REVIEW EXISTING METHODOLOGY OF RESOURCE BASED INVENTORY FOR MEASURING, REPORTING AND VERIFYING (MRV) CARBON ACCOUNTING FOR REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION AND ENHANCING CARBON STOCKS IN MERU BETIRI NATIONAL PARK (MBNP), INDONESIA

Rizaldi Boer
Kirsfianti Ginoga
Nur Masripatin

ITTO PD 519/08/Rev.1 (F):

In Cooperation with
Forestry Research and Development Agency
Ministry of Forestry, Indonesia
Bogor, 2010

REVIEW EXISTING METHODOLOGY OF RESOURCE BASED INVENTORY FOR MEASURING, REPORTING AND VERIFYING (MRV) CARBON ACCOUNTING FOR REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION AND ENHANCING CARBON STOCKS IN MERU BETIRI NATIONAL PARK (MBNP), INDONESIA

ISBN 978-602-95842-5-7

Technical Report No 4/2010, May 2010.

By: Rizaldi Boer, Kirsfianti Ginoga, and Nur Masripatin

This Report of Activity 2.1.1 Is a Part of Program ITTO PD 519/08 Rev.1 (F): Tropical Forest Conservation For Reducing Emissions From Deforestation And Forest Degradation And Enhancing Carbon Stocks In Meru Betiri National Park, Indonesia.
Collaboration Between:

- Pusat Penelitian Sosial Ekonomi dan Kebijakan Departemen Kehutanan
  (Center For Socio Economic and Policy on Forestry Research Ministry of Forestry)
  Jl. Gunung Batu No. 5 Bogor West Java Indonesia
  Phone : +62-251-8633944
  Fax. : +62-251-8634924
  Email : conservation_redd@yahoo.com
  Website : http://ceserf-itto.puslitsosekhut.web.id

- LATIN – the Indonesian Tropical Institute
  Jl. Sutera No. 1 Situgede Bogor West Java Indonesia
  Phone : +62-251-8425522/8425523
  Fax. : +62-251-8626593
  Email : latin@latin.or.id and aaliadi@latin.or.id
  Website : www.latin.or.id

- Meru Betiri National Park Department of Forestry
  Jalan Siriwijaya 53, Jember, East Java, Indonesia
  Phone : +62-331-335535
  Fax. : +62-331-335535
  Email : meru@telkom.net
  Website : www.merubetiri.com

Published by:
Center for Socio-Economic Research and Policy on Forestry-ITTO PD 519/08 Rev.1 (F).
Jl. Gunung Batu No. 5 Bogor 16610
Phone/Fax.: +62-251-8633944
Email : conservation_redd@yahoo.com
Web site : http://ceserf-itto.puslitsosekhut.web.id

LIST OF CONTENT

LIST OF TABLE

LIST OF FIGURE

SUMMARY

One of the key elements for REDD+ implementation is the development of transparent, comparable, coherent, complete and accurate measurement, reporting and verification (MRV) systems. These systems are a guarantee that parties will effectively meet their respective mitigation commitments. A major challenge in implementing this is to find ways of ensuring that local communities, can continue their livelihood or path of economic development open sustainably from the forests, while simultaneously building awaraness raising and capacity for measurable, and reportable verifiable mitigation actions from rehabilitation and conservation. The objectives of this study are to review a credible MRV system for monitoring emission reductions for REDD+, which would be aplicable to implement elsewhere, including Meru Betiri National Park (MBNP). For apllication of MRV the whole potentials stakeholders shall be engaged in the process and develop this MRV system. The study would focused on how should MRV mitigation commitments can be implementable and made comparable, and what does measurable, reportable and verifiable mean in relation to nationally appropriate mitigation actions (NAMA), and how it related to technology, and capacity-building support. In other words, how to develop a national MRV that meet international standard and cost effective need to be established. As a starting point, Ministerial of Forestry Decree No. 30/2009 about Mechanism for REDD in Indonesia provides a general answers to this questions.

Several methods that meet international standards for MRV are explained in great detail, including Intergovernmental Panel Climate Change (IPCC), and Voluntary Carbon Standard (VCS) for further investigation and feasibility for application. For IPCC methods, there are two basic elements needed for the inventory, namely (i) activity data, i.e. Data on the magnitude of a human activity resulting in emissions or removals taking place during a given period of time and and (ii) emission factor, a coefficient that quantifies the emissions or removals of a gas per unit activity. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission or removal for a given activity level under a given set of operating conditions. Activity data is grouped six land use categories i.e., Forest Land, Cropland, Grassland, Wetlands, Settlements, and Other Land. These land categories are further sub-divided into land remaining in the same category and land converted from one category to another.

In brief VCS guidance are as follows: (i) Determining the geographic boundary within which the activities will be implemented, and the types of greenhouse gases (i.e., CO_2, N_2O, CH_4) and sources and sinks that would be covered, and the carbon pools that will consider, (ii) Establishing baseline, (iii) Proving

additionality, (iv) Assesing and managing risk to reduce uncertainty or leakage, and (v) Estimating and monitoring net greenhouse gas benefits, using IPCC GL. Uses of full greenhouse gas accounting, providing annual estimates of overall GHG impacts expressed in terms of CO_2 equivalents employing global warming potentials (gwps). For monitoring net emissions reductions and GHG removals, to be eligible under the VCS, a robust and credible monitoring protocols as denned in the approved methodologies, (vi) Crediting period, for AFOLU should be the same as the life of the project, with a minimum of 20 years and a maximum of 100 years.

It is obvious that to establish system MRV, use of IPCC GL, taking into consideration step wise guidelines fromVoluntary Carbon Standard (VCS) is needed to provide simpler, high certainty, and verifyable. VCS explained in great detail steps by steps guidelined for designing MRV involving communities and relevant stakeholders, while IPCC 2006 GL provide guideline on how to undertake forest inventory and estimate emission reduction or removal of GHGs.

It is proposed that MRV system need to undertake steps as follows: (i) determination boundary of activity, including carbon pool that would be measured, (ii) established baseline, (iii) stratify the area, (iv) identify relevant carbon pool, (v) design sampling framework, (vi) assess and manage potential leakage, particularly from socio and economic driven factors, and (vii) estimation, monitoring and reporting emission reduction or enhancement of removal GHGs. To determine boundary of activity, a visualisation of medium and high resolution of remote sensing data need to be undertaken. In addition, a representative amount of permanent sample plot need to be established for ground truthing to check the accuracy, and increase reliability of data. Approached to determine baseline vary from the simplest to the complex methods. However they are linked to historic emission. Potential risk for leakage need to be assessed and managed. While estimation and reporting of emission reduction or removal are guided by IPCC 2006 method.

