

Carbon stock of the rubber conversion areas within Okomu Extension 1 concession of the former Okomu Forest Reserve, Edo State, Nigeria

By

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Summary

Above-ground carbon stock was estimated at the assessment site within the Okomu Extension 1 area using 1-ha belt transects in which all trees with diameter at breast height (dbh) ≥ 10 cm were measured, identified and their height estimated. The vegetation in the extension consisted exclusively of rubber plantations, with 204 ± 27.75 rubber trees per hectare. Above-ground carbon stocks averaged 36 ± 5.39 Mg C ha⁻¹, a low value compared to primary and even secondary forests in the region. Total above-ground carbon stock for the 500-ha extension was estimated to 17,995 Mg C.

Location and description of the assessment site within the Okomu Extension 1 concession

Location of the assessment area

The assessment area is contained in the Okomu Extension 1 Concession which is located in Edo State of Nigeria about 75km west of Benin City between the rivers Osse and Siluko to the east and west respectively and between longitude 5° 18' E and 5° 28' E and latitude 6° 15' N and 6° 25' N. The area has high rainfall with mean annual rainfall of about 2,100 mm, with the period from April to November being the main rainy season with peak in June, July and September. The driest months of the area are the months of December and January. Temperatures average about 25°C in the rainy season and about 28°C in the dry season. Mean monthly is 30.2⁰ C with relative humidity of about 65% during the afternoons throughout the year. The landscape is generally flat to gently sloping land of less than 1% gradient.

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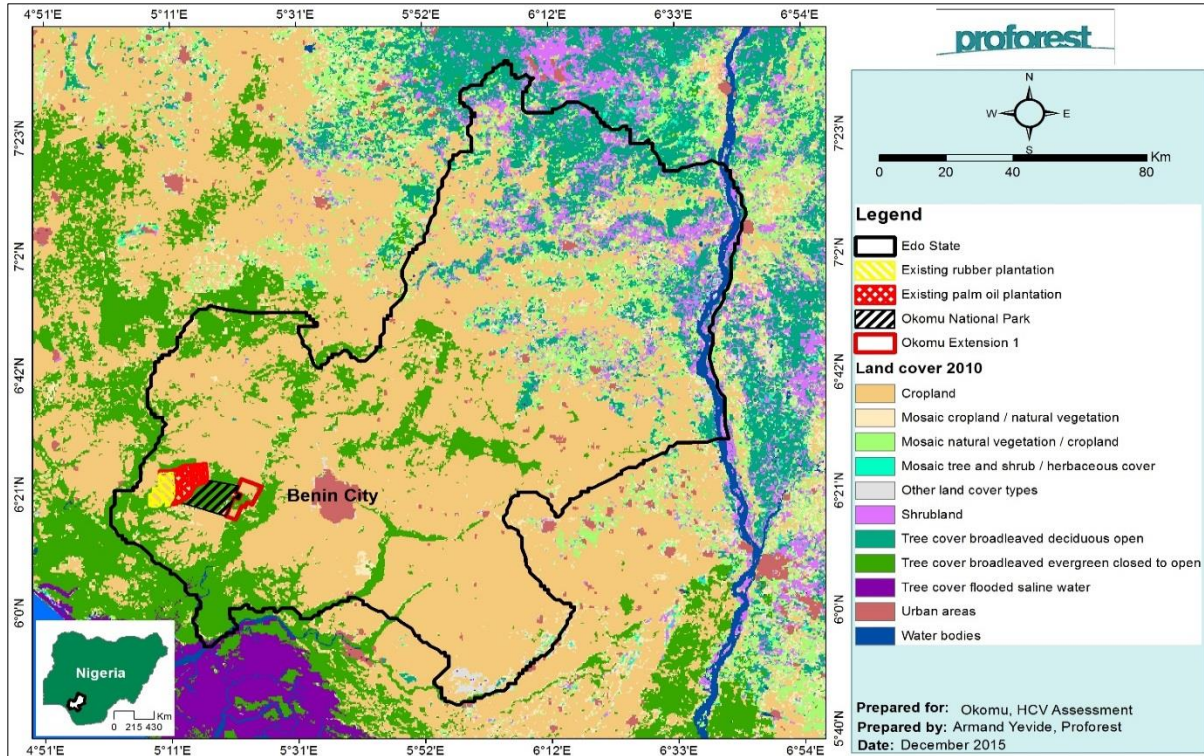


