Set up institutional system for monitoring forest carbon stocks in Meru Betiri National Park

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SUMMARY

Tropical Forest Conservation For Reducing Emissions From Deforestation And Forest Degradation And Enhancing Carbon Stocks In Meru Betiri National Park, Indonesia, is an ITTO funded activity number PD 519/08 Rev.1 (F). This activity has been applied in Indonesia since 2010 as a demonstration activity in conservation area to support readiness phase of REDD+. Monitoring and estimating carbon dioxide emissions from deforestation and forest degradation becomes a key element for any activities of Reducing Emission from Deforestation and Forest Degradation (REDD). As in DA REDD+ activity in MBNP, one of the main objective of the project is to establish credible system for the measuring, reporting and verifying (MRV) of carbon stocks in project area. The system is based on the general requirements set by the United Nation Framework Convention on Climate Change (UNFCCC) and the specific methodologies for the land use and forest sectors provided by the Intergovernmental Panel on Climate Change (IPCC).

According to IPCC GPG (2003) and IPCC Guideline (2006), five carbon pools namely above ground biomass, below ground biomass, soil, litter and necromass should be considered in REDD project. ITTO support for REDD+ activities in MBNP will last until 2013, meanwhile in 2012, a Project Design Document is prepared according to requirement by voluntary carbon standard of VCS. An approved VCS methodology of VM 0015 (avoided unplanned deforestation) would be applied for the project. The aims of this study are: to collect information of carbon stocks in project areas and to set up institutional system for monitoring forest carbon stocks that support exit strategy after project completion. If locally based forest monitoring is to become a key element of the MRV of REDD+ schemes, further quantitative assessments of the relative strengths of different locally based forest monitoring methods would be advisable. It would be useful also to explore the extent to which community members can monitor other aspects of central importance to REDD+ implementation like governance, livelihoods, and biodiversity. The linking monitoring to the decisions of local people may help make monitoring more relevant locally and hence sustainable.

Keywords: REDD+, carbon stock, Meru Betiri National Park, local people

1. INTRODUCTION

REDD + is a forest carbon mitigation of climate change to reduce the source by reducing greenhouse gas emissions through not only enhancing carbon sequestration, but also through reducing emission from deforestation and degradation, enhancing carbon stocks, conservation and sustainable management of forest. The on-going negotiations on REDD+ mechanism have yet to define what procedures and modalities for implementation. However, it is expected that to ensure effective and result-based mechanism, a REDD+ mechanism should be implemented in a successive phase and ensure additionality as compared to the business as usual level.

REDD+ is a performance based activity that the success of REDD+ is based on how much emission reduction and enhancement of carbon stock have been made. Tropical Forest Conservation For Reducing Emissions From Deforestation And Forest Degradation And Enhancing Carbon Stocks In Meru Betiri National Park, Indonesia, is an ITTO funded activity number PD 519/08 Rev.1 (F). This activity has been applied in Indonesia since 2010 as a demonstration activity (DA) in conservation area to support readiness phase of REDD+.

According to IPCC GPG (2003) and IPCC Guideline (2006), five carbon pools namely above ground biomass, below ground biomass, soil, litter and necromass should be considered in any mitigation activities including REDD+. This activity is conducted to identify various activities that directly or indirectly influence the reduction of GHG emissions, the increase GHG uptake and the increase of carbon stocks.

Objective of this study is to collect information of carbon stocks in project areas and to set up institutional system for monitoring forest carbon stocks that support exit strategy after project completion.

2. METHODOLOGY

A. Carbon Measurement

Plot measurement is the major work of carbon measurement. Here, above ground biomass, woody necromass, litter and soil sampling are measured in PSPs.

1. Above Ground Biomass (AGB) Measurement

Above Ground Biomass is measured for living trees and understorey. AGB of living trees is measured with non-destructive method and applies allometric equation to obtain biomass. The allometric equation defined as statistical relationship between key characteristic dimension(s) of trees that are fairly easy to measure, such as DBH or height, and other properties that are more difficult to assess, such as above-ground biomass. The allometric equations are established in a empirical way on the basis of exact measurements from a relatively large sample of typical trees.

In PSP measurement is carried out to record diameter of breast height, trees height and species of the trees. Measurement of diameter at breast height and tree height measurement is adjusted with trees characteristics. Figure 1 showed measurement of diameter at breast height on different characteristics of the tree. Measurement of tree height on some characteristics the trees is shown in Figure 2.

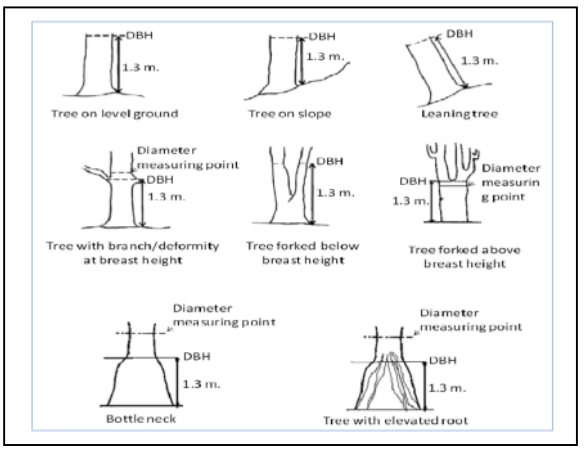

Figure 1. Measurement of diameter at breast height (1.3 m height) on some characteristics of the tree (Source: Subedi *et al.*, 2010; Karky and Banskota, 2007; MacDicken, 1997)

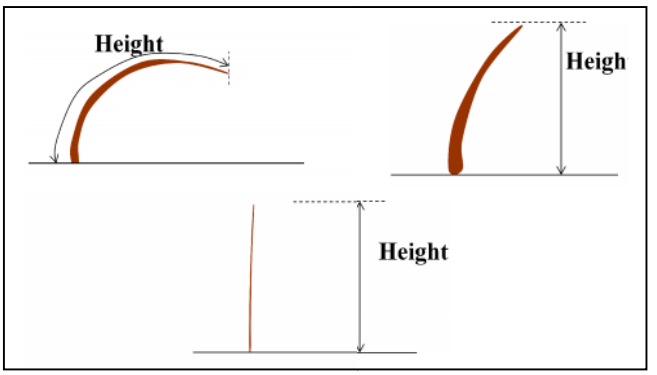

Figure 2. Height measurements on several characteristics of the trees

Wood samples with certain diameter are taken to identify wood density. For under storey, destructive sampling carried out on sub-plots of 0.5 x 0.5 m. The following should be carried out for under storey destructive sampling activities:

a. Determine the UC (Closure (%)) as the closure area by plant life / total area (0.5 m x 0.5 m)
b. Determine the UHmax (highest understorey height (m))
c. Create 10 sub plots within the plot for destructive sampling.
d. Cut down all understorey (herbs and small seedlings) (Figure 3).