RINGKASAN

Salah satu faktor penting untuk pelaksanaan REDD+ adalah pengembangan pengukuran, pelaporan dan verifikasi (MRV) yang transparan, komparabel, koheren, lengkap dan akurat. MRV merupakan jaminan komitmen negara-negara dalam implementasi REDD+. Tantangan untuk membangun MRV adalah bagaimana masyarakat dan para pihak terkait dapat meneruskan dan meningkatkan pembangunan ekonomi secara berkelanjutan dan sekaligus terbangun peningkatan kesadaran dan kapasitas dari kegiatan konservasi dan rehabilitasi. Kajian ini bertujuan untuk mengetahui bagaimana membangun MRV yang kredibel dalam pemantauan penurunan emisi dan penambahan serapan untuk REDD+ yang dilakukan pada Taman Nasional Meru Betiri. Studi ini akan memfokuskan pada bagaimana sistem MRV dapat dilaksanakan dengan metode yang ada, dan komparabel dengan kegiatan mitigasi nasional, serta bagaimana kaitannya dengan teknologi, dan peningkatan kapasitas pendukung yang diperlukan bagi para pihak yang terlibat? Sebagai langkah awal, Peraturan Menteri Kehutanan No. 30/2009 tentang tata cara REDD di Indonesia memberikan gambaran umum untuk menjawab pertanyaan ke arah sana.

Beberapa metode untuk mendukung sistem MRV telah dikaji secara menyeluruh dalam study ini untuk aplikasi MRV, seperti Intergovernmental Panel Climate Change (IPCC), dan Voluntary Carbon Standard (VCS). Untuk metoda IPCC ada dua elemen yang diperlukan untuk inventory, yaitu (i) Data kegiatan, data yang menunjukkan besarnya kegiatan manusia dalam penurunan atau peningkatan emisi pada periode tertentu, (ii) Faktor emisi, suatu koefiesien yang menunjukkan tingkat emisi atau serapan per unit kegiatan. Faktor emisi umumnya didasarkan pada perhitungan emisi atau serapan data rata-rata sampel per kegiatan per periode. Data kegiatan dikelompokan dalam enam kategori lahan, yaitu lahan hutan, lahan pertanian, padang rumput, lahan basah, pemukiman dan lahan lainnya. Kelompok lahan ini kemudian dibagi lagi kedalam bagian lahan yang dikonversi ke lahan lainnya atau tetap.

Untuk Voluntary Carbon Standard pada Pertanian, Kehutanan, dan Perubahan Penggunaan Lahan (AFOLU), proses untuk MRV terdiri dari beberapa tahap. Pertama, identifikasi skope kegiatan termasuk menentukan batasan geografis pelaksanaan kegiatan, tipe gas rumah kaca yang akan diukur (CO_2, N_2O, CH_4), dan pool perhitungan emisi dan serapan. Kedua, menentukan baseline termasuk memperkirakan unit voluntary carbon yang akan dihasilkan. Ketiga, membuktikan adanya penambahan atau additionality, termasuk validasi dari metodologi, yang merupakan urutan bagaimana memperkirakan emisi atau serapan. Keempat, menelaah dan mengelola resiko untuk mengurangi ketidakpastian atau kehilangan karena kebocoran. Kelima, memperkirakan dan memantau perbedaan bersih emisi

atau serapan dibandingkan dengan tingkat baseline, dan keenam, mengidentifikasikan dampak potensi negatif terhadap lingkungan dan sosial ekonomi serta upaya untuk menguranginya. Karena itu secara umum, untuk VCS perlu ditetapkan sebagai berikut: (i) pool karbon yang akan dihitung, memperkirakan emisi atau serapan per tahun dalam CO_2e, (ii) kejelasan dan kredibilitas metodologi pemantauan penurunan emisi, (iii) periode kredit untuk pemantauan, untuk AFOLU minimum 20 tahun dan maximum 100 tahun.

Untuk membangun sistem MRV, aplikasi metoda IPCC 2006 GL, dengan dukungan step tahapan kegiatan dari Voluntary Carbon Standard diharapkan akan memberikan sistem MRV yang sederhana, akurat dan dapat diverifikasi. VCS menjelaskan secara rinci langkah yang perlu dilakukan untuk merancang sistem MRV yang sekaligus dapat melibatkan parapihak dalam pelaksanaannya sementara IPCC 2006 GL menerangkan bagaimana untuk melakukan inventarisasi GHG dan memperkirakan serta melaporkan pengurangan emisi dan peningkatan serapan GHG.

Karena itu diusulkan untuk sistem MRV dilakukan langkah langkah sebagai berikut: (i) menentukan batas kegiatan, termasuk pool karbon yang akan dihitung, dalam hal ini perlu dilakukan visualisasi pengindraan jauh dengan resolusi sedang dan tinggi yang didukung oleh data lapang dari permanen sample plot, (ii)menentukan baseline berdasarkan beberapa pendekatan, (iii)stratifikasi area, (iv) identifikasi pool of carbon, (v) desain untuk sampling, (vi) identifikasi dan menentukan cara minimisasi potensial resiko dan kebocoran, dan (vii) memperkirakan, memantau dan melaporkan pengurangan emisi atau peningkatan serapan GHG dengan menggunakan IPCC 2006 GL.

I. INTRODUCTION

1.1. Background

At the global level, loss of tropical forest is often associated with the increasing level of atmospheric carbon-dioxide, which in turn accelerates the process of global warming. Forest analysts agree that the reasons for forest clearing are complex. However, it is widely accepted that increasing population pressure, combined with others social, economic and institutional pressures, play role in causing deforestation, forest degradation and non-conservation behaviour. In this case, it is worth to note that a substantial portion of deforestation can be attribute to farmers, communities, and related stakeholders. It is also important to understand why and under what mechanism communities clear forest, and what incentives would increase their participation to conserve the forest, and induce awareness of how serious the effects of clearing the forest on erosion, flooding, and hydrological balance.

