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CARBON STOCK ASSESSMENT OF TREE SPECIES IN SELECTED COMMUNITY-BASED FOREST MANAGEMENT PROJECTS IN KALINGA

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Abstract: **The study was conducted in Barangay Balong, Tabuk City, Kalinga and Barangay Ammacian, Pinukpuk, Kalinga Philippines. The study aimed to determine the demographic profile of the CBFM beneficiaries, and assess the carbon stock of the selected CBFM project sites. The methodologies used includes interview using structured questionnaire and measurement of trees at the diameter at breast height (dbh). Above ground biomass was computed through the allometric equation developed by Brown, (1997). Result showed that the respondents' age ranges from 17 to 72 years old, generally male, and married. The household size ranges from 5-8 members, while the average number of children is three. The average number of schooling is nine years.In terms of carbon accumulation of individual forest farm, Tabuk city had an average of 149. 96 Mg/ha. while Pinukpuk had an average of 360.82 Mg/ha.**

Keywords: **carbon stocks, biomass, community-based forest management, tree species.**

I. INTRODUCTION

The effect of greenhouse gases especially CO_2, on the warming of the atmosphere and the earth is of great importance. For this reason, studies are being conducted on certain measures such as limiting emissions in order to reduce the amount of CO_2 in the atmosphere. Forest ecosystems have a significant potential in this respect. Carbon can be stored in the biomass, soil, litter, and coarse woody debris pools in forest ecosystems. As a pollution sink, forests annually absorb million tons of carbon dioxide rendering the atmosphere clean and habitable for human race. As a complex living unit, they enhance floral and faunal diversity and the associated food web necessary in balancing the intricate global ecosystems. It provides wood, food, medicine, and other minor and major products. Forests also store, filter, and release huge amounts of superior quality of water for households, farms, hydroelectric power plants, water districts, various industries, and other consuming entities.

However, the undue pressure imposed on forests by the growing number of people has relentlessly damaged such ecosystems. Population pressure is also gradually depriving people of the environmental services that they used to enjoy everyday. The substantial increase in the demand for timber and timber products has depleted the world's forest (Carangdang, 1994) including that of the Philippines. In 1975, the country was the world's leading tropical hardwood producer but became a timber-importing nation in 1994 (Chiong-Javier, 2001 cited by Scherr et al., 2004). Hence, the Philippine government has designed various programs to ward off the forests' worsening condition.

One of the programs that have been adopted by the Philippine government is the Community-Based Forest Management (CBFM). Through Executive order 263 S 1995, CBFM has become the national strategy to ensure the sustainable development of the country's forestland. It is aimed to avert the vicious cycle of poverty, which is the main reason for the destruction of the uplands. It is likewise designed to ensure the protection and advancement of the right of the Filipino

people to a healthful and balanced ecosystem as provided for under Article II, Section 16 of the 1987 Philippine Constitution. Thus, all CBFM projects are designed not only to uplift the socio-economic conditions of the farmers but also to provide environmental services to our society.

The importance of conserving and managing community forest contributes to the additional sink for carbon. It is in this regard that quantification is necessary to determine the contribution of community based managed area as sink of carbon and potential source if destroyed.

Generally, the study assessed the carbon stock of tree species in selected CBFM projects in Kalinga Philippines.

Specifically, the study aimed to determine the demographic profile of the CBFM beneficiaries and aboveground biomass and carbon stocks found within the selected CBFM project sites.

II. METHODOLOGY

Site of the Study:

The sites include the Community-Based Forest Management (CBFM) projects in Barangay Balong, Tabuk City and Barangay Ammacian of Pinukpuk, Kalinga with an area of 80 has. and 1,030 has. respectively. The project was awarded to the Northern Balong Farmers Association (NBFA) on CY 2000 with CBFM Number 000005078 and Ammacian Taggay Upland Farmers Developers Association Incorporated (AMATUDAI) on May 23, 1997 with CBFM Number 000005016.

Like the rest of Northern Luzon, the Province of Kalinga is subjected to the northeast trade winds from November to March and the Southwest trade winds from June to October. The climate falls under type II with more or less evenly distributed rainfall throughout the year. On the average, June to January is the wet months while February to May is relatively dry. The highest rainfall occurs in August and the lowest in March.

The site ranges from flat to gently sloping particularly in Balong, Tabuk City and sloping to moderately steep in Barangay Ammacian, Pinukpuk, Kalinga Philippines.

Rapport Building:

Before the official conduct of the study, the researcher conducted courtesy calls to the CENRO officer of Tabuk City and Pinukpuk. The barangay captains and leaders of the community were also met to discuss the objective of the research and to obtain permission.