Figure 3. Destructive sampling for understorey (Source photo: JICA, 2002)

e. Weigh the fresh weight of whole plant.
f. After measuring the total wet weight, take the plant samples for dry weight measurements and carbon content. Dry weight obtained from oven at 105°C for 48 hours.

$$\text{Total dry weight} = \frac{\text{sample dry weight}}{\text{sample fresh weight}} \times \text{total fresh weight}$$

$$\text{Carbon content} = 0.5 \times \text{total dry weight}$$

After taking the sum of all the individual weights (in kg) of a sampling plot and dividing it by the area of a sampling plot for understorey (0.25 m^2), the biomass stock density is attained in kg m^{-2}, respectively. This value can be converted to ton/ha by multiplying it by 10. The biomass stock density of a sampling plot will be converted to carbon stock densities after multiplication with the IPCC (2006) default carbon fraction of 0.5.

g. A total of 10 sub plots of 0.5 m x 0.5 m made to formulate allometric equation as follows:

$$WU = m\,(UC \times UHmax)^{n}$$

Where:
WU: total understorey biomass
m, n: coefficients
UC: closure of understorey (%)
UHmax: understorey height (the highest) (m)

2. Woody Necromass Measurement

The dead organic matter pool (woody necromass) includes dead fallen trees, and other coarse woody debris above the soil surface. Within the plot, all woody debris and trunks (unburned part), dead standing trees, dead trees on the ground and stumps are sampled. Their height (length) and diameter are recorded, as well as notes identifying the type of wood for estimating specific density. The following should be carried out for woody necromass measurement:

a. Collect all of the standing stumps (DBH between 5 and 10 cm).
a. Collect all of the fallen stumps or wood with the base diameter between 10 and 15 cm.
b. Collect all of twigs or branches on the forest floor with the base diameter between 10 and 15 cm.
c. Calculate the volume of standing timber by measuring the DBH and length of standing timber.
d. Weigh the fallen timber, twigs and branches to determine the biomass and take samples for measurement of dry weight.
e. Dry weight obtained from oven at 105°C for 48 hours.
f.

3. Litter (Non Woody Necromass) Measurement

Litter consists of leaves and small branches above the ground as non woody necromass. Litter samples are collected from the same quadrants of 0.50 m x 0.50

m (0.25 m^2) as used for under storey sample. Basically it is separated from coarse litter and fine litter. Coarse litter is any tree necromass less than 5 cm diameter and/or less than 50 cm length, undecomposed plant materials or crop residues, all unburned leaves and branches. Fine litter is at organic layer (0-5 cm above mineral soil layer) in the same quadrates, including all woody roots.

The following should be carried out for litter measurement:
a. Place the frame size of 0.5 m x 0.5 m for the retrieval of litter.
b. Take all of the litter within the frame 0.5m x 0.5m until the ground floor in the frame is clean.
c. Dry weighted obtained from oven at 105°C for 48 hours.

To minimize the contamination with mineral soil, the coarse litter samples should be soaked and washed in water; the floating litter is collected, sun dried and weighed, the rest is sieved on a 2 mm mesh sieve and added to the fine litter fraction. A subsample can be taken to obtain dry weight.

4. Soil Samples

Soil organic carbon determined through samples collected from the default depth prescribed by the IPCC (2006). Soil samples are taken from three layers (depth), 0-10 cm, 10-20 cm dan 20-30 cm at six points on each plot. Soil samples are analyzed in the laboratory as composite samples to identify chemical properties such as pH and C content. Undisturbed soil samples are also taken for physical analysis, especially the 'bulk density', and (specific gravity) of the soil which is essential to convert the soil dry weights into soil volume. To estimate bulk density, soil sample is taken from three depths (0-10 cm, 10-20 cm, and 20-30 cm) by using standardized ring sampler. Similarly, one composite sample is collected from each layers in order to determine concentrations of organic carbon. The following should be carried out for soil samples:

a. Soil samples from each soil layer/horizon (0-10 cm, 10-20 cm, 20-30 cm) are taken by using a ring soil sampler of known height and volume. Place ring sampler at each depth with a range of 5 cm.
b. Place the ring soil sampler on the surface that has been determined (Figure 4).

Figure 4. The placement of ring soil sampler on the soil surface (Source photo: JICA, 2002)

c. Press the ring soil sampler to a depth of 5 cm in the first by using small hammer.
d. Place the ring soil sampler at a depth of 5 cm next.
e. Position ring soil sampler (Figure 5).

Figure 5. Position ring soil sampler (Source photo: JICA, 2002)

f. Press the ring soil sampler one by one carefully (Do not press the soil that is in the ring soil sampler).
g. Dispose excess soil from the ring soil sampler with a knife/machete (Figure 6).

Figure 6. Disposal of the remaining soil from the ring soil sampler (Source photo: JICA, 2002)

h. Take soil samples from the ring soil sampler and place it in a plastic bag. Then plastic bag is filled with composite soil samples from each depth (Figure 7).

Figure 7. Placement of soil samples in plastic sample (Source photo: JICA, 2002)

i. Dry-aired soil samples from the ring soil sampler.
j. Air dry weight of soil sample.
k. Calculate the value of soil bulk density.

$$\text{Soil bulk density} = \frac{\text{Air dry weight of soil sample (gr)}}{\text{Volume ring soil sampler } (cm^3)}$$

5. Data Analysis for Above Ground Biomass

The appropriate allometric equation should be selected to estimate the above ground biomass (AGB). The allometric equations for biomass usually consist of information on trunk diameter at breast height *DBH* (in cm), total tree height *H* (in m), and wood-specific gravity (in g/cm³). Baker *et al.* (2004) have shown that ignoring variations in wood density results in poor prediction of the stand (AGB). Therefore, the wood-specific gravity is an important predictive variable in the regression model. The choice of the best predictive allometric equations (models) in estimating AGB is developed by Chave *et al.* (2005) on the basis of climate and forest stand types. Equation (a) is good for moist forest stand, equation (b) for dry forest stand, and equation (c) for wet forest stand:

$AGB = 0.0509 * \rho D^2 H$ ……equation (a)
$AGB = 0.112 * (\rho D^2 H)^{0.916}$ …….. equation (b)
$AGB = 0.0776 * (\rho D^2 H)^{0.940}$ …… equation (c)

where,
ABG = above ground biomass [kg];
ρ = wood specific gravity [g cm^{-3}];
D = tree diameter at breast height [cm]; and
H = tree height [m].

After taking the sum of all the individual weights (in kg) of a sampling plot and dividing it by the area of sampling plot for trees (2000 m^2) and saplings-poles (500 m^2), the biomass stock density is attained in kg m^{-2}. This value can be converted to ton/ha by multiplying it by 10. The biomass stock density of a sampling plot will be converted to carbon stock densities after multiplication with the IPCC (2006) default carbon fraction of 0.5.

Before a specific allometric equation is used, it is good practice to test whether the equation can be applied by taking a small number of empirical measurements and comparing the predicted outcome with the measured outcome. How thr established allometric equation fits new observations can be tested using a reduced Chi-Square goodness-of-fit test. This test analyzes whether the variability between predicted biomass values and true biomass values is equal to the 'natural' variability in biomass values (Subedi *et al*, 2010).

$$\chi^2_v = \frac{1}{n-p-1}\sum_{i=1}^{n}\frac{\left(y_i - f_{allo}(DBH_i, height_i)\right)^2}{\sigma_i^2}$$

where:

χ^2_v = reduced chi square;
n = number of measurement taken in the field to test the established allometric equation;
p = number of parameters used in the allometric equation (i.e., 1 if only DBH is used and 2 if both DBH and height are used);
y_i = empirically determined biomass of the tree, *i*;
f_{allo} = the established allometric equation that is to be tested;
DBH_i = the DBH of the tree, *i*;
$height_i$ = the height of the tree, *i*; and
σ^2_i = the empirically determined variance of the biomass of the tree, *i*.

The allometric model assumed to be a 'good fit' when the reduced chi square equals is one (or close to).

6. Data Analysis for Woody Necromass

Analysis of woody necromass biomass will be calculated by following equations:

$$\text{Total dry weight} = \frac{\text{sample dry weight}}{\text{sample fresh weight}} \times \text{total fresh weight}$$

Carbon content = 0.5 x total dry weight

After taking the sum of all the individual weights (in kg) of a sampling plot and dividing it by the area of a sampling plot for woody necromass (0.25 m^2), the biomass stock density is attained in kg m^{-2}. This value can be converted to ton/ha by multiplying it by 10. The biomass stock density of a sampling plot will be converted to carbon stock densities after multiplication with the IPCC (2006) default carbon fraction of 0.5.

