ANNEX D.

Report of the carbon stock of forests 7 native communities of Ucayali

I. Objetive

Estimation the carbon stocks stored in the biomass the forests of Communities Native: Flor de Ucayali, Buenos Aires, Roya, Curiaca, Pueblo nuevo del Caco, Puerto Nuevo Sinchi Roca.

2.1 Specific objectives

- Estimate the carbon stock stored in the pool aboveground.

- Estimate the carbon stock stored in the belowground pool.

II. Ubication the area of study

The study area covers an area of 181,841.90 hectareas that correspond to the area of forest of native communities Calleria Curiaca, Flor de Ucayali, Pueblo Nuevo the Caco, Puerto Nuevo, Roya, Sinchi Roca and the catchment area most at risk deforestation around to the forest of these communities.

Politically, the native communities are located in the provinces of Coronel Portillo and Padre Abad in the department of Ucayali and the Province of Puerto Inca in the department of Huanuco.

Geographically the study area borders with the province of Coronel Portillo, the north with the region of Loreto, on the west by the department of Huanuco and south by the Communal Reserve El Sira.

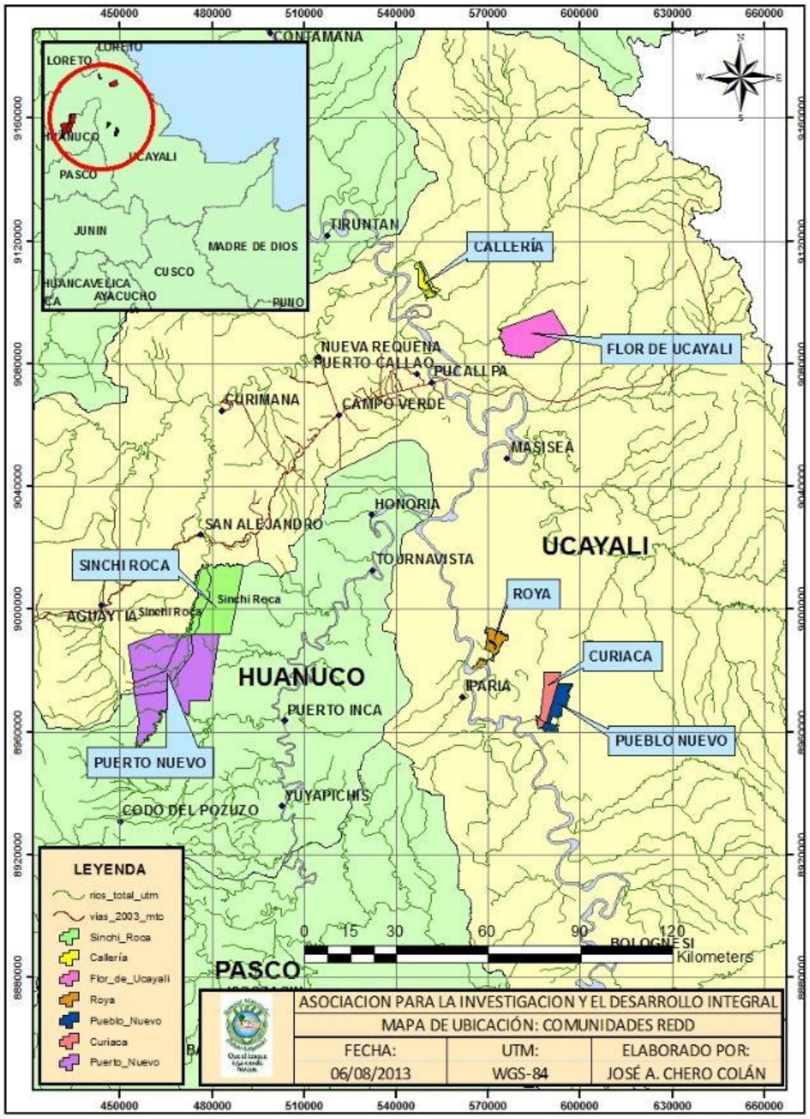

Figure 1. Map of ubication the area of study

III. Materials and methods

4.1 Methodology

The study área comprising an extension of 181,841.90 hectares that correspond to seven communities native beneficiary the Project OIMT-REDDES and the influence area with more deforestation risk around to the forest of these communities.

