



Carbon stock under four land-use systems in three varied ecological zones in Ghana

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Introduction

- Carbon exists as an inseparable component of vegetation, litter and soil organic matter
- Carbon stored in soil organic matter is important in mitigating global climate change
- Improves the livelihoods of resource-poor farmers and also improves soil properties such as
 - nutrient supply
 - moisture retention
 - increase land productivity and crop yields
- Degradation and deforestation have impact on the both vegetation and soil carbon stock
- Part of Spatially Explicit Modelling of Soil Organic Carbon (SEMSOC) project
 - to study various contributory factors that affect carbon sequestration in the country.

Objectives

- To assess the carbon stock under four different land-use systems
- To assess the trend at various ecological zones
- To feed into CENTURY, a biogeochemical model, with the current soil and biomass carbon stock
- The model would be used to simulate and quantify soil/biomass C over a period of time under a series of land-use and management options.

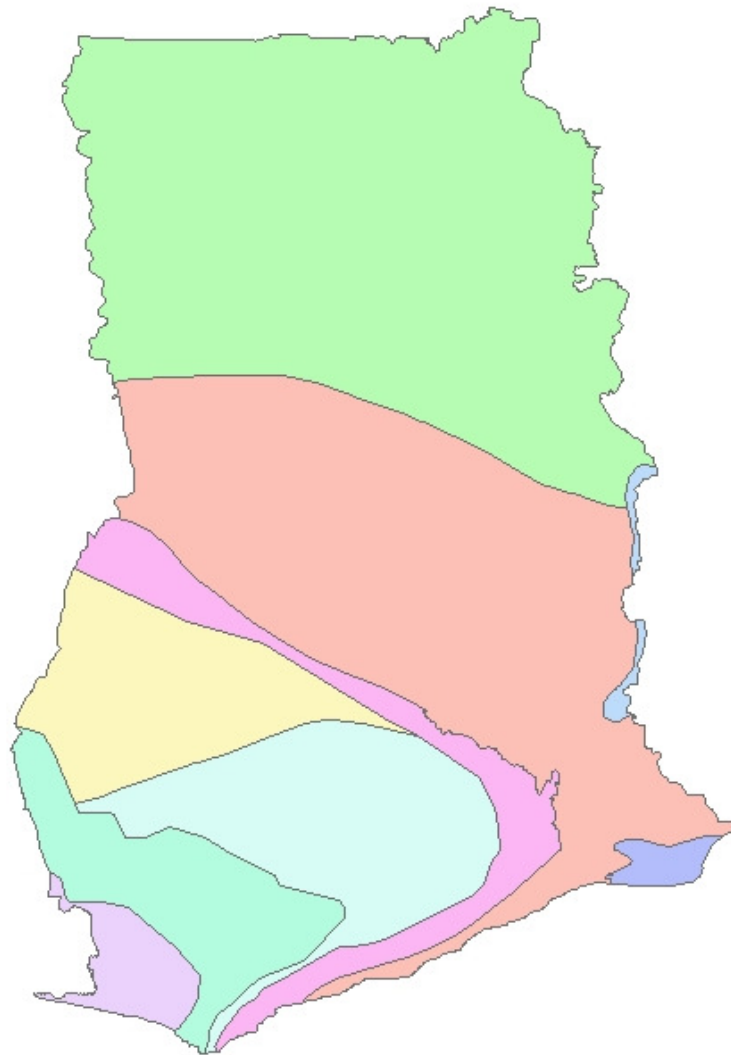
Plantation Establishment

- Cumulative Plantation Development 2002-2007 (ha)

| | |
|-----------------------------------------------|----------------|
| Modified Taungya System | 78,616 |
| Model Plantations | 69 |
| Community Forestry Management Project | 6,427 |
| Government Plantation Development Project | 29,465 |
| GPDP off-reserve | 3,900 |
| Urban Forestry | 2,650 |
| <i>Total</i> | 121,127 |
| <i>NB: 80% of the total is of Teak</i> | 96,902 |

Sites

- Kakum Forest Reserve in Moist Evergreen Forest Zone at Kakum
 - Mean annual rainfall between 1500 and 2000 mm
 - The reserve is under strict protection
 - No wildfires
- Awura Forest Reserve in Dry Semi-deciduous Forest Zone (Transition zone) at Ejura
 - Mean annual rainfall is about 1300 mm
 - Experiences occasional wild fires
- Upper Tamne Forest Reserve in the Savannah Zone at Bawku
 - Mean annual rainfall about 1000 mm
 - Experiences annual bush fire



Legend

MAP-ECOZONE

ADM0_NAME_

-  Wet Evergreen
-  Moist Evergreen
-  Moist Semi-deciduous (NW subtype)
-  Moist Semi-deciduous (SE subtype)
-  Dry Semi-deciduous
-  Guinean Forest-savanna mosaic
-  Central African Mangroves

Methodology

- Four land-use systems were identified
 - Natural Forest
 - Teak Plantation
 - Cultivated
 - Bush Fallow
- Temporary Sample Plots (TSP) were established
 - 25 x 25m (0.0625ha)
 - For the Teak and Natural forest sites, dbh of all trees within the TSPs were measured
 - Three or four 1.0 by 1.0m quadrates were set up in each plot

Methodology Cont.