7. Data Analysis for Litter

To determine the litter biomass, samples are taken destructively in the field within a small area of 0.25 m^2. Fresh samples are weighed in the field with a 0.1 gr precision; and a well-mixed sub-sample is then placed in a marked bag. A sample is taken to the laboratory and oven dried until constant weight to determine water content. For the amount of biomass per unit area is given by:

$$WL = \frac{W\ field\ fresh}{P} \times \frac{W\ dry\ sample}{W\ wet\ sample} \times \frac{1}{10000}$$

where:
WL = biomass of litter (t ha^{-1});
W field fresh = weight of the fresh field sample of litter, destructively sampled within an area of size P [g];
P = size of the area in which litter were collected [ha];
W dry sample = weight of the oven-dry sample of litter taken to the laboratory to determine moisture content [g]; and
W wet sample = weight of the fresh sample of litter taken to the laboratory to determine moisture content [g].

8. Data Analysis for Soil Organic Carbon

Soil samples from each of the three depths are composted and well-mixed per sampling plot and then prepared for carbon measurement by removing stones and plant residue > 2mm as well as by grinding. The carbon stock density of soil organic carbon is calculated as (Pearson *et al.*, 2007):

$SOC = \rho \times dp \times \%C$

Where:
SOC = Soil organic carbon stock per unit area (t ha^{-1});
ρ = soil bulk density [g cm^{-3}];

dp = the total depth at which the sample was taken [cm]; and
%C = carbon concentration [%].

9. Data Analysis for Total Carbon Stock Density

Carbon stock density is calculated by using the following formula (Subedi *et al.*, 2010). It should be noted that any individual carbon pool of the given formula can be ignored if it does not contribute significantly to the total carbon stock.

$$C(LU) = C(AGTB)+C(AGPB)+C(AGSB)+C(AGUB)+C(L)+C(WN)+SOC$$

where,
C(LU) = carbon stock density for a land-use category [ton ha^{-1}];
C(AGTB) = carbon in above ground tree biomass [ton ha^{-1}];
C(AGPB) = carbon in above ground pole biomass [ton ha^{-1}];
C(AGSB) = carbon in above ground sapling biomass [ton ha^{-1}];
C(AGUB) = carbon in above ground understorey biomass [ton ha^{-1}];
C(L) = carbon in litter [ton ha^{-1}];
C(WN) = carbon in woody necromass [ton ha^{-1}];
SOC = soil organic carbon [ton ha^{-1}].

The total carbon stock is then converted to tons of CO_2 equivalent by multiplying it by 44/12, or 3.67 (Pearson *et al.*, 2007).

B. Community Data Collection

Data collection was conducted in the villages of surrounding Meru Betiri National Park: Curahnongko, Sanenrejo, Wonoasri, Kebonrejo and Kandangan.

Data collection using two (2) methods: interviews and questionnaires.

a). Interview: to get a detailed and clear data then conducted using direct interviews to the public. Interviews were conducted one at a time by providing the appropriate questions of questionnaire that has been prepared (Annex 1).

b).Questionnaires: this method is done because of constraints of time and the number of respondents. This method is done in groups of 10-15 people, which in turn are given questionnaires to fill out the form together. Officers guide in each stage of the data needed, and if there is lack of clarity of intent required questionnaire can be asked directly to the officers of data collection.

Interviews and questionnaires were conducted to obtain data on the general condition of the community, education level, livelihood, income level, land

ownership, livestock ownership, community participation in land rehabilitation, assistance contributions of Government and Meru Betiri National Park.

3. RESULTS AND DISCUSSIONS

A. Aboveground Carbon Stock for Each Landcover Category

Aboveground carbon stock assessment in the area within MBNP has been conducted according to a guideline or Standard Operational Procedure for field measurement from previous study. There were 40 plots distributed within the MBNP that were used for carbon stock assessment (Figure 8). These plots were used as Permanent Sample Plot (PSP) as well, which represented forestland, cropland, agroforestry, and grassland landcover categories.

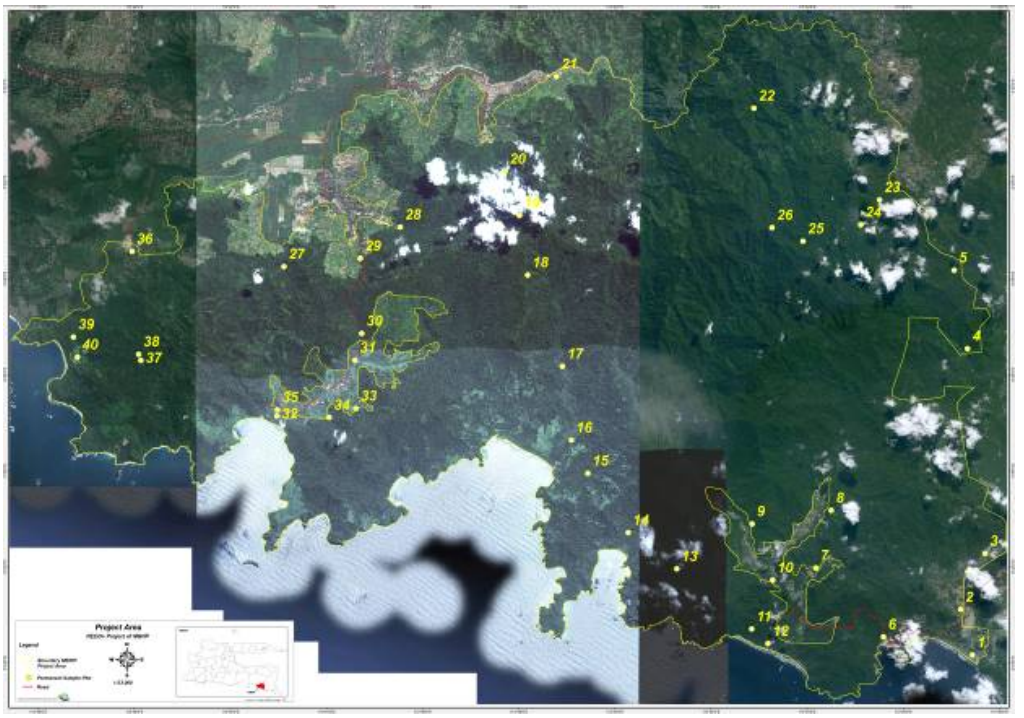

Figure 8. Permanent sample plots on MBNP

By following the selected guideline of carbon stock assessment, each landcover category within MBNP will have carbon stock value as following table, these values are carbon stock in maximum capacity (no significant increment), except landcover category agroforestry; this category are not in maximum capacity, with the high efforts and human intervention in the project scenario, this category will have significant increment.

Above ground carbon stock estimation at several zonation systems in MBNP varied between 28.7 – 145.98 ton/ha as presented in Table 1. Aboveground carbon stock in the nucleus zone is lower than in the forest zone (133.69 ton/ha). Forest zone has the highest carbon stock compared with other zones (145.98 Ton/ha). Because the nucleus zone is delineated based on the home range of Javanese tiger and not based on the vegetation density, therefore the carbon stock in the nucleus zone is lower than in the forest zone with higher vegetation density.

Table 1. Estimated aboveground carbon stock at different zonation systems in MBNP

No	Zone	Carbon stock (Ton/ha)
1	Nucleus	133.69
2	Forest	145.98
3	Use	118.34
4	Intensive use	98.8
5	Rehabilitation	28.7

Based on the land use system in MBNP the carbon stock is estimated between 28.7-166.63 Ton/ha (Table 2).