4.1.1 Determination of stratification the types the forest in the área of study

The stratification of the study area was made on the basis of thematic map of physiography prepared for the process of developing ecological and economic zoning of the department of Ucayali and Huanuco and adjusted with a satellite image Landsat 5 the year 2010.

Table 1. Estratification and surface área of study

Strata fisiográficos	Area (ha)
Low hill forest	26,291.94
Average hill forest	9,923.40
Riverbank complex forest	16,212.34
Lomada forest	899.69
High terrace forest	37,580.37
Low terrace forest	23,777.26
Medium terrace forest	67,156.91
Total	**181,841.90**

4.1.2 Design and sample size

The inventory conducted to determine the carbon content was type exploratory, with a design of optimal stratified sampling and an systematic random distribution in vegetation types identified in the study area.

Stratified sampling allows optimum distribution of the samples in proportion to the size of the stratum and its standard deviation (variance) according to the following formula:

$$n = \frac{t^2 \left(\sum_1^M \mathrm{Pj} \mathrm{S_j}\right)^2}{E^2}$$ (Total sample size)

$$nj = \frac{n \ \mathrm{Pj} \ \mathrm{S_j}}{\sum_1^M \mathrm{Pj} \ \mathrm{S_j}}$$ (Sample size for each stratum)

Where:

n = Total sample size
nj = Total Sample size for each stratum
Sj = The standard deviation of stratum j
Pj = Portion of the stratum j
t = Value of t-student
M = Number of strata

Using this formula is achieved a value tight of n and nj, which in all cases gave a size of sample minor that the conventional.

As mentioned above, through an analysis of variance is possible to decompose the total variance of the population on two sources of variation:

Variance between strata and variance within strata.

$$\sigma^2 = \sigma_y^2 + \sigma_\beta^2$$

Where:

σ^2 = Total variance
σ_y^2 = Variance between strata
σ_β^2 = Variance within the stratas or variance due to stratification

The sampling unit consisted of temporary plots and nested circular of 5, 16 and 30 meter radius. The maximum sampling error for with strata forest was 10%, compared to the average of the total carbon stored per hectare.

For added security of not exceeding the predetermined sampling error of 10% it added 10% more the plots to evaluated. This additional 10% will also allow addressing any unforeseen event that may prevent future again locate all plots[1].

The coefficients of variation (CV%) used for each stratum they are of forest inventories carried out in the department of Ucayali as shown in table 2.

Also in Table 3 it shows the sequence for calculating the number of plots planned to be evaluated.

[1] IPCC. 2003. Orientación del IPCC sobre las buenas prácticas para UTCUTS.

Table 2. Reference of the CV% used for of planning plots to evaluate

Stratas Fisiográficos	C.V. (%)	Source
Low terrace forest	32	Winrock International (2006)
High terrace forest	30	Perú Forest (1999)
High hill forest	31	Recavarren y Delgado (2009)
Low hill forest	41	Recavarren y Delgado (2009)
Otros	40	

Table 3. Number of plots evaludas by type of forest

Stratas fisiográficos	Area (ha)	pj	CVj	pj x CVj	∑(pj x CVj)2	Calculated plots	Final calculation of the number of plots
Low hill forest	26,291.94	0.14	41	5.93		8.80	8
Average hill forest	9,923.40	0.05	40	2.18		3.24	5
Riverbank complex forest	16,212.34	0.09	40	3.57		5.30	6
Lomada forest	899.69	0.00	40	0.20		0.29	5
High terrace forest	37,580.37	0.21	30	6.20		9.21	9
Low terrace forest	23,777.26	0.13	32	4.18		6.21	7
Medium terrace forest	67,156.91	0.37	40	14.77		21.94	22
Total	**181,841.90**			**37.03**	1,371.36	**Number calculated**	
						54.85	
						End number of plots	
						55	

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The number of plots evaluated were a total of 104 distributed over all physiographic strata the study area.

4.1.3 Sampling of biomass aboveground

In each plot we measure all types of woody vegetation with a stem diameter at breast height (DBH) equal or greater than 5 cm for nested plots of 5, 16 and 30 m radius. Also they have been considered the plants having several axes which together measured equal or more than 5 cm of DAP. Figure 2 shows the size of each plot nested and the measures of each individual corresponding.

According to the supplementary method and guidance on good practices emanating from the Kyoto Protocol, it made an adequacy of this methodology taking into account the indicators established with respect to the circular plots (IPCC, 2003).

