Mapping/assessing carbon stocks in the perspective of Payment for Environmental Services (PES) for rural communities in East Cameroon

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Abstract

Rural Africa plays an important role in the stabilization of the world's climate. Given that greenhouse gases are emitted from different sources and places, they accumulate over time and mix globally. Climate change can then be effectively tackled if collective actions are taken at global level. Though most decisions are taken by international conservation organizations, the implimetations are done at rural levels by local and indegenous communities who direclty depend on forest products. Reason why carbon stocks assessment at the MPEMOG Community Forest was done in order to establish a reference level for emission-reduction in the perspective of Payment for Environmental Services (PES) using the Chave *et al.* (2014) non-destructive allometric equation. From analysis of variance, carbon stock varied from 53.48±36.17 Ct/ha to 218.29±308.38 Ct/ha in Mixed cropland and Primary forest respectively equally the conversion of Primary Forest to Mixed cropland leads to the highest carbon loss (166.24 Ct/ha) and Cocoa plantations generate both economic and ecological values and contribute significantly to food security. The study concludes that the variation in carbon stocks depends on the degree of human influence and PES is an opportunity to contribute in forest sustainability while improving on the socioeconomic development of forest dependent populations.

Keywords : climate change, community forest, carbon stocks, benefit sharing

1. Introduction

Tropical forests play an important role in the stabilization of the world's climate with trees and other plants that remove great quantities of greenhouse gases such as carbon dioxide, nitrous oxide and methane in the atmosphere (Topa *et al.* 2009). These gases need to be reduced by 25 to 40% by 2030 from the 1990 levels (IPCC 2007). While the world's forests are absorbing carbon, they equally emit it. In order to tackle this, the Payment For Environmental Services (PES) mechanism under the auspices of the United Nation Framework Convention on Climate Change was set up to reduce carbon emissions from deforestation and forest degradation in developing countries and consists of providing financial incentives to countries which make efforts to lower their emissions level (Wertz-Kanounnikoff and Alvarado 2007).

In Cameroon, the 1994 forestry law divides its forest into two estates: a Permanent Forest Estate (PFE) and a Non-Permanent Forest Estate (NPFE). The NPFE is made up of a community forest and a communal forest. The establishment of a Community Forest (CF) is only possible in areas where communities have customary rights and receive technical assistance of the administration in charge of forests (Sunderly *et al.* 2011). The maximum area of a CF should not exceed 5 000 ha and local communities are granted management rights for a period of 25 years renewable on an area not exceeding 5 000 ha. Forest products resulting from the CF belong entirely to the village communities concerned and its management involves the participation and collaboration of various stakeholders including the local and indigenous population, government and non-government organizations (NGO's). The level of involvement of each of these stakeholder is dependent on the specific CF project, and the management system put in place (Oyono *et al.* 2007) and it is under the strict respect of a Simple Management Plan (SMP) and focuses on Timber Forest Products (TFPs) and Non timber Forest products (NTFPs) extraction. But the SMP does not mention ecosystem services such as carbon (Cuny 2011). Though the evolution of CF in Cameroon has been studied (Akoa 2007, Ezzine de Blas *et al.* 2008), there are many reasons to think that the policies put in place are not in favour of their good functioning as high finances are needed to start exploitation and to maintain the forest on exploitations: high cost of elaborating a simple management plan; high cost of exploitation equipment; high amount of money needed to follow up documents which most communities cannot afford; equally communities operate without full community members participation; and lack transparency and accountability especially with regards to benefit sharing (Fomete and Vermaat 2001; Adeleke 2006); furthermore, their land tenure rights are not secured. Meanwhile, Chhatre and Agrawal (2009) found that local communities can be effective conservation agents most especially when they have secure land tenure rights.