Figure 1: Map showing the location of Extension 1 in Edo State of Nigeria

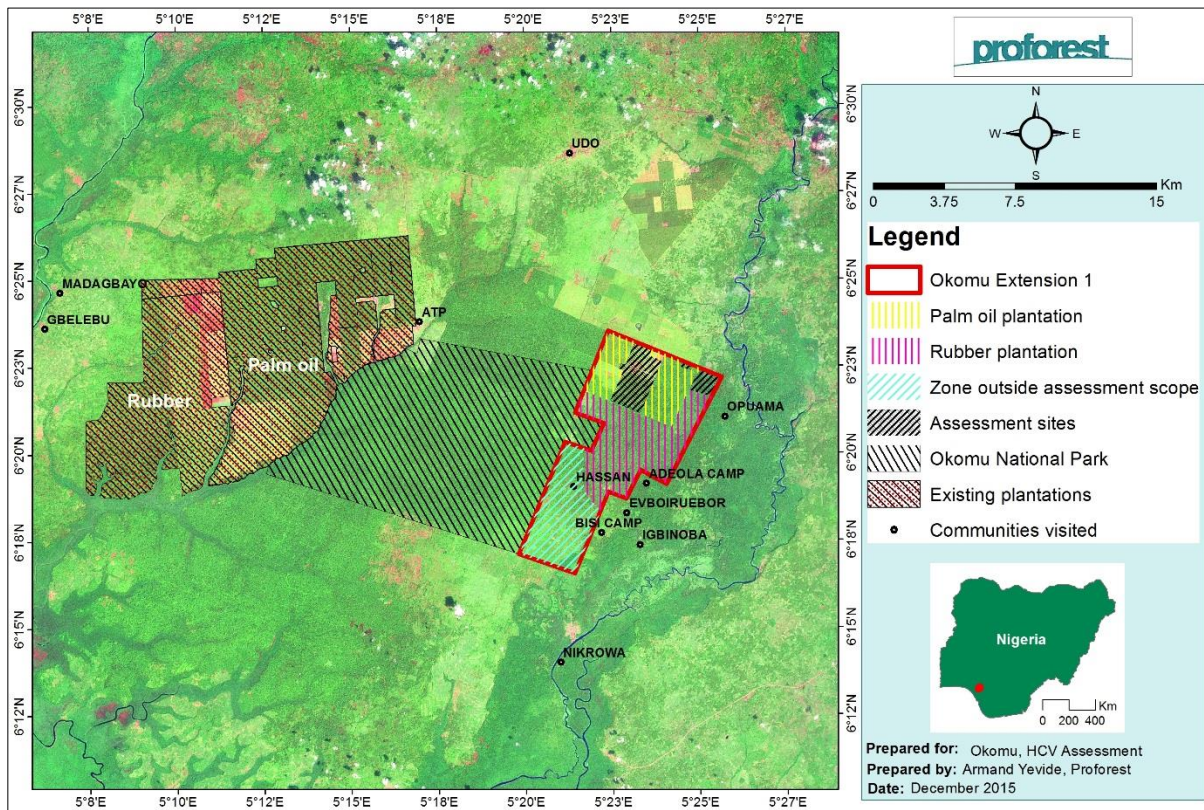


Figure 2: Location of the assessment sites within Okomu Extension 1 Concession

Description of the assessment area

The assessment area includes an existing rubber plantation block of 500 ha. The entire area of existing lowland swamp and riparian vegetation have been set aside as conservation areas not subject to future conversion to agricultural use. These areas (circa. 250ha) have therefore not been included in the carbon assessment. This patch of swamp forest is evidently degraded, being selectively logged and under pressure from agricultural encroachment. Similarly, the southern portion of the Extension I concession, (south of the Arakhuan River), and which adjoin to the Okomu National Park is not included in the scope of this assessment.

The OOPC's Extension I concession previously was part of the Okomu Forest Reserve. Following de-reservation of parts of the forest reserve as a result of severe deforestation and forest degradation, the area was allocated to local private interests for oil palm and rubber development between 1993 and 2001.