Parcelas Circulares Anidadas

Diameter of trunk	Radii of plots
5 – 19.9 cm de DAP	5m
20 – 49.9 cm de DAP	16m
> de 50cm de DAP	30m

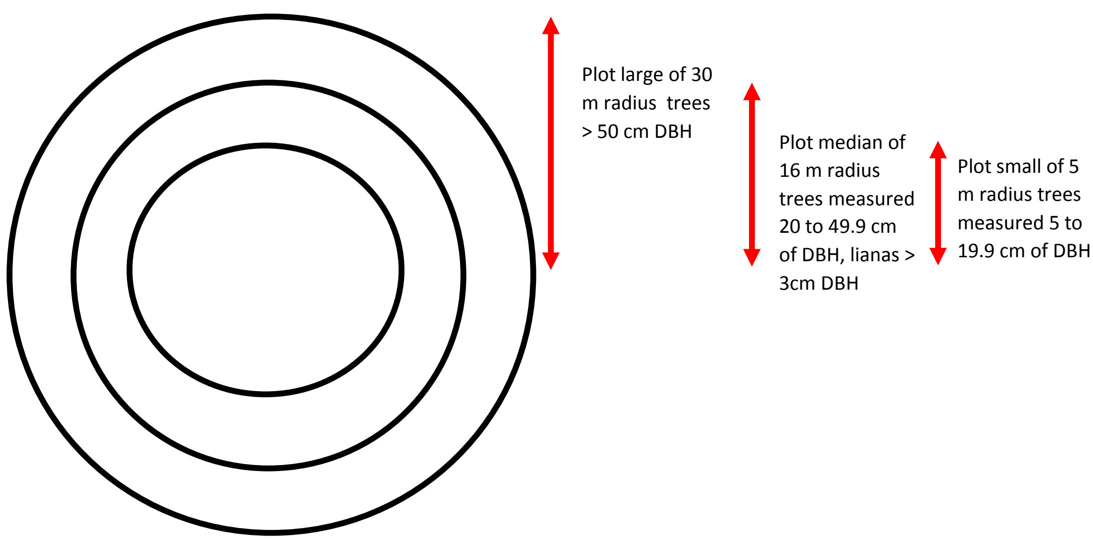

Figure 2. Shape and size of the evaluation plots

4.1.4 Equations used for calculating biomass

For calculations of biomass it used direct method that establishes Chapter 4 on complementary methods and guidance on good practices emanating from the Kyoto Protocol. For the purpose of our work is only considered some criteria that this methodology establishes, as this method is aimed at permanent plots.

The formulas used for calculating biomass were:

a) Allometric equation to estimate biomass aboveground:

$$AGB = \rho x \exp(-1.499 + 2.148(\ln(D)) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3$$

Where:
ρ = basic species density
D = diameter at breast height (DBH), cm
ln = natural logarithm

Source: Chave et al. (2005)

b) Allometric equation to estimate aboveground biomass of the species cético (*Cecropia sp.*)

$$\text{Biomass} = 12.764 + 0.2588 * (\text{dbh})^{2.0515}$$

Where:

dbh = Gama the DBH (cm): 5 – 40 cm

Source:
Pearson et al. (2005)

c) Allometric equation to estimate the aboveground biomass palm

$$\text{Y} = 10.0 + 6.4 * \text{TH}$$

Where:

TH= Total height of the palm tree in (m)

Source: Fragi and Luyo. (1995). Cited by Brown, S. y Pasa, E. (2007)

d) Allometric equation to estimate the aboveground biomass of lianas

$$Biomass = \exp(0.12 + 0.91 * Log(BA\ at\ dhb))$$

Where:
BA at dhb = basal area the DBH

dhb= DBH is set to 12 cm but is applicable to more

Source: Putz, F. (1983). Cited by Pearson et al. (2005).

e) Allometric equation to estimate aboveground biomass Palm the wasaí

$$\text{Biomass} = 6.666 + 12.826 * \text{Ht}^{0.5} * \text{Ln}(\text{Ht})$$

Where:

Ht = overall height, set only up 33m

Source:
Pearson et al. (2005). Cited by Winrock (2006)

f) Allometric equation to estimate the aboveground biomass of ungurahui palm (*Oenocarpus bataua*)

$$Y = 23.487 + 41.851 * (LN)Ht))^2$$

Where:
Y= dry matter above ground, Kg (árbol)-1
Ht = overall height in (m)