REDD+[1], which hopefully would take into action in 2012, are the global mechanism that would provide positive incentive for communities, public and private stakeholders through their participation in reducing emission from deforestation and degradation, forest conservation, sustainable forest management and enhancement of forest carbon stocks. Natural parks as conservation forests are good places for for understanding reducing emission from deforestation and degradation as well as conserving and enhancing carbon stocks. One of national parks, Meru Betiri National Park (MBNP), is a representative areas with many of the challenges usually faced in reducing illegal logging, forest encroachment and managing forest conservation in one side and poverty reduction of community living surrounding the forest on the other side. This is important as Indonesia has large areas of conservation forest, amounting to about 18 per cent of the forest jurisdiction area of 126.8 hectares (Forestry Statistic, 2006).

[1]Reducing emissions from deforestation and forest degradation (REDD); and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (+) in developing countries. Scope of activities include all activities which result in reducing emissions, increasing removals, and stabilization of carbon stocks in forestry sector at national level. Within sub national level include reduction in deforestation rate, reduction in forest degradation, maintaining and enhancing forest carbon stocks through forest conservation, incremental change in forest cover, sustainable management of forest, increase forest cover due to afforestation and reforestation, and other land management.

One of the key elements for REDD+ implementation is the development of transparent, comparable, coherent, complete and accurate measurement, reporting and verification (MRV) systems. These systems are a guarantee that parties will effectively meet their respective mitigation commitments. A major challenge in implementing this is to find ways of ensuring that local communities, can continue their livelihood or path of economic development open sustainably from the forests, while simultaneously building awaraness raising and capacity for measurable, and reportable verifiable mitigation actions from rehabilitation and conservation. Local communities are dependent on the species diversity and ecosystem services of natural forests to maintain their way of life, and they also play a crucial role in conservation of forests, including maintaining and monitoring activities to manage forests sustainably. It is therefore essential to mitigate climate change, and safeguard the interests of local communities.

1.2. Objective

The objectives of this study are (i) to review a credible MRV system for monitoring emission reductions from REDD+, (ii) to review existing approaches and methods to assess and monitor forestry and other natural resources, land use and management practices (iii) to develop an MRV approach appropriate for Meru Betiri National Park (MBNP), one of conservation forest facing the above challenges, and (iv) to briefly assess the effective institutional system for the MRV.

II. CONCEPTUAL FRAMEWORK

The first part of this report decribes general conceptual framework of the study on MBNP on how to improve the livelihoods of local communities living inside and in the surrounding area of MBNP through participation in avoiding deforestation, degradation, biodiversity conservation as well as developing MRV system. The second part provide overview of the MRV system and existing approaches and methods to assess and monitor forestry and other natural resources, land use and management practices, in order to provide a qualitative and quantitative information on the state, use, management and trends of these resources and the ecosystems. The assessment covers a wide range of biophysical and socio-economic variables, and thus provides a holistic view of land use and its impacts for the forest ecosystem as a whole. In particular, the information can be used to plan, design and implement national and international policies and strategies for REDD+ and REDD+, and to understand the relationship between resources and users of resources. The third part describes MRV system suitable for MBNP, taking into consideration relevant COP decision and REDD strategy in Indonesia and possible institutional arrangement for the MRV.

The general framework and approach of the study is presented in Figure 1. On the left hand side of the Figure 1 shows local problems (Problem 1). These include lack of participation, awareness and institusional problem that creates a demand for improvement of participatory mechanism from local, national and global level. On the right hand side is a problem within natural park areas, which tend to have lack of conservation behavioural activities from the communities, deforestation and forest degradation (Problem 2).

To mitigating Problem 1, a process to deal with communities, public and private stakeholders in the management of MBNP in relation to its conservation goal, has to be developed. In this study the steps followed by the process is the following: (i) conduct consultation process participated by all local stakeholders, and assess how the future risk might look like and impact on the livelihood of the community, (ii) promote existing initiatives to empower community involvement in conservation through various schemes, (iii) enhance community-forest partnership, and self controlling for development of goods and services which provide various alternative benefits including sources of income to community, and (iv) scale up and replicate the successful lessons learnt and good practices of agro-forestry to wider communities and areas of the MBNP. Potential risk that may emerge from the conflict of interest between local communities and the management of the Park would be minimised through for example the utilization of goods and services from the area, in traditional and commercial perspectives.

