: Sampling juvenile trees

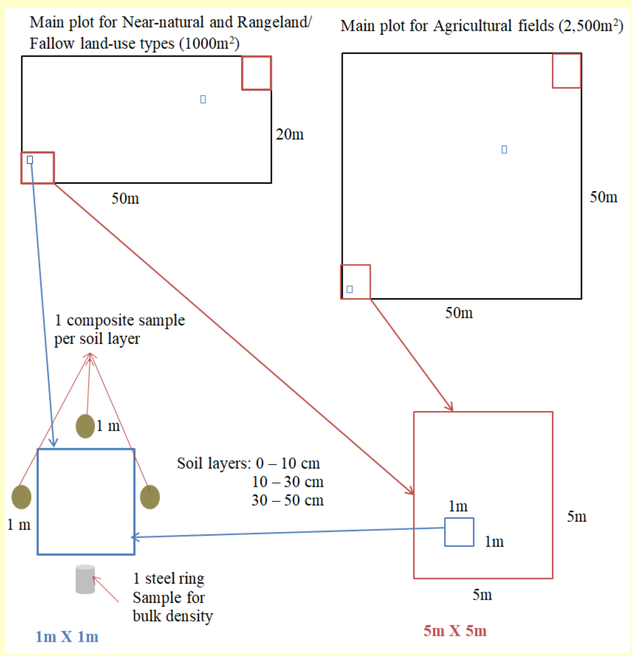

Fig 2: Plot design for data collection

Data analysis

Evaluation of carbon stocks was focused on:

Aboveground biomass (AGB): Allometric equation for moist climates by Chave et al. (2014).

AGB (kg) = $0.0673 \times (\rho D^2 H)^{(0.976)}$, where ρ is wood density, D is diameter at breast height (cm) and H is height

● Below-ground biomass (BGB): was extrapolated from AGB allometric equation developed by Cairns, Brown, Helmer, and Baumgardner (1997):

BGB = exp (-1.0587 + 0.8836ln (AGB))