- Within the quadrates all plants (mostly herbs) were destructively sampled
- All litter within the quadrates were collected
- Fresh Weight of Litter and Herbaceous plants measured on site
- Dry Weight determined at the Lab.
- Wood, herbs and litter were analyzed at the Laboratory for Carbon and Nitrogen Content
- Soil samples were collected from the quadrates
 - 0-20 cm and 20-40 cm
 - Soil texture and organic carbon were determined at the laboratory
 - Bulk density samples were collected from the same soil depths

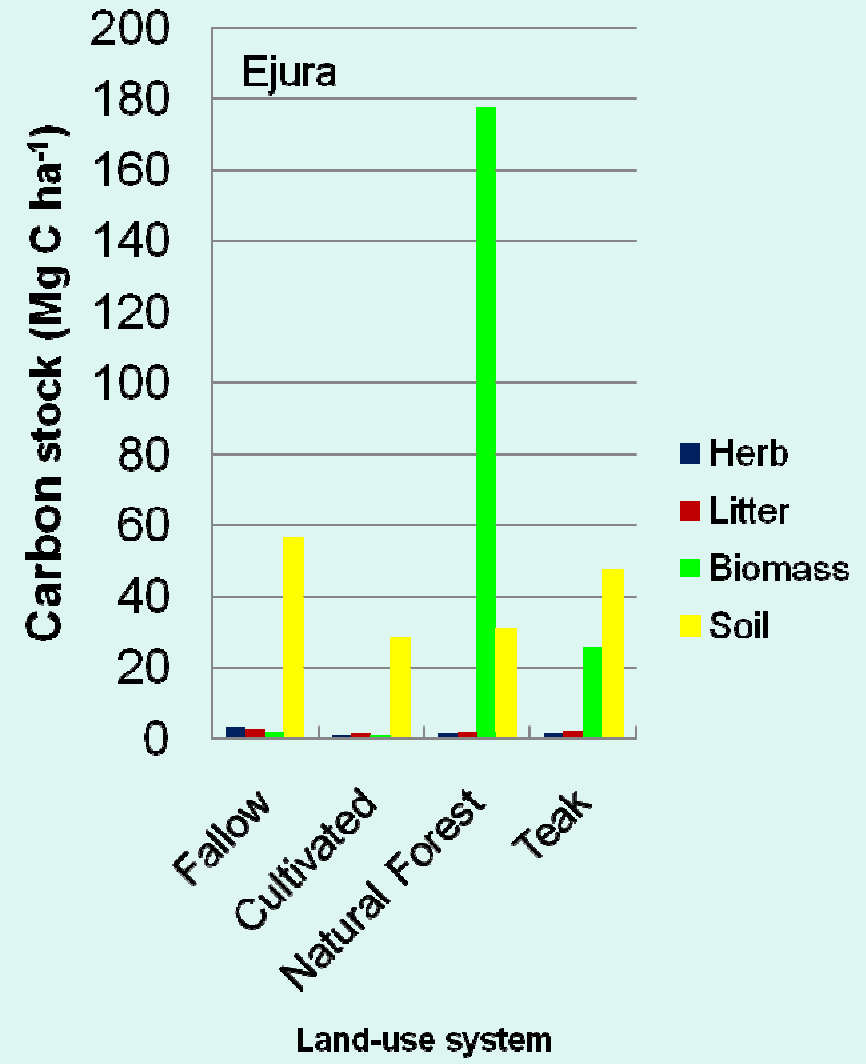
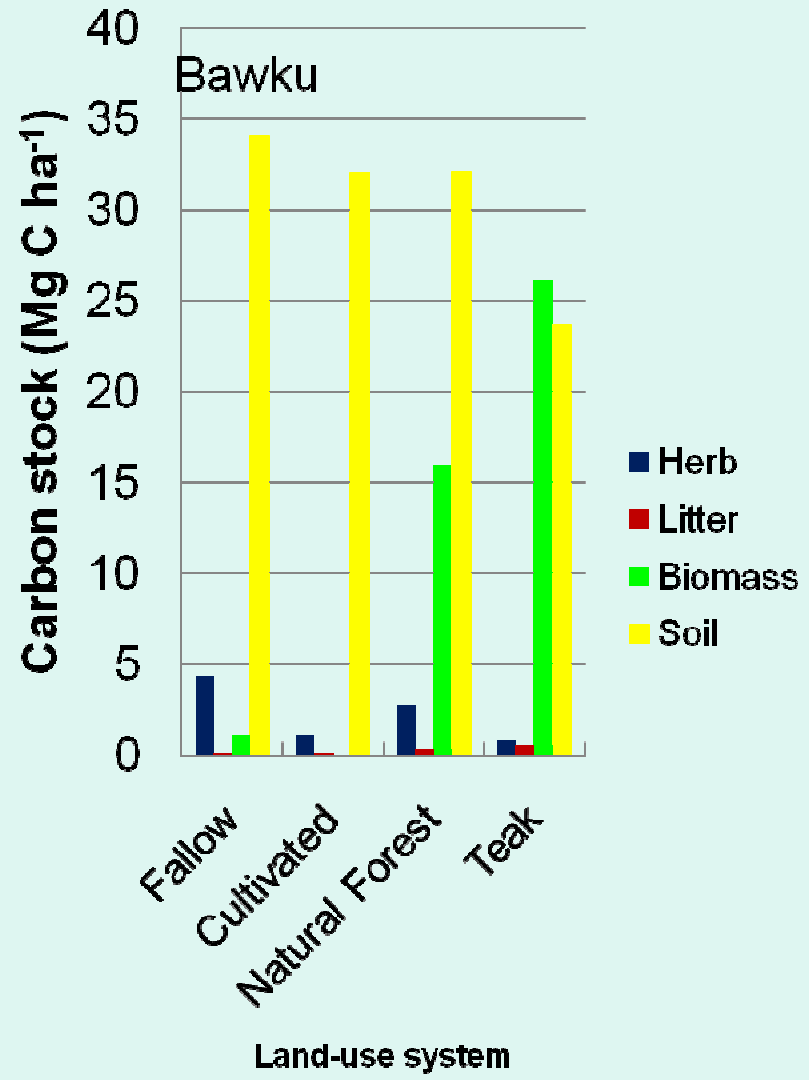
Methodology Cont