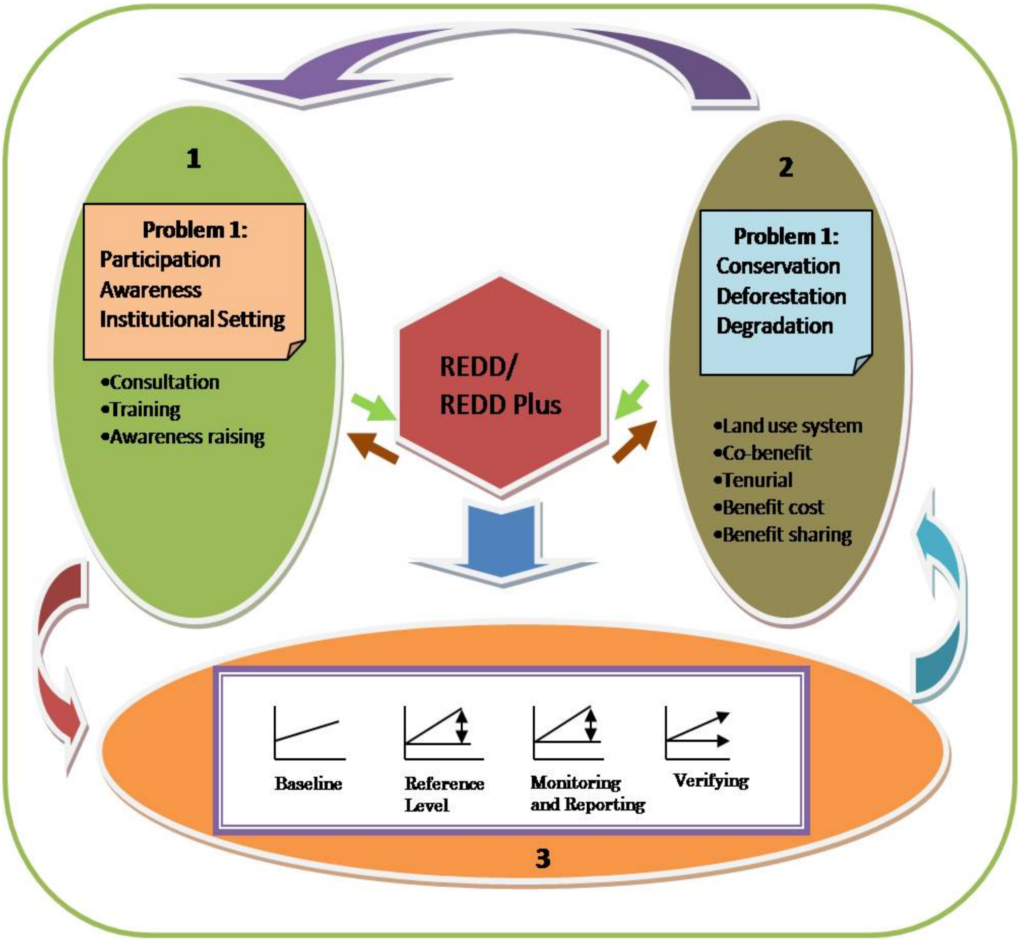


Figure 1. Research Framework of the Study

In addition, to overcome the lack of institutional setting for conservation and combating illegal logging, an integrated approach involving various roles of public and private stakeholders will be identified and further discussed. This approach will contain both law enforcement for combating illegal logging and community prosperity enhancement. Successful approach for REDD+ in the MBNP will be explained and documented based on what have been implemented and observed in the field and in the surrounding area.

For mitigating Problem 2, capacity in measuring, reporting and verifying resource base inventory and carbon accounting should be improved. This includes capacity in producing a report on comprehensive baseline data and estimation of emissions reduction and carbon stock enhancement, which is based on a established and validated robust system for monitoring emission reduction and enhancement of carbon stocks.

As a whole, programs for addressing the two problems is divided into three phases. Phase 1 will be from 2010-2011. The main activities in this 1st Phase are to establish comprehensive framework for stakeholders engagement and to establish Permanent Sampling Plot (PSP)-Data collection for Carbon Accounting. Phase 2 from 2011-2012 is to consolidate Phase 1 and to develop activities for Phase 2 (applied methods for carbon accounting). Phase 3 from 2012-2013 is to develop comprehensive capacity (communities, public and private) and comprehensive capability (all pools and applied tool), and to disseminate lesson learnt and good practices.

III. OVERVIEW OF EXISTING APPROACH AND METHODOLOGY

Stabilization levels of atmospheric carbon-dioxide to avoid further impact of climate change is clearly set in the IPCC AR 4. It is clear that to avoid the increase of atmospheric tempherature beyond 2°C need the lowest stabilization level of 450 ppm CO_2-eq. For achieving that level, developed countries need to reduce their aggregate emissions by 25-40% from 1990 levels by 2020, and 80-95% by 2050 (Table 1). While developing countries have to take action to reduce emission growth, i.e. keep emissions below business as usual (BAU) emission trend, and increasing the gap between BAU and the actual emissions path. In this case both developed and developing countries need National Appropriate Mitigation Actions (NAMAs), combined with policy and positive insentives.

Table 1. Level of emission reductions and deviations from baseline for various stabilization levels for Annex I and non-Annex I countries (IPCC, 2007, Box 13.7)

Scenario	Region	2020	2050
440 ppm CO_2-eq	Annex 1	-25% to – 40%	-80% to – 95%
	Non-Annex	Substantial deviation from baseline in Latin America, Middle East, East and Asia	Substantial deviation from baseline in all regions
550 ppm CO_2-eq	Annex 1	-10% to – 30%	- 40%to – 90%
	Non-Annex 1	Deviation from baseline in Latin America and Middle East, East Asia	Deviation from baseline in most regions, especially in Latin America and Middle East
650 ppm CO_2-eq	Annex 1	0% - 25%	-30% to - 80%
	Non-Annex 1	Baseline	Deviation from baseline in Latin America and Middle East, East Asia

As mandated ini Decision 1/CP.13 of the Bali Action Plan, the study would focused on how should measurable, reportable and verifiable mitigation commitments be made comparable, and what does measurable, reportable and verifiable mean in relation to nationally appropriate mitigation actions, and how it related to technology, finance and capacity-building support. In other words, a national MRV that meet international standard and cost effective need to be developed. To do this, a break MRV down into its components, i.e., measurable, reportable, and verifyable and focus what is meant by measurable, reportable and verifiable would be undertaken to better understood the details of technical parameters. The outcome of the MRV system will be a National forest GHG Inventory to report on REDD+ activities to the UNFCCC Secretariat.

The most common approach to estimate GHG emissions is the IPCC methods. In addition Voluntary Carbon Standard (VCS) provides a step-wise guidance for dealing with methodological issues associated with Agriculture, Forestry and Other Land Use (AFOLU) projects. These two methods would be elaborate in great detail below.

3.1. Voluntary Carbon Standard (VCS)

The VCS was initiated by the Climate Group, consisting of the International Emission Trading Association (IETA) and the World Economic Forum in 2005 and has the backing of the World Business Council for Sustainable Development and several NGOs. With the collaboration of risk experts, investors, NGOs and project developers, the VCS developed the Agriculture, Forestry and Other Land Use (AFOLU) program in 2007. The Voluntary Carbon Standard (VCS) has a quality standard for voluntary carbon offset, including forestry carbon offset. The recent review (Lopes, 2009) found that VCS scores one of the best across a range of criteria to ensure that carbon credits are "real, verified, permanent, additional and unique and meet international standard for forestry carbon credits. The review was based on information available from the VCS website (Voluntary Carbon Standard, 2009); Tool for AFOLU Methodological Issues (VCS, 2008a); and Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination (VCS, 2008b).

In general, VCS guidance for MRV need to consider several aspects, as follows (VCS, 2008a):

1) Using recogniced methodological guidance, such as IPCC2006 GL,
2) Need to determine the land eligibility,

3) Define boundary, including types of anthropoghenic GHGs and pool of carbon,
4) Establishing baseline,
5) Assessing and managing leakage or displacement of activity, and
6) Estimating and monitoring net project greenhouse gas benefits.

Using recogniced Methodological Guidance. In general, every AFOLU activities, need to measure, estimate and monitor all significant GHG sources, baseline, and reference scenario level[2]. To to this, determination and quantification of the baseline and reference scenario, including the leakage assessment shall follow recogniced and standard guideline such as IPCC 2006 GL for AFOLU.