Socio-demographic Profiling:

Socio-demographic profiling was conducted through an interview schedule prepared for the purpose. A local resident was hired who served as the guide in the conduct of the study. Respondents of the study composed 50 percent of the total beneficiaries of CBFM projects in the two sites.

Carbon Stock Assessment:

This study quantified the carbon stocks found within the aboveground biomass. A total of 69 (20 m x 20 m) sampling plots were laid out within the study sites. 34 in Ammacian, Pinukpuk and 35 in Balong, Tabuk City. Diameters and common name of trees having a dbh of 10 cm and above were recorded.

Above ground biomass was computed using the following allometric equation (adopted from Brown, 1997).

$Y=\exp [-2.134+2.530*\ln (D)]$

Where Y=biomass per tree in Kg

D=dbh in centimeters

In=natural logarithmic

Carbon Stock= Biomass x 0.45

The biomass of all measured trees were summed and divided over the sample area to derive total tree biomass density [expressed as Megagrams (Mg) dry matter/ha, where 1 Mg = 1 ton]. Tree biomass density was converted to the equivalent amount of C by multiplying by 45percent, which is the average C content of wood samples collected from secondary forests from several locations in the Philippines (Lasco & Pulhin, 2000).

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Data Analyses:

Data from primary and secondary sources were analyzed by quantitative methods. Means and percentages were used to describe the demographic profile of the CBFM beneficiaries. T-test was used to determine differences in the two project sites in terms of carbon stock.

III. RESULTS AND DISCUSSIONS

Socioeconomic Characteristics:

Age and Gender:

There are a total of 69 respondents of the study. For the CBFM project sites in Tabuk City, the number of respondents is 35 representing 50% of the CBFM beneficiaries while in Pinukpuk, 34 respondents representing 50% of the CBFM beneficiaries. The respondents' ages range from 17 to 72 years old with an average age of 43.8. Majority of males were interviewed.

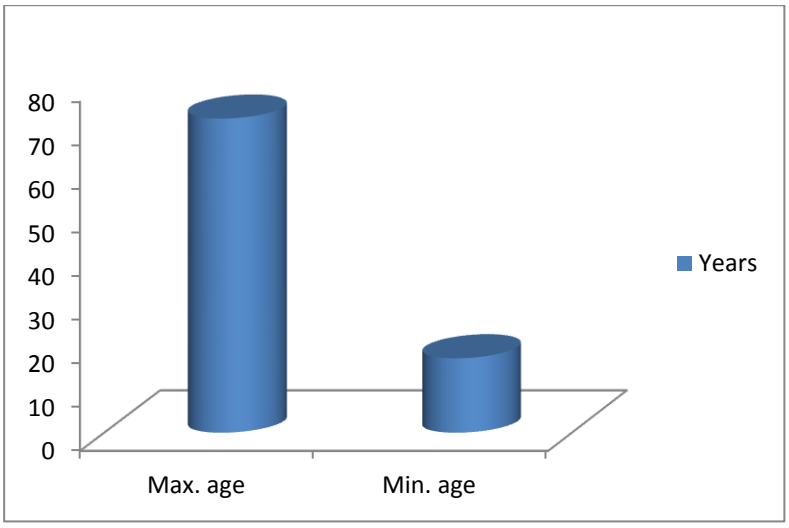

Figure 2: Minimum and maximum ages of the respondents

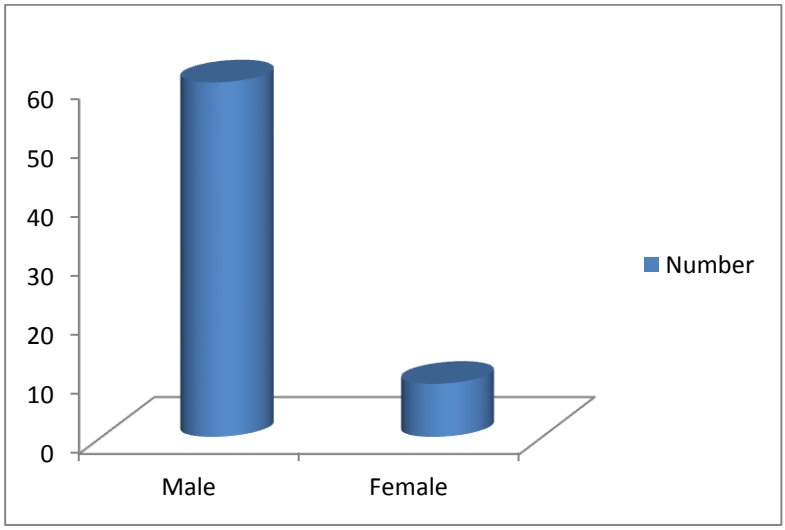

Figure 3: Distribution of Respondents as to Gender

Civil Status and Household Size:

Majority of the respondents (Table 1) were married and most of the household had 5-8 members. The average number of children is 3.