Table 2. Estimated above ground carbon stock at several land cover types in MBNP

No	Land cover	Carbon stock (Ton/ha)
1	Primary forest	135,02
2	Secondary forest	166,63
3	Plantation	98,8
4	Bushes	93,38
5	Paddy fields	28,7
6	Shrub	24,08

Secondary forest has the highest carbon stock of 166.63 Ton/ha. Primary forest has lower carbon stock than secondary forest, i.e. 137.69 Ton/ha. This is because the designation of the primary and secondary forest of MBNP is not based on vegetation density stratification. Secondary forest in MBNP landcover map is actually densed vegetated and has high diameters compared with the primary forest that are grown with bamboo forest. The highest carbon stock after the primary forest is found in forest plantation estate (133.29 Ton/ha), because it is

dominated with old *Hevea braziliensis* trees. The lowest carbon stock is found in shrub and bushes (24.08 Ton/ha). Paddy fields in MBNP are intercropped with forest trees, so it provides 28.7 Ton/ha higher carbon stock than shrub and bushes.

The highest aboveground carbon stock in MBNP is classified as good (166.63 Ton/ha). Carbon stock in the tropical forests in Asia varies between 40-250 Ton/ha for vegetation and 50-120 Ton/ha for soil. Meanwhile, carbon stock of each land cover types in rehabilitation zone (t C/ha) can be seen in Table 3.

Table 3. Carbon stock of each land cover types in rehabilitation zone (t C/ha)

Landcover	Carbon stock (tC/ha)
Grassland	7.2
Cropland	2.9
Agroforestry	28.7

B. Institutional System

a. Meru Betiri National Park Structure

According to the Regulation of the Minister of Forestry No. P.03/Menhut-V/2007 on 1 February 2007 about Organization and Administration of the National Park Authority decided Meru Betiri National Park including type A of national park with the organizational structure as follows (Figure 9).

The main task of Meru Betiri National Park is to conserve natural resources and their ecosystems, based on legislation. To carry out these basic tasks, Meru Betiri National Park has the function of programme development of Meru Betiri National Park, protection, preservation and utilization of national parks and their ecosystems, carry out promotional and information, species conservation of natural resources and preserve the natural attractions, and implement administrative affairs.

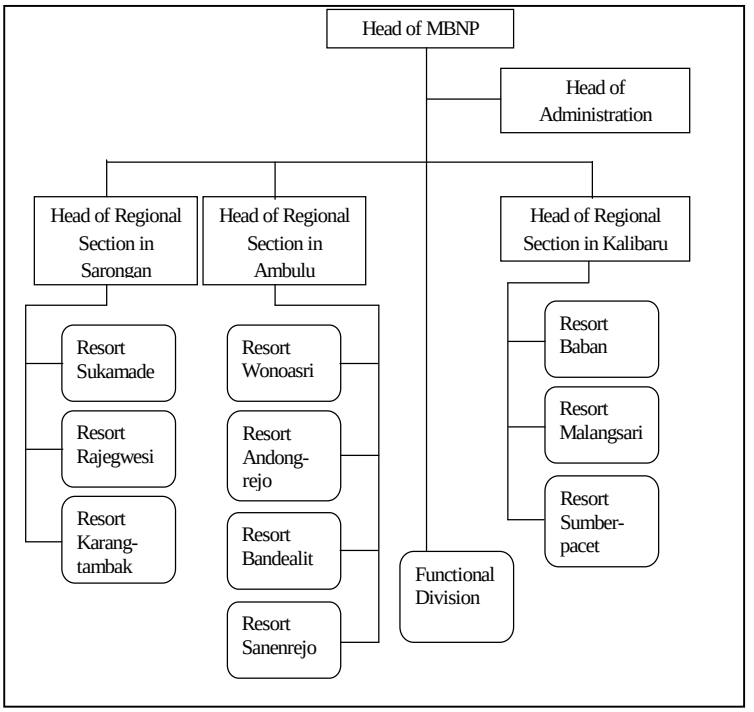

Figure 9. Organizational structure of Meru Betiri National Park

b. Community Structure

Community structure analysis divided into data on the general condition of the community, education level, livelihood, income level, land ownership, livestock ownership, community participation in land rehabilitation, assistance contributions of Government and Meru Betiri National Park. These data is very crucial for establishment and set up institutional system for monitoring forest carbon stock in Meru Betiri National Park. There are many literatures about methods of natural resource monitoring covers an externally driven approach in that professional experts from outside the study area set up, run and analyze the results from a monitoring programme that has been funded by a remote agency (e.g. Goldsmith, 1991; Spellerberg, 2005; Sutherland, 1996). But, Sheil (2001) reported that this approach has been criticized for being expensive to sustain over time and reliant on skills that are not endemic and Danielsen *et al.* (2009) suggested that linking monitoring to the decisions of local people may help make monitoring more relevant locally and hence sustainable.

General Condition of the Community

MBNP is surrounded by two districts and 11 villages with the total population of approximately 23.800. The majority of the community is living as land owning

farmers (40%) and non-land owning farmers as labors (40%) and the rest are traders, construction labors and others. The average community income is very low, approximately UD$150 per year. To support day to day living, most community members search alternatives sources of income, and frequently through illegal logging/harvest in the National Park area for both timbers and other Non-Timber Forest Products including biological diversity.

LATIN, a local NGO will involve in the project implementation has established initiatives to promote income generating activities, such as domestication and cultivation of medicinal plants and processing traditional medicine (such as jamu). However, due to limited resources, the model has not been expanded to other parts of the National Park. Currently, Agro-forestry models planted with medicinal plants, Parkia, Pangium, Enterelobium, bamboo and some other plants, have contributed to the improvement of community prosperity in pilot site of this Park. However, due to limited resources, the models have not been expanded to other areas of the Park. Intervention by this proposed project will significantly accelerate the enhancement of the models and good practices to wider areas of the Park.

Land use rights in buffer zone of national park are rewarded to the community. They grow agricultural plants and fruit trees (and also medicinal plants, if they intend to). They are interested in enrichment planting with high-value medicinal plant existed in the national park area. Through the project, the community would grow shade resistance medicinal plant and be able to harvest fruits, bamboo, rattan and also the medicinal plants with the development of community-based forest enterprises with the engagement of local NGOs including an housewife organization on planting herbal medicine at home gardens.

In detail, the number and distribution of the population in the villages surrounding national park can be seen in Table 4. The table illustrated that Wonoasri village has the highest population density amount 1,554.37 N/km^2, otherwise in Curahnongko village has the lowest population density amount 20.17 N/km^2. Overall, the proportion of females much more that is 50.22% compared to male population that only 49.88%.

Table 4. Distribution and population density of the villages surrounding the area of Meru Betiri National Park

No.	Village	Size (km^2)	Population Number		Total	Density (N/km^2)
			Male	Female		
	Jember District					
1	Ds.Curahnongko	283.390	2,883	2,833	5,716	20.17
2	Ds. Andongrejo	262.790	2,683	2,826	5,509	20.96
3	Ds. Wonoasri	6.180	4,841	4,765	9,606	1,554.37

4	Ds. Curahtakir	77.863	5,517	5,908	11,425	146.73
5	Ds. Sanenrejo	88.946	2,889	2,981	5,870	65.99
	Banyuwangi District					
6	Ds. Sarongan	27.001	2,892	2,978	5,870	217.40
7	Ds. Kandangan	18.064	4,423	4,205	8,628	477.64

Education Level

Level of education in the villages surrounding national park can be seen in Table 5. Overall of respondents from 5 villages namely Kebonrejo, Kandangan, Sanenrejo, Curahnongko and Wonoasri showed that approximately 50% - 80% of respondents only educated up to primary school level (elementary school). Approximately 12% - 38% had never graduated from elementary school, and about 32% -52% graduated from elementary school. Approximately 5% -22% to get an education to junior high school and about 3% -13% graduated from high school level.