Determining the land eligibility or identifying scope of activity. VCS include Agriculture, Forestry and Other Land Uses (AFOLU) in the list of eligible activities. There are four categories of AFOLU, i.e., Afforestation, Reforestation and Revegetation (ARR), Agricultural Land Management (ALM), Improved Forest Management (IFM), and Reducing Emissions from Deforestation (RED) that need to be clearly defined. In this case, REDD+ as mandated by Bali Action Plan are eligible under VCS. Distinction between these land activities need to be described to remove potential overlap and gap.

For REDD activities, the term "forest" must have been attached for a minimum of 10 years prior to the start date. Common forest definition are three threshold parameters i.e., minimum forest area, tree height and level of crown cover. Under the Kyoto Protokol, a “forest” is defined according to these three parameters as selected by the host country. As for Indonesia, these three parameter are minimum forest area of 0,25 ha, tree hight $\geq$5m, and level of crown cover $\geq$30% as mentioned in Ministerial of Forestry Decree No. P. 14/Menhut-II/2004 about Clean Development Mechanism (CDM). In this regard, the definition of forest may also include result from remote sensing analysis required from Activity Data of IPCC 2006 GL, as long as, the forest term meet the requirement of host country threshold level and consistently used.

Determining boundary. The term boundary refers to all anthropogenic emissions by sources and/or removals by sinks of GHGs arising from activities and practices under the control of the project proponent. In a general sense, project boundaries can be thought of in terms of geographical area, temporal limits (project duration), and in terms of the project activities and practices

[2] Reduction in emission of GHGs and/or enhancement of stock from REDD+, estimated based on measurement of past and future emission

responsible for greenhouse gas emissions and removals that are significant and reasonably attributable to the activities undertaken within.

Spatial boundaries of the lands need to be clearly established so as to facilitate accurate measuring, monitoring, accounting, and verifying of activities. These boundaries need to be identifiable by all stakeholders including proponents and stakeholders. When describing physical boundaries, the following information is worthy to include (IPCC, 2003): (i) Name of the area, (ii) Map(s) of the area (paper format and/or digital format, if available), (iii) Geographic coordinates, (iv) Total land area, (v) Details of ownership/ jurisdiction and (vi) Land use and management history of the selected site(s).

It is expected that the boundaries remain unchanged during the duration of the project. In the event that boundary changes are inevitable, subject to the rules agreed for projects, then these would need to be reported and inclusions and/or exclusions of physical land area need to be surveyed using the above described methods.

There are several methods and tools employed to identify and delineate physical project boundaries. These include, amongst others, the following: (i) Permanent boundary markers (e.g., fences, hedgerows, walls, etc.), (ii) Remote sensing data e.g., satellite imagery from optical and/or radar sensor systems, aerial photographs, etc., (iii) ground-based surveys to delineate property boundaries, (iv) Global Positioning Systems, (v) National certified topographic maps with clearly defined topographic descriptions (e.g., rivers/creeks, mountain ridges); and (vi) Other nationally recognized systems (e.g., National park, etc). Any or combination of these methods or tools can be choose provided accuracy is maintained.

In determining boundary, the crediting period need also to be estimated, as well as sources and sinks of emission reduction or removal from greenhouse gases (GHG) such as CO_2, N_2O, CH_4. The types of the carbon pools that will consider need to be clearly set. The selection of carbon pool and type of GHG included will depend on the significance of the pool and selected tier for each land category.

For estimating GHG emission or removal from each carbon pool, the representative permanent sample plots (PSPs) need to be established for ground truthing. There are some guidelines for establishing PSPs (Cf., Asmoro, 2009, Hairiah and Rahayu, 2007, Hairiah *et al*., 2001a and b).

Establishing baseline. Baseline refers to the scenario that reasonably represents the anthropogenic emissions by sources and anthropogenic removals by sinks of greenhouse gases that would occur in the absence of the proposed activities. Baselines can also be seen as the future projection of emissions from deforestation and degradation under the absence of REDD or a reference for measuring reductions in emissions from deforestation and degradation. This implies the need to assess potential greenhouse gas emissions and removals in a manner and consistent with associated activities in the project. A baseline shall cover emissions from all gases, and source categories within the project boundary.

In general, there are three approach for baseline methodology, i.e., (i) Historical approach, including a straight projection of the past, and an average of the past, (ii) Modeling approach, it is modeled on planned land use spatial and non spatial model, and (iii) Other approaches, this approach to be discussed and negotiated in SBSTA.

On the regional scale, modelling is proving successful for predicting future emissiom from deforestation and degradation, once the drivers were correctly identified. Various models are already available and others are under development, with a view to identifying the vulnerability of forest areas to deforestation and degradation. Factors that have been identified as important are accessibility (closeness to roads, rivers, settlements, agricultural areas and slope) and pressure on land (population density, markets, tenure, among others). Various studies found a close relationship between deforestation and one or more of these factors expressed spatially in maps, and the degree of correlation between deforestation and its drivers can be analysed (Castillo-Santiago *et al.*, in press). With these tools, a vulnerability index could be created for each forest area (de Jong *et al.*, 2005; Castillo-Santiago *et al.*, in press). Brown (2007) compared various modelling approaches and found that they gave comparable results over short time scales of 5–10 years and that spatially specific models could improve the prediction of where deforestation would take place as can be seen in Figure 2 (Skutsch, *et al.*, 2007).

Soares-Filho *et al.* (2006) have used such a model to estimate future deforestation rates over the whole Amazon Basin under different management scenarios, including not only traditional conservation measures, but also different levels of enforcement of environmental legislation, the paving or non-paving of major roads, etc., and from this have estimated carbon emissions per scenario (using the approximation that 85% of the carbon contained in forest trees is released on deforestation). This demonstrates the enormous carbon gains that can be made through different management regimes, but more particularly, the value of such modeling as a tool for making predictions.