Source:
Pearson *et al.* (2005). Cited by Winrock, 2006

g) Allometric equation for calculating carbon in aguaje

$$\text{Y} = 0.00006 * (Ht)^3 + 0.0046 * (Ht)^2 - 0.043 * (Ht) + 0.1259$$

Where:
Y = biomass the aguaje in tons (t)
Ht = total height the aguaje (m)

Source:
Freitas et al., 2006.

h) Allometric equation to estimate below-ground biomass of tree species

$$\text{Biomass} = \exp(-1.0587 + 0.8836 * \text{Ln (BSS)})$$

Where:

BSS= aboveground biomass

ln = natural logarithm

Source:
cairns et al. 1997. Cited by IPCC. (2003)

The carbon stored in the below-ground tree biomass was estimated from the biomass aboveground. This was done to the group case of hardwood and ceticos. With regard to of palms are considered the ratio belowground biomass / aboveground biomass of 0.20 to forests tropical rain established by the IPCC guidelines (2006) for national inventories of greenhouse gases.

i) Relationship biomass / carbon

$$\text{Carbono} = \frac{\text{Biomass}}{2}$$

Source: IPCC (2006)

j) Relationship carbono/CO_2-e

44/12 = molecular weight ratio of CO_2 a carbono, t CO_2-e[2]
Source: IPPCC (2003)

4.2 Equipment and materials

Table 4. Equipment and materials used

Equipment	One brigade	
	Unit	Quantity
SUUNTO TANDEM	Unidad	1
Forcípula	Unidad	1
GPS	Unidad	1
Photographic camera	Unidad	1
Distanciómetro laser	Unidad	1
Balance of hand analytical	Unidad	1
Balance gramera	Unidad	1
Personal equipment		
Kitchen accessories	Kit	1
First aid kit	Kit	1
Rain plastic	Unidad	6
Pad	Unidad	6
Rubber boots	Par	6
Antern	Unidad	6
Sleeping	Unidad	6
Field materials		
Wincha de 50 metros	Unidad	1
Shears	Unidad	1

[2] Módulo Metodológico REDD: Estimación del carbono almacenado en la biomasa aérea y subterránea de los reservorios de árboles y no-árboles vivos (CP-AB)

Water tape	Unidad	8
Indelible thick down	Unidad	6
Engrampador	Unidad	1
Staples	Caja	4
Field board	Unidad	1
Pencil	Caja	2
Draft	Unidad	6
Sharpener	Unidad	2
Micas	Docena	5
Flashlight alkaline battery (A)	Par	12
GPS alkaline battery (AA)	Par	10
Alkaline battery for EDM (AAA)	Par	8
Notebook	Unidad	3
Backpack	Unidad	3
Field Guide	Unidad	2
Maps	Unidad	10
Evaluation forms	Hojas	500

IV. Results

Carbon content was determined in t / ha of the forests in 07 native communities beneficiaries project REDDES OIMT and was validated the strata of forests established for the lifting of information from the sample plots.

The number of plots were evaluated a total of 104, distributed throughout the study area.

5.1 Carbon content

Carbon content (t/ha) for each reservoir, with information collected through sample plots, evaluated according to each physiographic strata in the study area was estimated.

Table 5. Table 5 carbon contents according to their pools

Stratas fisiográficos	Pool aboveground (tC/ha)	Pool belowground (tC/ha)
Low hill forest	136.75	34.31
Average hill forest	96.90	25.36
Riverbank complex forest	134.34	35.35
Lomada forest	110.22	31.25
High terrace forest	104.24	33.50
Low terrace forest	81.20	20.53
Medium terrace forest	117.62	29.76

5.2 Calculo estadístico

The average carbon stored in living vegetation, from 5 cm diameter at breast height is 136.40 tons per hectare. The sampling error achieved was 6.83%, the which it is by under the established at the beginning of study, as shown in table 6 for statistical parameters evaluated in 104 plots.

Table 6. Statistical parameters calculated

Parameters	Value
Number of plots	104
Min (tn/ha)	8.34
Max (tn/ha)	298.48
Average (tn/ha)	136.40
standard deviation	53.94
CV %	39.53
Sampling error (%)	7.63