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Table 1: Household size of the respondents

HOUSEHOLD SIZE	NUMBER OF RESPONDENTS	PERCENTAGE
1-4	29	42
5-8	33	48
9 and above	7	10
TOTAL	69	100

Number of Years of Schooling:

As shown in Table 2, majority of the CBFM respondents had attended and finished college. The respondents' average number of schooling was 9.46 revealing medium level of educational attainment.

Table 2: Educational Attainment of the respondents

EDUCATIONAL ATTAINMENT	NUMBER OF RESPONDENTS	PERCENTAGE
No Schooling	4	5.80
Elementary Level	7	10.14
Elementary Graduate	9	13.04
High School Level	4	5.80
High School Graduate	13	18.84
College Level	16	23.19
College Graduate	16	23.19
TOTAL	69	100.00

Vegetation of the two CBFM Project Sites:

As shown on the table, CBFM project in Pinukpuk, Kalinga had 33 species while 29 species in Tabuk City, Kalinga. This shows the diversity of species planted in the CBFM project sites. According to the respondents, they planted cacao, coffee, antipolo, avocado, caimito, nangka, lanzones, mango, rambutan and santol as source of food.

Table 3: Vegetation Composition of the two CBFM Project sites

Amacian, Pinukpuk	**Balong, Tabuk City**
Alim *(Melanolepis multiglandolusus)* Rein. Ex Blum)	Acacia (*Acacia auriculiformis*) A. Cunn. Ex. Benth
Almon (*Shorea almon*)	Alim *(Melanolepis multiglandolusus)*Rein. Ex Blum
Anabiong *(Trema orientalis)* (Linn.) Bl.	Anabiong *(Trema orientalis)* (Linn.) Bl.
Antipolo (*Artocarpus blancoi)* (Elm.) Merr	Antipolo (*Artocarpus blancoi)* (Elm.) Merr
Anuling (*Pisonia umbillifera)* (J.R. Forst. & G.Forst.)	Avocado (*Persia americana*) Gaertn
Avocado (*Persia americana*) Gaertn	Bagalunga *(Melia dubia*) Cav.
Cacao (*Theobroma cacao)* L.	Bagras (*Eucalyptus deglupta)* Blume
Coffee (*Coffea robusta)*	Bignai pugo *(Antidesma montanum)* Blume
Dao (*Dracontomelon dao)* (Blanco) Merr. & Rolfe	Binunga (*Macaranga tanarius)* (L.) Mull. Arg.
Dapdap (E*rythrina orientalis*) Linn	Caimito (*Chrisuphylum cainito*) L.
Himbabao (*Broussonetia luzonica)* (Blanco) Bureau	Dita *(Alstonia scholaris)* (L.) R. Br.
Is is (*Ficus ulmifolia*) Lam	Gmelina (*Gmelina arborea)* Roxb.
Gmelina (*Gmelina arborea*) Roxb.	Hauili *(Ficus septic)* Burm. F.
Kakauate (*Gliricidia sepium)* (Jack.) Walp.	Ipil ipil (*Leucaena leucocephala)*
Kalumpit *(Terminalia edulis)* Blanco	Is is (*Ficus ulmifolia*) Lam
Lanete (*Wrightia pubescens*) (Blanco) Ngan	Kakauate (*Gliricidia sepium)* (Jack.) Walp.
Lanzones (*Lansium domesticum)* Jack.	Kalumpit (*Terminalia microcarpa)* Blanco
Mahogany (*Swietenia macrophylla)* King	Lanete (*Wrightia pubescens*) (Blanco) Ngan
Mango (*Mangifera indica)* L.	Mahogany *(Swietenia macrophylla)* King
Malapapaya (*Polyscias nodosa)*	Mango (*Mangifera indica)* L.
Marang(*Litsea perrottetii)*	Malapapaya (*Polyscias nodosa)*
Mayapis (*Shorea palosapis*)	Marang (*Litsea perrottetii)*
Nangka (*Artocarpus heterophyllus*) Lamk	Nangka (*Artocarpus heterophyllus*) Lamk
Narra (*Ptericarpus indicus)* Willd.	Neem tree (*Azadirachta indica*) L.
Pagsahingin (*Canarium asperum)* Benth.	Pagsahingin *(Canarium asperum)* Benth.
Rain tree (Albizia *saman)* (Jack.) Merr.	Panglomboien (*Syzygium simile)* (Merr.) Merr.