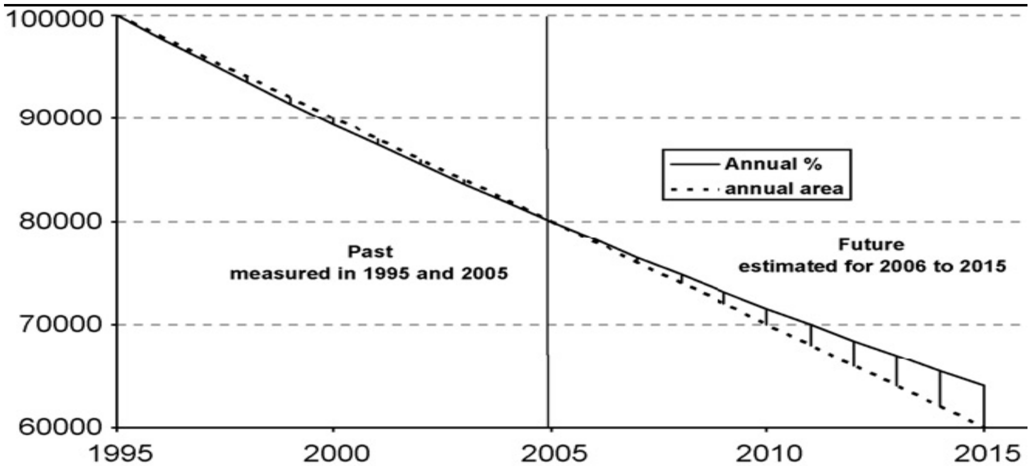


Figure 2. Baselines constructed on annual area of forest loss versus percent of remaining forest lost (Skutsch, 2007).

Baseline emission scenarios created by these models involve two steps: (i) the future deforestation trend is estimated based on comparison of historical land-use maps separated by a number of years, using either the annual percentile rate of deforestation or simple linear estimates (the difference may be significant, as shown in Figure 2, and (ii) estimate the carbon densities of the forests predicted to disappear in the future. The biomass densities of these forests are estimated from the most recently available inventory data.

Assess and manage leakage. Leakage is defined as any increase in greenhouse gas emissions that occurs outside boundary, but is measurable and attributable to the project activities. Its effects on all carbon pools shall be assessed and significant effects taken into account when calculating net emission reductions. Accounting for positive leakage is not allowed. Leakage caused by market effects is not considered except for the case where timber production is significantly affected.

The risk of non-permanence i.e., the potential reversibility of sequestered/ protected carbon must be addressed clearly. Because VCS does not include mandatory future verification of the carbon benefits previously claimed, an accounting method must be employed that credibly, yet cost-effectively, deals with this non-permanence issue. To do this, the adequate amount of buffer reserves of non-tradable carbon credits to cover unforeseen losses in carbon stocks need to be reserved. The amount of buffer credits that a given project must deposit into the pooled VCS buffer account is based on an assessment of the potential future carbon loss.

To minimise leakage, it is needed to: (1) undertaking the initial risk assessment, which must consider both transient and permanent potential losses in carbon stocks; and (2) determining the appropriate buffer reserve based on guidance provided in this document. This self risk assessment must be clearly documented and substantiated where possible. During verification, the VCS verifier will evaluate the risk assessment and adjust it as appropriate before Voluntary Carbon Units (VCUs) can be issued. The risk assessment can be seen in Table 2.

Table 2. Risks Assessment to reduce leakage

Type of Risk	Driver
General	Unclear land tenure and potential for dispute
	Financial failure
	Technical Problem
	Mis-management
Economic	Land encroachment, Income shortage, rising land price
Regulatory and social	Political instability, Social instability Lack for monitoring and enforcement
Natural disturbance	Forest fire
	Incidence of pest and disease
	Extreme climatic events (e.g. floods, drought, winds)
	Volcanoes, earthquakes, landslides

Estimate and monitor net project greenhouse gas benefits. The IPCC 2006 Guidelines shall be used for estimating $CO_{2\text{-}e}$, sink enhancement, and reductions in forest carbon stocks caused by removals of biomass exceeding regrowth. These Guidelines shall also be followed in terms of quality assurance/control and uncertainty analysis.

In addition to approving complete methodologies, the VCS will support innovation by approving new simple, consessive and transparent tools with cost effeftive. Community and/or environmental impacts of projects are another important factors to take into account under this process. The VCS encourage stakeholders consultation process, and to use relevant tools and best-practice standards to ensure that projects are appropriately designed, and where possible generate social and environmental benefits beyond climate change mitigation.

Therefore, steps for MRV based on VCS guidance are as follows: (i) Determining the geographic boundary within which the activities will be implemented, and the types of greenhouse gases (i.e., CO_2, N_2O, CH_4) and sources and sinks that would be covered, and the carbon pools tha will consider, (ii) Establishing baseline, (iii) Proving additionality, (iii) Assesing and managing risk to reduce leakage, and (iv) Estimating and monitoring net greenhouse gas benefits, using IPCC GL. Uses of full greenhouse gas accounting, providing annual estimates of overall GHG impacts expressed in terms of CO_2 equivalents employing global warming potentials (GWPs). For monitoring net emissions reductions and GHG removals, to be eligible under the VCS, a robust and credible monitoring protocols as denned in the approved methodologies, (v) Crediting period, for AFOLU should be the same as the life of the project, with a minimum of 20 years and a maximum of 100 years.

3.2. IPCC GL

IPCC methods as international recognised standard, has been used for measuring GhGs inventory in Indonesia National Communication 2009. This methods provide choice of land representation approach and emission estimation (tier), as can be seen in Table 3. While the most demanding approach is using spatially specific data from interpretation of remote sensing data and tier 3 for estimating emission.

Table 3. Land Representation and Accounting

Approach for activity data: Area Change	Tiers for emission factors: change in C stocks
1. Non-spatial country statistics (e.g. FAO) – generally gives net change in forest area	**Tier 1 (basic).** IPCC default mean annual increment (for degradation) and/or forest biomass stock (for deforestation) values for broad continental forest types—includes six classes for each continental area to encompass differences in elevation and general climatic zone; default values given for all vegetation-based pools
2. Based on maps, surveys and other national statistical data	**Tier 2 (intermediate).** Country specific data: Mean annual increment and/or forest biomass values from existing forest inventories and/or ecological studies. Default values provided for all non-tree pools. Newly-collected forest biomass data.
3. Spatially specific data from interpretation of remote sensing data	**Tier 3 (most demanding).** Repeated measurements of trees from permanent plots and/or calibrated process models. Can use default data for other pools stratified by in-country regions and forest type, or estimates from process models.