Results

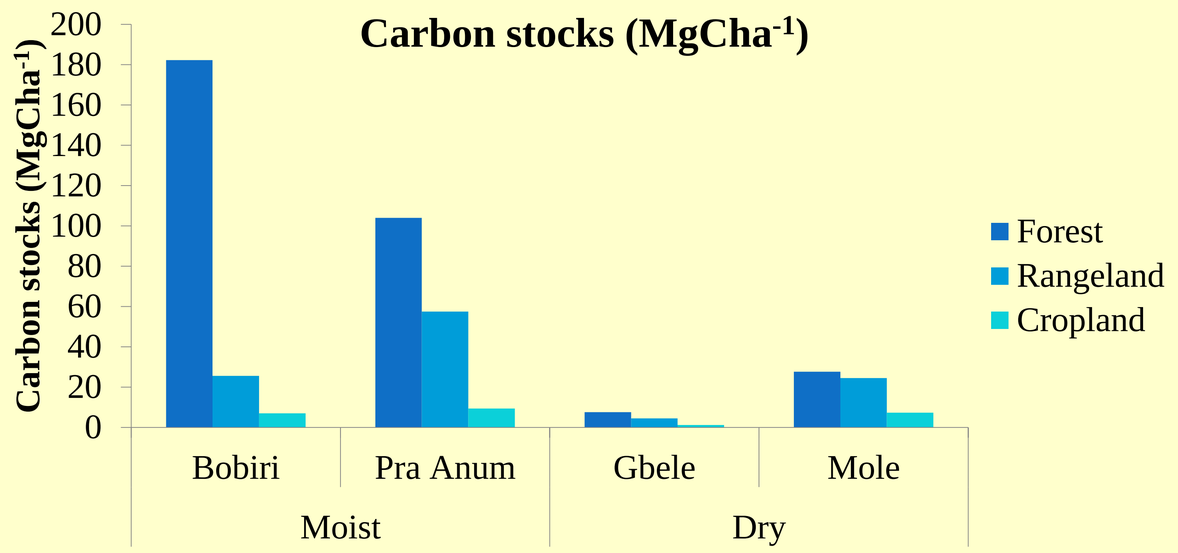

Fig 3: Estimated mean carbon stocks for selected study sites based on Eco-zone

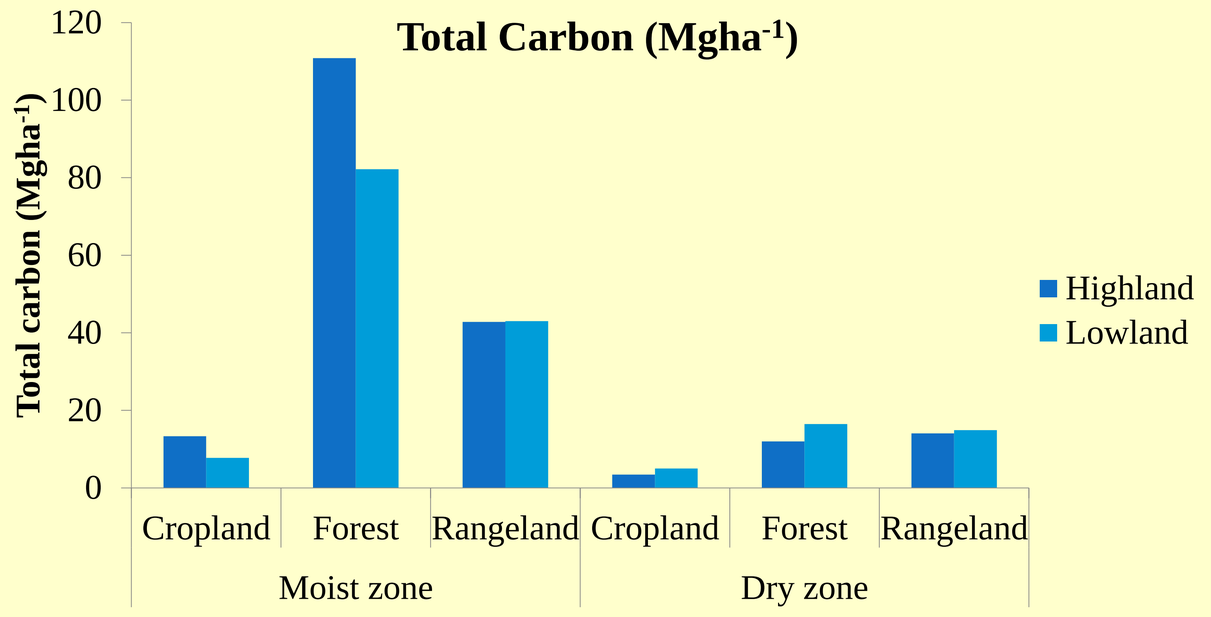

Fig 4: Estimated total carbon for selected study sites based on Topography

Generally, the selected land-use types in the moist zone recorded higher total carbon stocks than the land-use types in the dry zone (Fig. 3 and 4, df = 1, F=30.658, p = 0.000). The strong significant difference (df = 2, F=25.852, p = 0.000) attests to research that natural ecosystems hold high carbon stock in comparison to other land-use systems (Adu-Bredu et al., 2008).

Tree integration on-farm is an important ecological exercise to encourage and enforce across all sites, especially in the dry zones, to enhance climate mitigation.

Conclusions

It has been shown from the results of this study that natural forests hold high carbon stocks than other land-use types. Conversion of the natural forests to cultivated and rangeland land-use systems led to the reduction in carbon stocks. The integration of trees on cropland and rangeland can ameliorate this downward trend. These findings are relevant for proper land use planning towards the achievement of Ghana's nationally determined contributions (NDCs).

References

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