Rambutan *(Nephelium lappaceum)* L.	Philippine chesnut (*Castanopsis philippinensis*)Vid.
Santol (*Sandoricum koetjape)* Burm. F.) Merr	Santol (*Sandoricum koetjape)* Burm. F.) Merr
Tangile (*Shorea polysperma)* (Blanco) Merr.	Tibig (*Ficus nota*) Merr.
Tibig (*Ficus nota)* (Blanco) Merr.	
Tindalo (*Afzelia rhombodea*) (Blanco) Vidal	
Tuai (*Bischofia javanica)* Blum	
White lauan *(Shorea contorta)* Vidal	

Diameter Class Distribution in the two CBFM Project Study Sites:

Table 4 presents the diameter class distribution in the study sites to give better picture on the sites.

Table 4: Diameter Class Distribution of Trees in the CBFM Project Study Sites

DIAMETER CLASS	PINUKPUK	TABUK CITY
10-20	164	630
21-30	245	460
31-40	207	138
41-50	112	23
51-60	61	9
61 and above	53	
TOTAL	842	1260

The diameter of the trees in the CBFM project in Pinukpuk, Kalinga is distributed 10-61cm and above which means that the trees are either planted or naturally grown. In the CBFM project in Tabuk City, majority of their trees belong to diameter class 10-30 cm which indicates that these are planted species.

Aboveground Carbon Stock Assessment:

Biomass is used to provide an estimate of the carbon reservoirs in ecosystems based on the fact that about half of it is Carbon. Biomass density (expressed as dry matter per unit area) indicates the potential amount of CO_2 that can be released to the atmosphere when vegetation is burned or cleared.

Parallel to the rise in concern about climate change, there is also considerable interest in the role and importance of forests for carbon sequestration and storage. CBFM projects had been providing various and enormous environmental services to the surroundings or adjacent communities. The huge amount of carbon stocks of the site is a manifestation that considerable volume of such element has been stored and kept from intensifying the global warming phenomenon. Such contribution must also be responsible for the pleasant microclimatic condition of the area giving the local people a human-friendly and habitable place to stay (Pasa 2006 as cited by Rodolfo 20012).

Table 5: Aboveground carbon stock of the Community-Based Forest Management Projects

PROJECT SITES	**CARBON STOCK (Mg/ha)**
TABUK CITY	149.96
PINUKPUK	360.82
Mean	255.39

On the comparison of the aboveground biomass of the two sites of Community Based Forest Management Project, the two sites revealed significant difference as exemplified by the t-value of 6.10 compared to t-tabulated value of 1.996. The study revealed that Pinukpuk had higher carbon stock with 360.82 Mg/ha while Tabuk City had 149.96 Mg/ha. This could be attributed to the fact that the project site in Pinukpuk reached the climax stage earlier than that of the Tabuk City site. This is due to its favorable chemical and environmental condition.

The aboveground biomass of the project sites of Community- Based Forest Management in Pinukpuk, Kalinga is comparable to the biomass estimates derived for secondary forests in the Philippines. IPCC estimated that second growth forests in the Philippines had biomass densities of 300-700 Mg/ ha. (Houghton 1996). Using the same allometric equation used in this study, Lasco, et al. (2004) reported that mature secondary forests in Mt. Makiling in Luzon island have aboveground biomass of 576 Mg/ha. Kawahara et al. (1981) obtained a biomass density of only 265 tons/ha. in a Dipterocarp forest in Mindanao 20 years after logging. Recently, Pulhin (2003) reported a biomass density value of 285.63 Mg/ha. for a secondary forest in Isabela province.

The findings of the study also corroborates the findings of Sales, et al (undated) stating that the total C storage capacity of a 15-year-old *G. arborea* tree farm was estimated at 64 Mg/ha while that of a 25–year-old *S.macrophyllus* was estimated at 159 Mg/ha. Considering that the CBFM project sites were planted dominantly of fast growing species such as *Gmelina arborea* and Swietenia *macrophyllus* with different ages.

The aboveground biomass of the two sites is comparable to Vietnam's forests. The average biomass carbon stock of Vietnam's forests in 2005 was about 105 Mg/ha, Benktesh D. Sharma (2013).

IV. CONCLUSION

Based on these results, the following conclusions were drawn:

1. The respondents' age ranged from 17 to 72 years old with an average age of 43.8 years, generally male, married, with an average number of children of 3 and an average of 9 years in schooling.
2. There is a significant difference in terms of carbon stock between two CBFM sites.

V. RECOMMENDATIONS

1. In order to achieve the objectives of the Community Based Forest Management Projects, regular project monitoring and evaluation should be conducted.
2. Aside from monitoring and evaluation, extensive management should also be implemented to meet the goals and objectives of the program..
3. There is a need to develop better methodologies and techniques and to strengthen the planning activity process.
4. Concerned government agencies should look into the longer term for security of tenure.
5. Concerned government should provide facilities in the community in order to encourage full cooperation and participation of residents to the CBFM projects.

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