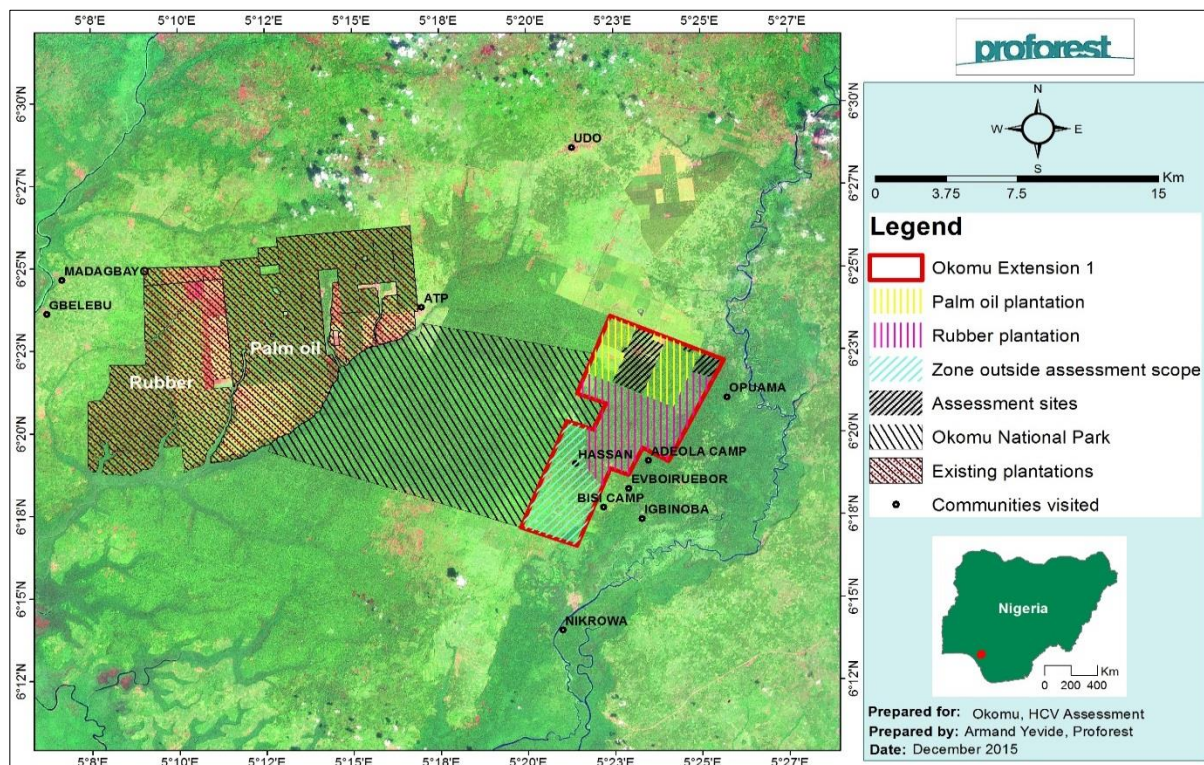


Figure 3: Landscape map showing locations of the assessment area within Extension 1, existing plantations and nearby communities

Method

Experimental design

We estimated above-ground carbon stocks of the Okomu concession in extension 1 using five 1-ha (500m x 20 m) belt transects. Each transect was subdivided into 25 quadrats of 20x20 m (400

m²) each. Only leaving trees with trunk diameter at breast height (dbh) ≥ 10 cm were measured using a diameter tape. These big trees account for the major part of the biomass in tropical lowland forests (Slik et al., 2013). In addition to the dbh measurement, the height of each individual tree was estimated visually. The two parameters were used in the estimation of above-ground carbon stock. Each quadrat within the transects was assigned to a vegetation type. The number of quadrats in each vegetation type was used to estimate its area within the entire extension.

Data Analysis

We used the latest improved allometric model that uses tree height, trunk diameter and wood density as covariates of aboveground biomass (Chave et al., 2014), and the assumption that carbon concentration is about half (47.5%) of the biomass (Whittaker & Likens, 1973; Brown, 1997; Losi et al., 2003; Nasi et al., 2009). The biomass was estimated for each individual tree (including all stems for multi-stemmed trees) using the equation:

$$AGB = 0.0673 \times (\rho D^2 H)^{0.976}$$

Where **AGB** is aboveground dry biomass (in kg); ρ is wood density (in g/cm³) and **D** is dbh (in cm).

Wood density was compiled from (Chave et al., 2009), the African Wood Density Database (Carsan et al., 2012) as well as the World Agroforestry Centre wood density database (http://worldagroforestry.org/regions/southeast_asia/resources/db/wd). The only tree species recorded in the inventory was the economically important *Hevea braziliensis* (Willd. ex A. Juss.) Müll. Arg. Commonly known as rubber tree. The wood density for this species is 0.4872 g/cm³.

Results

The five 1-ha belt-transects surveyed within the Okomu concession were all in rubber plantations. A total of 1,018 living rubber trees with dbh ≥ 10 cm were censused within the five hectares, averaging 204 individual trees per hectare. Total biomass estimated for these trees was 378.81 Mg, corresponding to 179.94 Mg of carbon and an average of 36 Mg C ha⁻¹.

Table 1: Tree density and aboveground carbon stock of trees with dbh ≥ 10 cm in five 1-ha belt transects in Okomu extension 1. N = total number or individuals

Transect	Carbon (Mg ha ⁻¹)	N
01	42.82	228
02	30.38	174
03	31.63	175
04	40.22	210
05	34.90	231
Total	179.94	1,018
Average	35.99	204
Stand. Dev.	5.39	27.75

Discussion and conclusions

The Okomu extension 1 was covered by a rubber plantation. No primary or secondary forest was identified in the area. In average, carbon standing stock in the Okomu concession was 36 Mg C ha⁻¹. This value is very low compared to other tropical forests in Africa. Standing carbon stock estimates for African lowland evergreen forest using inventory data 202 Mg C ha⁻¹ (Lewis et al., 2009, 2013). The low carbon stock of the Okomu extension forest can be attributed to the low tree density, only 119 individuals/ha compared to 426 individuals/ha in African lowland forest (Lewis et al., 2013). Based on the fact that the entire extension 1 is a rubber plantation, we estimated the total carbon stock in trees with dbh \geq 10 cm to 17,995 Mg in the total extension 1 (Table 1).

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