Table 5. Percentage of education level

Education	Percentage of education level				
	Kebonrejo	Kandangan	Sanenrejo	Curahnongko	Wonoasri
Not passed elementary school	20.9%	26.3%	23.5%	38.7%	12.4%
SD (Elementary school)	32.3%	47.3%	38.0%	43.4%	52.6%
SLTP (Junior high school)	22.1%	7.3%	8.5%	7.9%	4.8%
SLTA (High school)	13.3%	8.4%	8.0%	3.8%	0.0%
D3 (Diploma)	0.8%	0.8%	0.0%	0.0%	0.0%
Perguruan Tinggi (University)	0.4%	0.8%	0.0%	0.0%	0.0%
Tanpa keterangan (No information)	10.3%	9.2%	22.0%	6.3%	30.1%
Respondent (Number)	263	262	200	318	209

Low levels of education lead to the lack of understanding to preserve forests. The community just think how to meet the needs today or this week through utilizing of wood forest products, bamboo and the others. In addition, the community has activity of forest clearing for agriculture.

Livelihood

Percentage of livelihood type from each village surrounding national park can be seen in Table 6 below.

Table 6. Percentage of livelihood type

Livelihood type	Percentage of livelihood type				
	Kebonrejo	Kandangan	Sanenrejo	Curahnongko	Wonoasri
Farmer	11%	18%	36%	56%	35%
Hodge	16%	10%	43%	19%	42%
Garden Employees	24%	5%	0%	3%	10%
Trader	14%	2%	7%	3%	3%
Workman	0%	1%	3%	3%	2%
Garden Hodge	5%	32%	0%	2%	4%
Freelance Hodge	10%	2%	0%	0%	0%
Sugar Crafters	0%	3%	0%	0%	0%
Entrepreneur	0%	8%	8%	2%	0%
Others	21%	17%	5%	12%	5%
Respondent	**263**	**262**	**200**	**318**	**209**

Table 6 showed that most of the villagers are farmers (approximately 11%-56%) and as a hodge (approximately 10%-42%). Farmers here defined as someone who cultivate their own land for agricultural activities (farming), while hodge is someone who does agricultural activities to help others who have agricultural land, this was due to not having their own farms. The other livelihood with sizable percentages among all respondents is garden employees (approximately 5%-24%). The percentage of trader, garden hodge and entrepreneur approximately 5%-19%. Furthermore, in small percentage amounts is as teacher, workman, driver, etc., only about 1-5 people.

Income Level

With the composition of the livelihood type by the villagers as mentioned above, it is clear to note that the level of income as most people are low. This can be seen from Table 7, which shows the average of income per month per villager amount Rp. 505,601. - to Rp. 1,215,093. -. For Curah Nongko and Kandangan villages, the average income of those village is better than three (3) other villages amount Rp. 1,054,915 and Rp. 1,215,915, respectively. The income was higher than the local minimum wage of Jember District amount Rp. 875,000, -.

Table 7. Income level

Income	Income (Rp)				
	Kebonrejo	Kandangan	Sanenrejo	Curahnongko	Wonoasri
Total income (year)	2,594,524,100	3,821,449,000	1,967.043.500	4.025.557.232	1.268.046.300
Respondent (person)	**263**	**262**	**200**	**318**	**209**
Income/person/year	9,865,111	14,585,683	9,835,218	12,658,985	6,067,207
Income/person/month	822,093	1,215,474	819,601	1,054,915	505,601

Meanwhile, conditions in the villages of Sanenrejo and Kebonrejo almost the same, the level of income of the people in those villages are still below the local minimum wage of Jember District. Average income of villagers in Kebonrejo amount Rp. 822,093.- and Sanenrejo village amount Rp. 819,601.-. The income is considered a mediocre to meet the needs of families living every day. Most of these income will be depleted to meet basic material needs every day. So many villagers from Kebonrejo and Sanenrejo who find a second job.

Land Ownership

Percentage of land ownership in the villages surrounding national park can be seen in Table 8. Comparison between one village to another is different depend on spesific land ownership.

Table 8. Percentage of land ownership

Land type	Percentage of land ownership				
	Kebonrejo	Kandangan	Sanenrejo	Curahnongko	Wonoasri
Agricultural land	3%	2%	0%	1%	0%
"Tegalan" land	11%	2%	0%	3%	2%
Garden land	23%	19%	68%	54%	43%
Agricultural, tegalan and garden land	8%	27%	30%	23%	33%
Not having land	56%	49%	3%	19%	22%
Respondent (person)	263	262	200	318	209

Table 8 illustrated that about 97% of the respondents in Sanenrejo village have agricultural land and 68% of them dominated by gardens. However, furthermore, many people in Sanenrejo only had the land size about 400-800 m^2. For There are about 50% of respondents in Kebonrejo and Kandangan villages did not have agricultural land. Agricultural land owned by Kandangan villagers was quite big amount 2,000-5,000 m^2 per person, meanwhile, agricultural land ownership in Kebonrejo village was not too big only amount 500 m^2. For Curahnongko and Wonoasri villagers, it is approximately 19%-22% of respondents did not have agricultural land. Meanwhile, there are mostly Curahnongko and Wonoasri villagers had garden land amount (43%-54%).

Livestock Ownership

Percentage of livestock ownership in each village surrounding national park can be seen in the Table 9 below.

Table 9. Percentage of livestock ownership

Livestock	Percentage of livestock				
	Kebonrejo	Kandangan	Sanenrejo	Curahnongko	Wonoasri
Chicken	8%	13%	1%	4%	9%
Sheep	15%	2%	2%	3%	8%
Cow	13%	20%	49%	41%	15%
Others	1%	1%	0%	1%	5%
Chicken, sheep, cow	5%	8%	1%	13%	29%
Not having livestock	58%	56%	48%	39%	34%
Respondent (person)	**263**	**262**	**200**	**318**	**209**

Table 9 showed that approximately 34%-58% of the respondents did not have livestock for their livelihood. Livestock of sheep and cows is more dominant than chicken livestock. It is affected by the price of the chicken are not as attractive as sheep and cows. Sheep become the second largest selection after cows. There are about 8%-15% of respondents in Wonoasri and Kebonrejo villages choose sheep livestock due to ease in sheep livestock and sheep selling price. Price of adult sheep (weight 30-35 kg) could reach amount Rp. 700,000.- to Rp. 800,000.-. In Idul Adha day, the price of sheep could reach amount Rp. 1,000,000.-.

Community Participation in Land Rehabilitation

Rehabilitation activities in Meru Betiri National Park using patterns of collaborative/partnership through involving of communities around the national park area by mutual agreement and supported by stakeholders. Stakeholders obligated to help and support the rehabilitation efforts that undertaken by Meru Betiri National Park. The community participation in mutual agreement can be done through:

1. Communities can cultivate land in the rehabilitation zone of national park area.
2. Communities are required to plant trees using native (endemic) species that have benefit as medicine or other benefits.
3. Communities should plant intercropped in between the trees until a certain time limit (after 5 years will be evaluated).
4. Not allowed/prohibited to plant the crops such as cocoa, coffee, tobacco, etc.
5. Harvested fruit product was owned by farmers, meanwhile the tree should not be cut down and became a national park asset.
6. Land was owned by state and it is should not be converted into property rights or other statuses.
7. Community shall keep the area of Meru Betiri National Park together with Forest Ranger (Polhut).