Payment for environmental services through REDD+ as explained by Angelsen *et al.* (2012) refers to the distribution of both the monetary and the non-monetary benefits generated through the implementation of REDD+ projects what other researchers call direct and indirect benefits. Benefit sharing mechanism is very complex and involves so many actors who have the right to carry out activities and claim benefits from a particular area of land and its associated natural resources (Peskett

2011). Benefit sharing through the PES focuses on the effectiveness and efficiency that is on the goal of carbon emissions reduction stipulating that, benefits should be used as an incentive and should be distributed to the communities that bring about emissions reduction by changing their behaviour and actions. In the main time the idea of equity or co-benefits focuses on the actors who have the right to benefits from the income, with less attention given to their contribution in reducing carbon emissions (Angelsen 2008). According to Assembe *et al.* (2013), benefit sharing should be decentralized to minimize transaction cost and to avoid national / elite capture. Sama and Tawah (2009) reasoned that the separate right to trade and benefit from carbon should be treated like other natural resource ownership and thus depend on the type of forest in question. In that light, CF in Cameroon, belonging to the NPFE, is administered by the local and indigenous population on the basics of their customary rights (Karsenty and Assembe 2011); thus CF are eligible to carbon benefits. Other arguments stipulated that carbon credits are intangible assets (Dkamela 2011) and take the form of a monetary asset representing the result of an action, implying that carbon benefits will be shared among forest actors who actually are behind the action. Due to the complexity of benefit sharing mechanisms most countries involved in REDD+ have proposed various types of benefit sharing mechanisms, indicating that there could be multiple channels for distributing payments, with each sending the benefits to different actor groups. The PES through the REDD+ mechanism will be of help to many developmental sectors at rural level, especially in the agriculture and forest sectors. As regards the agriculture sector, it is found that agriculture is one of the main causes of deforestation, stopping or reducing deforestation implies looking for a durable alternative for extensive agriculture. Amougou (2010) believes that, funds from the REDD+ projects will help; intensify agriculture, ameliorate seeds productions, aid in agriculture mechanisation and increase in the output. For the forest sector, these funds will help fight against illegal forest exploitation, reinforce control and structure local market, reduce pressure on fuel wood, ameliorate forest cover while increasing on the carbon storage potential. Cameroon benefits sharing mechanisms have not yet been designed. In order to ensure effectiveness, efficiency and equity in benefit sharing, there should be good transparency, accountability and good management of the related revenues that meet the needs of local communities (Peskett 2011; Luttrell *et al.* 2012; Assembe *et al.* 2013).

However, the United Nations Framework Convention on Climate Change mitigation role through forest carbon conservation and sequestration options has become a major policy instrument. That is why, the study on “Forest Carbon Assessment in the MPEMOG CF”, carried out within the COBAM project, wishes to evaluate carbon stored in various Land Use Types (LUT) in order to establish a reference level for emission-reduction in a perspective of Payment for environmental services.

2. Research method

2.1. Location of the study site

The MPEMOG CF is found in the Tri-National de la Sangha (TNS) landscape and area endowed with lot of natural resources and it is located 38 km along the road from Yokadouma to Mparo covering a

surface area of 5000 ha. Administratively it belongs to the Yokadouma sub-division in the Boumba and Ngoko division of the East region of Cameroon. The area has an equatorial climate with four seasons (a long dry season from December to mid-March, a short rainy season from mid-March to June, a short dry season in July-August and a long rainy season from August to November). Cloud cover is relatively high, with precipitation averaging 1500-2000 mm per year. The average monthly temperatures vary between 23.8°C to 26.1°C. Relative humidity is between 60-90% and sometimes gets saturated during the dry season.

2.2. Methodology

There are several method used in evaluating carbon stocks depending on the scale. For the purpose of this project **Carbon stock** was assessed by aggregating Above Ground Biomass (AGB) to Below Ground Biomass (BGB), multiplied by the Conversion Factor of 0.47 and submitted under analysis of variance on statistica 10:

- Carbon stock = CF * (AGB + BGB),

Where AGB was evaluated by applying Chave *et al.* (2014) allometric equation in which:

- $AGB\ (kg) = 0.0673 * (\rho D^2H)^{0.976}$

Using parameters; ρ (density g/cm), D (diameter cm), and H (height m) of each individual tree and BGB was evaluated by multiplying AGB by the conversion constant of 0.235:

- BGB (kg) = R * AGB

3. Results and discussion

3.1. Land used types sampled

Prior to ground-based inventories, an unsupervised classification was done from SPOT 4 (20 m resolution) and Land sat (30 m resolution) with the software ENVI 5. Many Land Use Types were identified but seven were chosen based on the objectives namely: Cocoa plantation (dominated with the presence of *Theobroma cacao*), Mixed cropland (Presence of food crops (cassava, maize, bean)), Old fallow (growth of *Afromomum spp*. in great number and more than seven years of fallow), Young fallow (abundance of herbaceae,and maranthaceae of less than 5 years of fallow), Primary forest (absence of legacies that suggested previous anthropogenic activities), Secondary forest (presence of legacies that suggested previous anthropogenic interventions such as timber logging. The massive abundance of light demanding tree species e.g. *Musanga cercropoîdes*), and Wetlands (temporally flooded, thick dark-brown coloured soil).