- Soil organic carbon was determined at the laboratory by Walkley and Black method,
- The bulk density was determined from oven-dried core samples at 105°C for 24 h.
- Soil carbon was calculated.
- Aboveground biomass was estimated as:
 - For teak; $W = 0.066 d^{2.565}$, $R^2 = 0.965$ (Asomaning 2006)
 - For the natural forest; $W = \text{Exp}(2.119 + 2.525 \times \text{Ln}(d))$
 - (Brown 2002)
 - For the savannah: $W = \text{Exp}(-1.996 + 2.32 \times \text{Ln}(d))$
 - (Ponse-Hernandez, 2004)
 - For below-ground: $W_b = \text{Exp}(-1.0587 + 0.8836 \times \text{Ln}(W_a))$
 - (Pearson et. al. 2005)

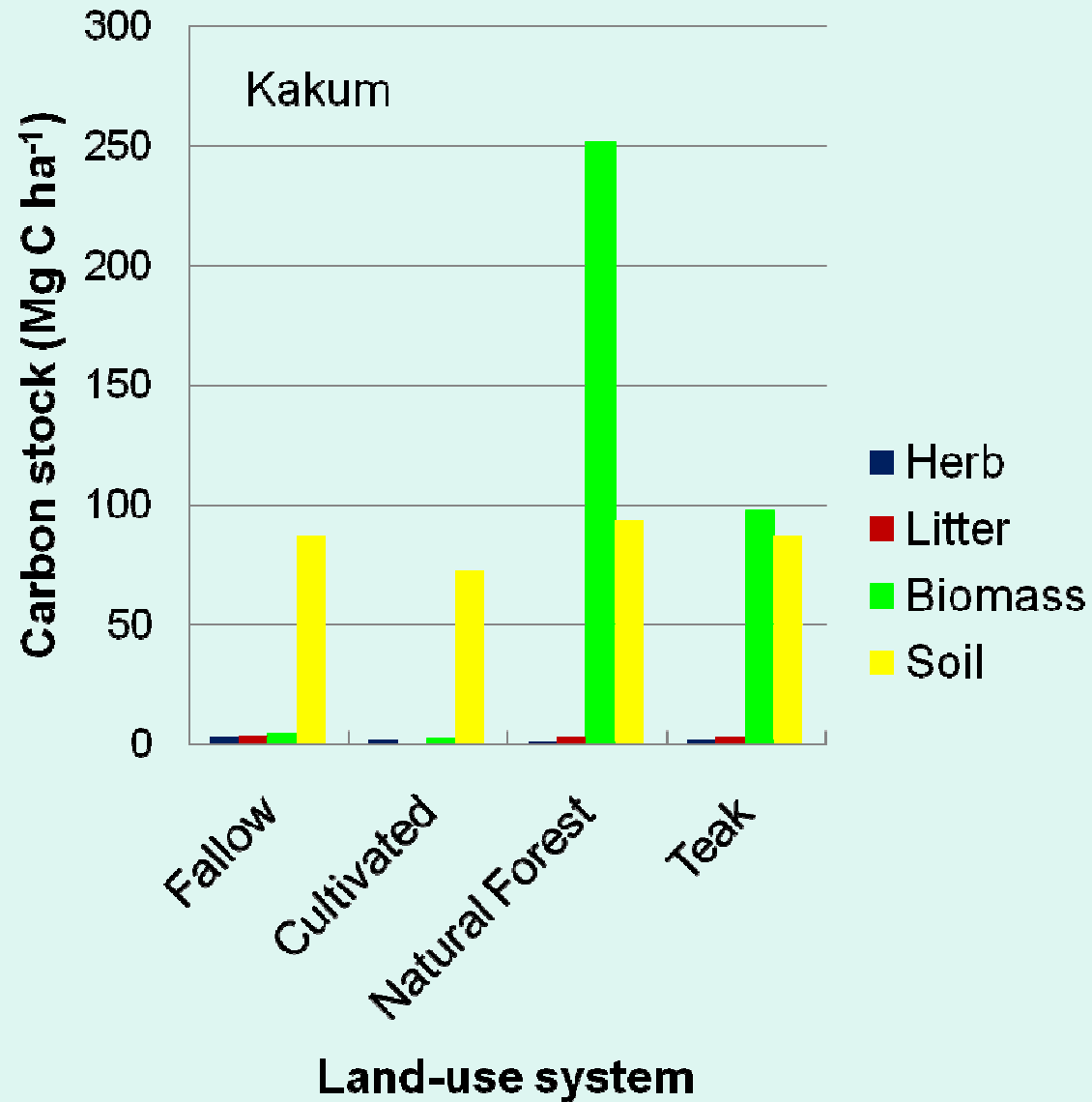
Results: Carbon content

| Site | Mean | Min | Max | SD |
|--------|-------|-------|-------|------|
| Litter | 29.98 | 16.50 | 40.27 | 6.06 |
| Herbs | 37.46 | 20.13 | 48.0 | 6.33 |
| Wood | 47.46 | 37.85 | 49.40 | 2.33 |

Results: Carbon stocks at various sites



Results: Carbon stocks at various sites



Components of carbon stock (Mg C ha⁻¹)

| Land-Use | Site | Woody biomass | Herb | Litter | Soil C |
|-----------------|-------------|----------------------|-------------|---------------|---------------|
| Fallow | Bawku | 0.95 | 4.28 | 0.08 | 34.05 |
| | Ejura | 1.68 | 3.28 | 2.40 | 56.72 |