Rehabilitation zone management together with communities also provides many benefits to the community that is extra income from intercropping plants and

harvested fruit product. Table 10 showed that percentage of villagers surrounding national park who use the rehabilitation land for cultivation. There are no villagers in Kebonrejo who use the rehabilitation land for cultivation due to Kebonrejo village area does not interact directly with the rehabilitation zone border. Meanwhile, it is only 4% of respondents in Kandangan village who use the rehabilitation land for cultivation.

Table 10. Percentage of income level in rehabilitation land

Aspect	Income				
	Kebonrejo	Kandangan	Sanenrejo	Curahnongko	Wonoasri
Respondent (person)	263	262	200	318	209
Farmer in rehabilitation land (person)	-	10	96	84	77
Farmer in rehabilitation land (%)	-	4%	48%	26%	37%
Intercropped income (Rp/year)	-	12,369,515	200,170,500	223,805,000	585,846,500
Income per person per month (Rp)	-	103,079	173,759	222,029	634,033

Table 11 illustrated that the number of farmers who have received the results of main trees in land rehabilitation and also the amount of extra income from the main trees.

Table 11. Income gained from main trees in rehabilitation land

Village	Total income (Rp)	Number of farmers (person)	Income per farmer (Rp)	Income per month (Rp)
Kandangan	13,584,500	76	178,743	14,895
Curahnongko	520,000	2	260,000	21,667
Wonoasri	53,795,000	74	726,959	60,580

Land rehabilitation in Meru Betiri National Park have both of the advantages and benefits from harvested intercropping crops and harvested fruit from main tree. It is expected that farmers in rehabilitation land are not only taking care of intercropped plants, but also caring for main trees.

Assisstance Contributions of Government and Meru Betiri National Park

The government have attention to the community surrounding forest area toward development and improvement of public welfare. The existence of the remote villages that very far from the city does not preclude the government to keep attention the community welfare in surrounding forest area. Table 12 showed that percentage of government assisstance in each village. The assistance could come

from central government, local governments, technical agencies and even political parties.

Table 12. Percentage of government assisstance

Assisstance type	Percentage of government assisstance				
	Kebonrejo	Kandangan	Sanenrejo	Curahnongko	Wonoasri
Rice/Main needs	0%	30%	24%	60%	17%
Money	9%	7%	8%	0%	11%
Sheep	0%	0%	0%	0%	1%
Others (Seedlings, Fertilizer)	0%	12%	6%	1%	0%
No assisstance	91%	51%	62%	39%	71%
Respondent (person)	263	262	200	318	209

Type of assistance provided by the government are also a variety of forms, but the assisstance that received by villagers was dominated in the form of rice/main needs. The assistance that received by the villagers depend on general conditions of community, land condition, income level, and the most important is tailored to the needs of the community.

Meru Betiri National Park not only provides rehabilitation land for cultivation intercropped and main trees but also provides other assistance in the form of training and seedlings. Seedlings were given to farmers who work the rehabilitation land. Meru Betiri National Park will provide seedlings whenever farmers need it. Table 13 showed that percentage of assisstance recipients from Meru Betiri National Park was given to the villagers surrounding national park.

Table 13. Percentage of assisstance recipients from Meru Betiri National Park

Village	**Respondent (person)**	**Assisstance recipients (person)**	**%**	**Remarks**
Kebonrejo	263	0	0%	Training of catfish fisheries
Kandangan	262	4	2%	Seedlings
Sanenrejo	200	28	14%	Seedlings
Curahnongko	318	86	27%	Seedlings
Wonoasri	209	75	36%	Seedlings

Kebonrejo village that do not border directly to the National Park area was not get seedlings assisstance. However, the Meru Betiri National Park remains empower the villagers by providing of catfish fisheries training. The training is an initiative of the villagers who are members of the farmers institution was established Betiri Meru National Park namely SPKP (Sentra Penyuluhan Kehutanan Perdesaan /Rural Forestry Extension Center). After that training, it is expected that villagers will decrease their activity in forest area for taking forest

products to meet their needs, so that the pressure/disturbance to the national park area can be reduced.

c. Carbon Stock Monitoring System

Based on community structure data in the villages of surrounding Meru Betiri National Park, it is very important to involve the villagers in monitoring based community in term of keep the security of national park area and also they will get incentif from their involvement in forest carbon stock monitoring.

The primary tasks which communities would need to carry out in monitoring forest carbon stock comprise the following:

1. Mapping and geo-referencing the boundaries of the forest, if this data is not already available.
2. Establishing a system of permanent sample plots and regular measurement of the standing biomass stock in each of the sample plots.
3. Calculation of carbon stocks from the measured forest parameters (e.g. diameter at breast height and tree height).
4. Assessment of leakage.
5. Monitoring of other environmental variables such as biodiversity changes (though this need not necessarily be quantitative).

The structure of organizational for monitoring forest carbon stock is the configuration of the hierarchical levels and specialized units and positions within an organization. Field measurement team should be well-organized to better synergize all field measurement activities. The organizational structure of field measurement in MBNP is shown in Figure 10.

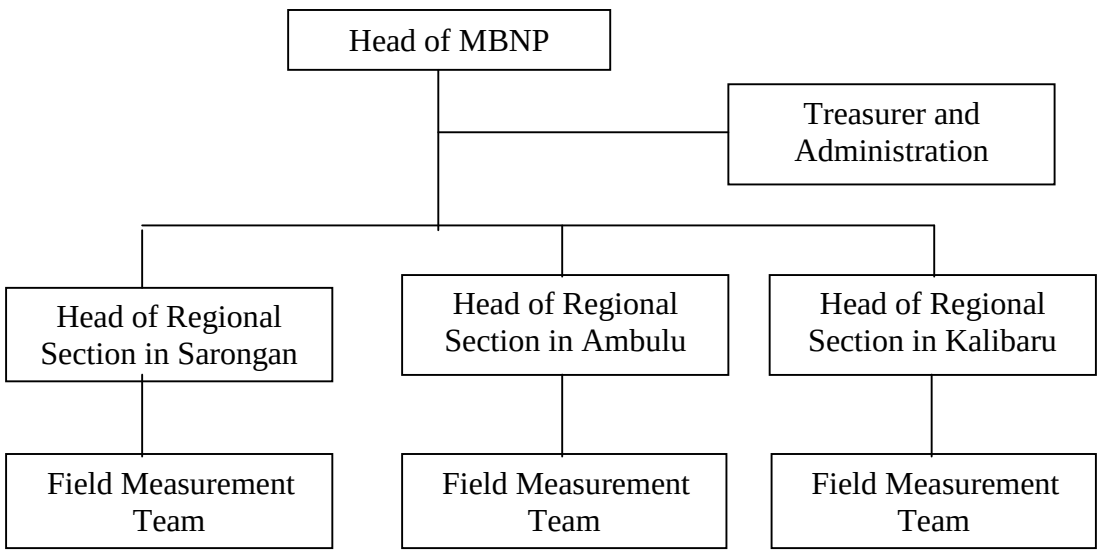

Figure 10. The organizational structure of field measurement in Meru Betiri National Park

Role and responsibility of each member are as follows:

a. Head of MBNP; as head of the institution, Head of MBNP taking overall responsibility of field measurement results.
b. Head of Regional Section; taking responsibility as Team Leader to report the field measurement to the Head of Meru Betiri National Park. Head of Regional Section should coordinate with the field team before, during and after field measurement.
c. Treasurer and Administration; taking responsibility in preparing budget, administration and report after the completion of field measurement. Treasurer and Administration responsible to Head of Meru Betiri National Park and should provide report of each activities being done to the Head of Regional Section.
d. Field Team; conducting field measurement in the forest. Field measurement team consists of staff/technical staff of MBNP and local community surrounding forest. Field Measurement Team responsible to Head of Regional Section.