3.2. Carbon stocks per land use type per hectare

Carbon stock varied from one Land Use Type to another and the highest quantity was found in **Primary forest** 218.29Ct/ha, this amount drops in **Secondary forest** 142.93Ct/ha, **Cocoa plantation** 141.5Ct/ha, **Wetlands** 122.13Ct/ha, **Old fallow** 115.6, **Young fallow** 106.8Ct/ha, and the least amount of carbon is stored in the **Mixed cropland** use 52.04Ct/ha. This trend followed that of Zapfack *et al* (2013).

3.3. Change in carbon stocks when converting one land use to another

The conversion of Primary forest to other LUT such as Mixed cropland for agricultural purposes has historically been the most common land use change, and results in the reduction of terrestrial carbon pools though the amount and rate of carbon loss depends on the agricultural practices.

Primary forest is taken as a reference because it represents an intact forest (that which has not been influenced by any anthropogenic activity such as wood logging). It was realized that the highest carbon loss occurs when converting Primary forest to Mixed cropland (166.24 t/ha) and the least occurs when converting Primary forest to Secondary forest (75.36 t/ha). One pertinent observation made is that Cocoa plantation has a good carbon storage potential and helps to sustain the environment and the cocoa seeds when sold serve as a source of income. This has helped to meet the need of food security and the new policy reform of forest conservation on the same piece of Land.

3.4. Contribution of some species to the carbon storing potential

In all these LUTs some species are recognized of having a high carbon storage potential per hectar (Table 1).

Table 1. Contribution of the 10 most abundant carbon storing species in the entire landscape

Specie name	Carbon stock (Ct/ hectar)
Klainedoxa gabonensis	190.6
Albizia zygia	114.4
Macaranga conglomerate	102.4
Ricinodendron heudelotii	99.9
Terminalia superba	95.2
Piptadeniastrum africanum	87.6
Canarium schweinfurthii	62.9
Duboscia macrocarpa	62.2
Nesogordonia papaverifera	54.8
Entandrophragma cylindricum	51.6

4. Conclusion and Way Forward

4.1. Conclusion

The study on Forest Carbon Evaluation in the MPEMOG CF which is in a heterogeneous landscape characterized by mosaics of plant communities **vary** in **carbon stock** within seven LUTs (Cocoa plantation, Mixed cropland, Old fallow, Young fallow, Primary forest, Secondary forest and Wetland). The study revealed that, Primary forest storing 218.29±308.38 Ct/ha has a comparatively high mean carbon stock than the rest of LUTs because of the intactness of the forest that which has not been influenced by any human activity. Whereas, Secondary forest 142.93±171 Ct/ha has the second highest storage potential because of it nearness to the natural forest which is under reconstitution and the least amount of carbon is stored in Mixed cropland 52.0±56.2 Ct/ha due to the high anthropogenic influence, lowering the carbon storage potential.

Difference in carbon stocks performed within LUTs indicate that a relatively large proportion of carbon is loss when converting a Primary forest to Mixed cropland, consequently leading to an increase in CO_2 emissions in the atmosphere; thus a loss in ecologic value of the LUT. In the main time, Carbon stock enhancement in fallow lands (young and old) can be more effective if practices such as reforestation, or agroforestry is carried out rather than waiting for natural reconstitution.

4.2. Way forward

- Further studies are required in the MPEMOG Community Forest. At regular intervals of five years to evaluate the **advantages of the PES approach of forest managemen**t with respect to improvement of community member's living standard (infrastructural development, level of literacy, their allowances and their implications in the CF;
- **Policy reforms** are needed at country level to provide **clear**, **secure, enforceable** and **non-discretionary** tenure rights over carbon at community forest level;
- **More emphases** should be made on the education of the **girl child** and **pigmies**. In order for them to be **full partakers** in decision making committees with regards to their community forest;
- For an accurate, replicable and complete carbon stock evaluation it will be proper to develop specific allometric equation for the Congo Basin.

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