| | Kakum | 4.58 | 2.51 | 3.44 | 86.95 |
| Cultivated | Bawku | | 1.09 | 0.08 | 32.02 |
| | Ejura | 0.82 | 0.67 | 1.34 | 28.37 |
| | Kakum | 2.23 | 1.34 | 0.42 | 72.30 |
| Natural Forest | Bawku | 15.92 | 2.68 | 0.26 | 32.14 |
| | Ejura | 177.66 | 1.57 | 1.70 | 30.88 |
| | Kakum | 252.03 | 0.61 | 3.27 | 93.47 |
| Teak stand | Bawku | 26.09 | 0.77 | 0.50 | 23.64 |
| | Ejura | 25.61 | 1.49 | 2.11 | 47.57 |
| | Kakum | 97.82 | 1.68 | 3.08 | 87.21 |

Total carbon stock under the various land-uses (Mg C ha⁻¹)

| | | Land-Use | | | |
|--------------|-------------|--------------|--------------|----------------|---------------|
| Site | | Fallow | Cultivated | Natural Forest | Teak stand |
| Bawku | Mean | 39.36 | 33.19 | 51.00 | 51.00 |
| | Minimum | 36.63 | 33.17 | 47.18 | 43.57 |
| | Maximum | 42.09 | 33.21 | 54.17 | 58.43 |
| | SD | 3.86 | 0.02 | 3.28 | 10.50 |
| Ejura | Mean | 64.08 | 30.87 | 211.81 | 76.78 |
| | Minimum | 63.83 | 30.76 | 135.53 | 72.32 |
| | Maximum | 64.33 | 30.98 | 284.06 | 81.24 |
| | SD | 0.35 | 0.16 | 61.18 | 6.31 |
| Kakum | Mean | 95.46 | 75.12 | 349.38 | 138.40 |
| | Minimum | 92.83 | 75.09 | 301.83 | 133.27 |
| | Maximum | 98.09 | 75.15 | 394.30 | 143.53 |
| | SD | 3.72 | 0.04 | 47.15 | 7.26 |

- Thank you

- Merci