Field measurement team consists of team leader, field crews and labors. Number of field team personnel (field crew/labor) depends to budget and time available. Number of personnel could be added if there is enough budget and time. Minimal number of field crew and labors needed for each PSP is shown in Table 14. Figure 11 showed the structure of field measurement team.

Table 14. Minimal number of field measurement team personnel in each PSP

No.	Indicators	Field Crew (person)	Labors (person)
1.	Above ground biomass:		
	a. DBH (cm) of stand (saplings, poles and trees)	1	1
	b. Height (m) of stand (saplings, poles and trees)		
	c. Seedlings and shrubs	1	2
2.	Litter	1	1
3.	Soil		
4.	Necromass	1	1
Total		**4**	**5**

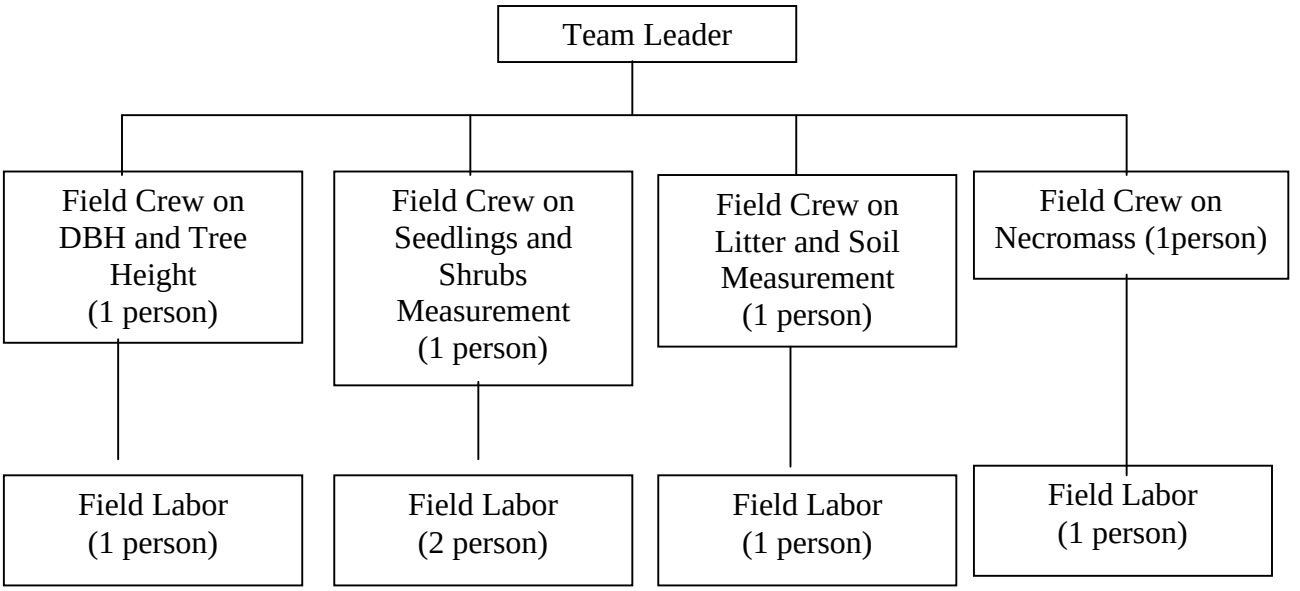

Figure 11. Structure of field measurement team

Database supporting strongly is very important in term of monitoring of forest carbon stock that accountable and transparant. Meru Betiri National Park have established many Permanent Sample Plots that distributed accross in all zone area of national park. It is needed the structured and integrated data management so that its data management will more organized and useful for stakeholders. The organization of data can be done using aplication of database system.

Almost all computer aplication is supported with database facility. Database is the most important component in information system due to its function as collector and organizer of all data inside the system. Database is data groups that linked each other was analyzed and organized became an useful information.

Generally, the objectives of database are: accessibility and speedy in data collecting, efficiency of data storage space, data accuracy, data availability completeness, data security and sharebility.

The establishment of monitoring database of forest carbon stock is very important for data availability and data organization. It is expected that monitoring database can be accessed by all stakeholder fastly in term of suppport the forest carbon monitoring in Meru Betiri National Park.

The database system that was established will be linked to the Meru Betiri National Park's website for purposing the sustainability of monitoring and

reporting of forest carbon stock in Meru Betiri National Park. It is expected that the linking between database system and website can be accessed by stakeholders.

Regarding to the community structure condition, the organizational structure of field measurement and the structure of field measurement team in Meru Betiri National Park, it can be made the flowchart of set up institutional and carbon stock monitoring system in Meru Betiri National Park as shown in Figure 12.

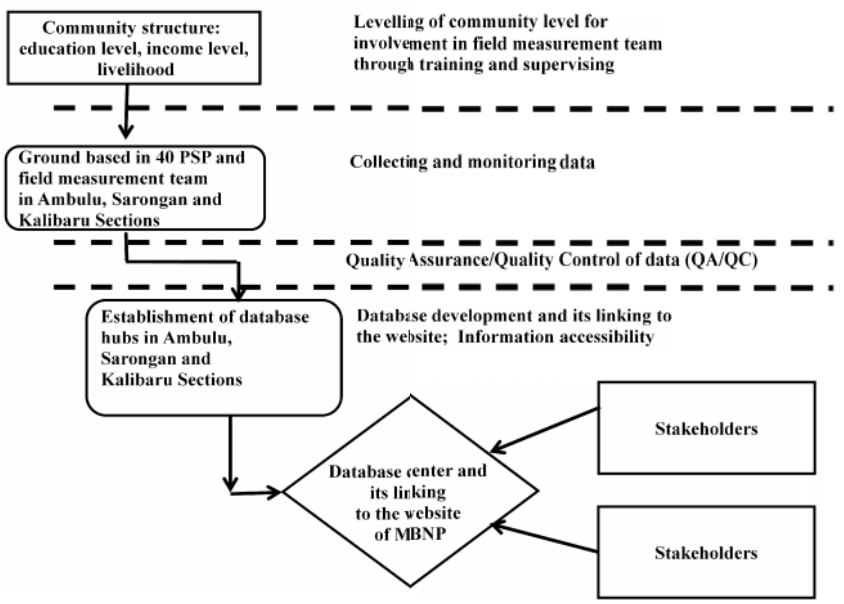

Figure 12. Flowchart of set up institutional and carbon stock monitoring system in Meru Betiri National Park

d. Possible Barriers and Advantages

The involvement of villagers in monitoring forest carbon stocks in Meru Betiri National Park not only give some advantages but also face some possible barriers.

Some possible barriers that will need to be dealt with include:

- Training will be needed to ensure that the strict procedures approved by the IPCC or the others procedures are followed.
- Supervision may be required in early stages.
- Reliability of community measured data would have to be assured.
- Local people might be tempted to exaggerate the carbon stock increases if they are rewarded on the basis of these.

•As with all REDD+ carbon measurements, third party independent verification will be required.

There are in addition multiple practical benefits to involving local people in monitoring of carbon stocks under REDD+:

- A large workforce can be recruited to facilitate collection of large amounts of data across scales not otherwise feasible.
- Villagers or local people surrounding the national park area can complement scientific endeavors with their skills and knowledge that scientists may lack (Berkes *et al.*, 2000) and they can also provide crucial ecological data in national park areas where academic studies have not been executed (Doswald *et al.*, 2007; Aswani & Hamilton, 2004). They are much more knowledgeable about the local area in Meru Betiri National Park.
- Local labor from villagers surrounding the national park area may be partly voluntary and cost will be low and efficient (Moller *et al.*, 2004)

4. CLOSURE AND RECOMMENDATION

A. CLOSURE

If locally based forest monitoring is to become a key element of the MRV of REDD+ schemes, further quantitative assessments of the relative strengths of different locally based forest monitoring methods would be advisable. Danielsen *et al.* (2011) stated that it would be useful also to explore the extent to which community members can monitor other aspects of central importance to REDD+ implementation like governance, livelihoods, and biodiversity.