For inventory of GHG, IPCC has developed methods that have been broadly applied by countries ratifying the UNFCCC. This method provides steps and data required for measurement, monitoring, and reporting changes in emissions. This method can also be used as a tool to determine the emission level (REL) or the reference level of emissions (baseline). In this way the IPCC has developed methods for 3 times, the method of the IPCC in 1996, the revised 1996 IPCC Guideline, the IPCC Good Practice Guidance (GPG) in 2003 and 2006 IPCC Guideline. IPCC method development can be seen in Table 4.

Table 4. Development of IPCC Methods 1996, IPCC GPG 2003, and the IPCC GL 2006

Description	IPCC 1996	IPCC GPG 2003	IPCC 2006
Name	LUCF	LULUCF	AFOLU
The number of categories of land/ Source emission or absorption	5	6	6
carbon pool			6 carbon pool
Method	Simple	More Complete	Complete
Complete Complete Accuracy/	Tier 1	Tier 1- Tier 3	Tier 1-Tier3
Data and information	Global	Specific Location	Global and Specific Location
GHGs	CO_2	CO_2 and Non CO_2	CO_2 and Non CO_2 from soil,

Significant differences occurred from 1996 to the IPCC revised 2003 IPCC GPG mainly because land cover changes to 6 categories of Forest Land, Crop Land, Grass Land, Wet Land, Settlement, and Other Land. It is expected that by implementing these six categories of land will produce an inventory of land cover changes more accurately, and reduce uncertainty (reduced uncertainty), and consistent in the distribution of land categories. This method also requires the need to estimate absorption/emission for all categories of land, stock and non-CO_2 carbon relevant.

Processes or stages required to conduct an inventory of emissions by IPCC GL 2006 can be seen in Figure 3. In general, there are two basic elements needed for the inventory, namely (i) the activities of data from land uses changes on 6 categories of land, namely a land change matrix (LCM) or a matrix of land changes, and (ii) emission factor/removal, the ability of vegetation/forest/

carbon pool to grow and store carbon. Databases for LCM is the mapping result from satellite data. Inventory process begins with the interpretation and analysis of remote sensing. Then made adjustments to land cover categories in accordance with the IPCC GL 2006 of 6 categories of land, as shown in Table 5.

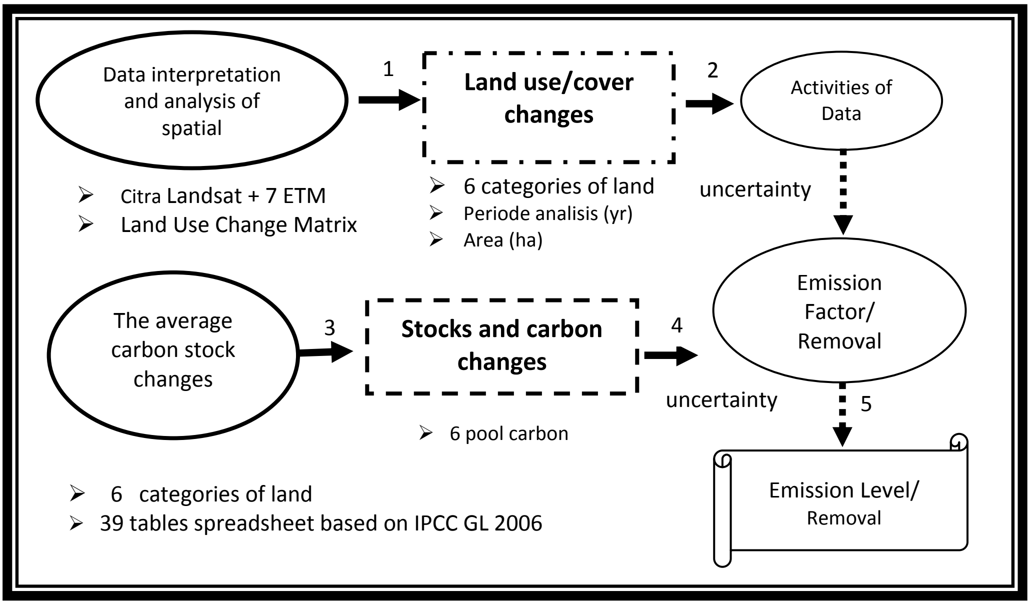


Figure 3. Step of GRK Inventory

Activities of data analysis on each land category start with: i) visual interpretation of remote sensing data, ii) ground truthing, iii) assessment of accuracy (Accuracy assessment), re-interpretation, iv) activities to improve the reinterpretation of the results that have been made based on groundtruthing information, and v) making land cover change matrix or LCM. In this analysed, land cover are analysed for every 3 years, according to the condition of inventory data that have been done in the Directorate General of Planning, Ministry of Forestry. The data included in the calculation are based on formated Excel worksheet of IPCC Table amounted to 39, as shown in Table 6.

Table 5. Adjustment of Land Category With IPCC GL 2006

Forestry Department statistic	**Adjustment with IPCC GL 2006**
23 categories of land	6 categories of land
1. Forest (7 categories): 1) Primary Dryland Forest 2) Econdary Dryland Forest 3) Mangrove Forest Primary 4) Secondary Mangrove Forest 5) Swamp Forest Primary 6) Swamp Forest Secondary 7) Forest Plantation 2. Non-forest (14 categories): 8) Agriculture dryland 9) Dry land Agriculture and shrubs 10) Plantation 11) Rice 12) Shrub/scrub 13) Savana 14) Kingfisher swamp 15) Swamp 16) Transmigration 17) Settlement 18) Pond 19) Land open 20) Mining 21) Port of air/sea 3. No data (category 2), 22) Cloud 23) No data	1. Forest land (4 sub categories) 1) Dryland Forest 2) Mangrove Forest 3) Swamp Forest 4) Forest Plantation 2. Crop land (3 subcategories), 5) Dryland Agriculture 6) Plantation 7) Rice 3. Grass Land (1 sub categories),: 8) Grass Land 4. Wetlands (1 sub categories), 9) Swamp 5. Settlements (1 sub categories), 10) Settlement 6. Other Lands (1 sub categories), 11) Pond, Cloud