The linking monitoring to the decisions of local people may help make monitoring more relevant locally and hence sustainable.

B. RECOMMENDATION

The linking between database system establishment and website of Meru Betiri National Park so that it can be accessed by stakeholders.

Socialization and community/villagers recruitment for involving in monitoring of forest carbon stock.

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Annex 1. Questionaire for establishment the income level data baseline of community in the villages surrounding Meru Betiri National Park

KUESIONER
PENYUSUNAN BASELINE DATA TINGKAT PENDAPATAN MASYARAKAT MODEL DESA KONSERVASI BALAI TAMAN NASIONAL MERU BETIRI

Responden	Petugas
.....	.....

A. IDENTITAS RESPONDEN

1. Nama : .....
2. Alamat : .....
3. Umur : .....tahun
4. Jenis Kelamin : a. Pria b. Wanita
5. Pendidikan Terakhir : Tidak tamat SD/SD/SLTP/SLTA/D3/Perguruan Tinggi*
6. Pekerjaan : Utama ..... Sampingan .....
7. Agama : .....
8. Status Perkawinan : Menikah/ Belum Menikah/ Duda/ Janda*
   a. Jika menikah, berapa jumlah anggota keluarga Anda? (..... orang)
   b. Jumlah keluarga yang menjadi tanggungan Anda adalah ..... orang.
9. Latar Belakang :
   a. Penduduk asli/ pendatang*
   b. Jika pendatang, mulai kapan menetap .... tahun, daerah asal ....
   c. Alasan menetap .....

B. TINGKAT EKONOMI RESPONDEN

1. Kepemilikan Lahan :
   a. Sawah : ..... m^2
   b. Tegalan : ..... m^2
   c. Pekarangan : ..... m^2
   d. Total : ..... m^2
2. Kepemilikan Ternak :

Jenis	Jumlah
a.	.....
b.	.....
c.	.....

3. Penghasilan Per bulan : Rp .....
4. Jenis pendapatan dari berbagai macam sumber mata pencaharian :

a. Tani (di luar rehabilitasi)

Pendapatan

Jenis panen	Panen Setahun (kali)	Produksi/ panen (Kg)	Harga/ kg (Rp)	Jumlah (Rp)
1.	.....	.....	.....	.....
2.	.....	.....	.....	.....
3.	.....	.....	.....	.....

Pengeluaran

Jenis tanaman	Pupuk (Kg)	Pestisida (Rp)	Buruh (Rp)	Lain-lain (Rp)	Jumlah (Rp)
1.	.....	.....	.....		
2.	.....	.....	.....		

b. Hasil Hutan

Pendapatan

Jenis hasil hutan	Pengambilan per tahun (kali)	Satuan pengambilan	Harga per satuan	Jumlah (Rp)
1.	.....	.....	.....	.....
2.	.....	.....	.....	.....
3.	.....	.....	.....	.....

c. Lain-lain

No	Mata Pencaharian	Pendapatan (Rp/Tahun)	Keterangan
1	Buruh Tani	.....	.....
2	Pekerja	.....	.....
3	Pedagang	.....	.....
4	.....	.....	.....

5. Pengeluaran keluarga selama satu bulan :

No	Jenis Kebutuhan	Jumlah (Kg)	Nilai (Rp)	Keterangan
1	Pangan	....	....	....
2	Sandang	....	....	....
3	Obat-obatan	....	....	....
4	Biaya Sekolah	.....	.....	.....
5	Transportasi	.....	.....	.....
6	Sosial	.....	.....	.....
7	Selamatan	.....	.....	.....
8	Pajak	.....	.....	.....
9	.....	.....	.....	.....
10	.....	.....	.....	.....
	Jumlah (Dikali 12 untuk dapat data tahunan)			.....

6. Apakah mempunyai usaha sendiri/ home industri : .....
   a. Jenis : .....
   b. Hasil per bulan : Rp .....
   c. Berapa lama : .....
   d. Kendala yang dihadapi : .....

C. PENERIMAAN BANTUAN

1. Apakah pernah menerima bantuan? (Ya / Tidak)*
2. Jika Ya (pernah menerima bantuan) :
   a. Asal bantuan : .....
   b. Jenis bantuan : .....

c. Jumlah : .....

3. Apakah pernah menerima bantuan dari Taman Nasional Meru Betiri ? (Ya / Tidak) *
4. Jika Ya, dalam bentuk apa?
   a. Uang Rp .....
   b. Peralatan ..... , Jenisnya .....
   c. Ternak ..... , Jenisnya .....
   d. Bibit :

No	Jenis	Jumlah	Keterangan
1	.....	.....	.....
2	.....	.....	.....
3	.....	.....	.....
4	.....	.....	.....
5	.....	.....	.....

e. Bantuan lain : .....

D. LAHAN GARAPAN (PERTANIAN/PERKEBUNAN)

1. Apakah Anda mempunyai lahan garapan ? (Ya / Tidak)*
2. Jika Ya, berapa luas lahan yang dimiliki?
   a. Kurang dari 0,25 ha
   b. 0,25-0,5 ha
   c. Lebih dari 0,5 ha
3. Status lahan tersebut ? (Milik sendiri/ Sewa)*
4. Lokasi lahan tersebut ?
   a. Di dalam desa,
   b. Di luar desa, di .....
5. Berapa pendapatan rata-rata yang diperoleh dari lahan garapan selama satu bulan ? Rp .....

E. KELOMPOK TANI REHABILITASI TAMAN NASIONAL MERU BETIRI

1. Nama kelompok tani .....
2. Berapa kali pertemuan anggota kelompok tani dalam satu bulan ? .....
3. Apakah kelompok tani Anda mendapat pembinaan ? (Ya / Tidak)*
   Oleh siapa ? .....
   Berapa kali dalam satu bulan ? .....
4. Berapa luas lahan garapan Anda ? .....
5. Hasil tanaman tumpang sari

Pendapatan

Jenis panen	Panen Setahun (kali)	Produksi/ panen (Kg)	Harga/ kg (Rp)	Jumlah (Rp)
1.	.....	.....	.....	.....
2.	.....	.....	.....	.....
3.	.....	.....	.....	.....

Pengeluaran

Jenis tanaman	Pupuk (Kg)	Pestisida (Rp)	Buruh (Rp)	Lain-lain (Rp)	Jumlah (Rp)
1.	.....	.....	.....		
2.	.....	.....	.....		
3.	.....	.....	.....		

6. Hasil tanaman pokok

Berapa kali tanaman pokok sudah berbuah? .....

Pendapatan

Jenis panen	Panen Setahun (kali)	Produksi/ panen (Kg)	Harga/ kg (Rp)	Jumlah (Rp)
1.	.....	.....	.....	.....
2.	.....	.....	.....	.....
3.	.....	.....	.....	.....

Pengeluaran

Jenis tanaman	Pupuk (Kg)	Pestisida (Rp)	Buruh (Rp)	Lain-lain (Rp)	Jumlah (Rp)
1.	.....	.....	.....		
2.	.....	.....	.....		
3.	.....	.....	.....		

7. Berikan saran Anda untuk pengelolaan tanaman rehabilitasi : .....