Table 6. IPCC 2006 GL Worksheet AFOLU

No	Category	Table Calculation
1	Forest Land	A1. Forest – Remaining Forest (AG and BG biomass)
2		A1. Forest – Remaining Forest (Harvest)
3		A1. Forest – Remaining Forest (Fuel wood)
4		A1. Forest – Remaining Forest (Disturbance)
5		A1. Forest – Remaining Forest (Peat soils)
6		A2. Land – Converted Forest (AG and BG biomass)
7		A2. Land – Converted Forest (Harvest)
8		A2. Land – Converted Forest (fire wood)
9		A2. Land – Converted Forest (Disturbance)
10		A2. Land – Converted Forest (DOM)
11		A2. Land – Converted Forest (Mineral soils)
12		A2. Land – Converted Forest (Organic soils)
13	Crop land	B1. Crop land – Remaining Crop land (AG and BG)
14		B1. Crop land – Remaining Crop land (mineral)
15		B1. Crop land – Remaining Crop land (Organik)
16		B2. Land – Converted Crop (AG dan BG Biomasss)
17		B2. Land – Converted Crop (DOM dan serasah)
18		B2. Land – Converted Crop (Mineral)
19		B2. Land – Converted Land Petanian (Organik)
20	Grass land	C.1 Grass land – Remaining Grass land (Mineral)
21		C.1 Grass land – Remaining Grass land (Organik)
22		C2. Land – Converted Grass land (AG dan BG biomass)
23		C2. Land – Converted Grass land (DOM dan serasah)
24		C2. Land – Converted Grass land (mineral)
25		C2. Land – Converted Grass land (organik)
26	Wet land	D1. Wet Land – Remaing Wet land (CO_2_peat)
27		D1. Land – Converted Wet land (CO_2_peat)
28		D1. Land – Wet Land (CO_2_peat)
29		D1. Land – Wet Land (N_2O_peat)
30		D2. Land – Converted Wet land (N_2O_peat)
31		D2. Land – Converted Wet land(CO_2_Flooded)
32	Settlement	E.1. Settlement – Remaining Settlement (Organik 1 of 1)
33		E.2. Land – Converted Settlement (Biomasss1 of 1)
34		E.2. Land – Converted Settlement (DOM, necromas)
35		E.2. Land – Converted Settlement (Mineral)
36		E.2. Land – Converted Settlement (Organik)
37	Other Use	F.2. Land – Converted to others land use (Biomass)
38		F.2. Land – Converted to other land use (Mineral)
39		F.2. Land – Converted to other land use (Organik)

IPCC Guidelines provide options for measuring transparent, consistent, comparable, complete, accurate, verifiable, and efficient recording and reporting carbon stocks and change by sources and removals from land use change in which either one or combination of the two approaches, i.e., land based approaches and activities based approaches could be adopted. (Figure 3) (IPCC, 2006). A "land-based" approach in carbon accounting, stars with understanding the change of carbon stock in six carbon pools on lands containing activities. This involves first defining the applicable activities, and in the next step identifying the land units on which these activities occur. Next, the change in carbon stocks on these land units during the relevant period is determined. It needs also to be clear whether a non-CO_2 greenhouse gas emission estimates would also need to take into acount. Some modifications could be made regarding, for example, baselines, leakage, timing issues, permanence, and uncertainties.

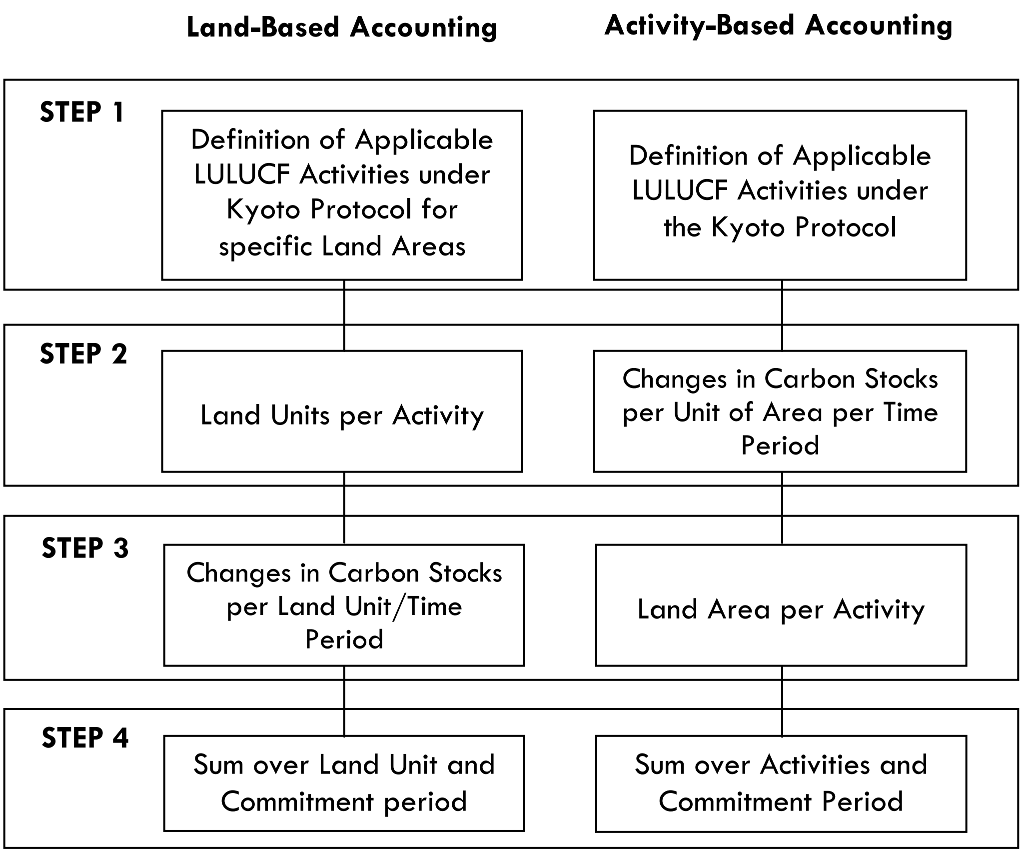


Figure 4. Accounting Approaches (IPCC, 2006).

The estimate of the emission is done by relating information on the extent to which a human activity takes place (activity data, AD) to coefficients that quantify the emissions or removals per unit activity (emission factors, EF). In response to this, the Measurement and Reporting components of the proposed MRV system consist of the following three components (Figure 2): (1) a Satellite Land Monitoring System to assess activity data on forest area and forest area changes; (2) a National Forest Inventory to assess emission factors on carbon stocks and carbon stock changes; (3) a National GHG Inventory to estimate and report anthropogenic emissions by sources and removals by sinks.

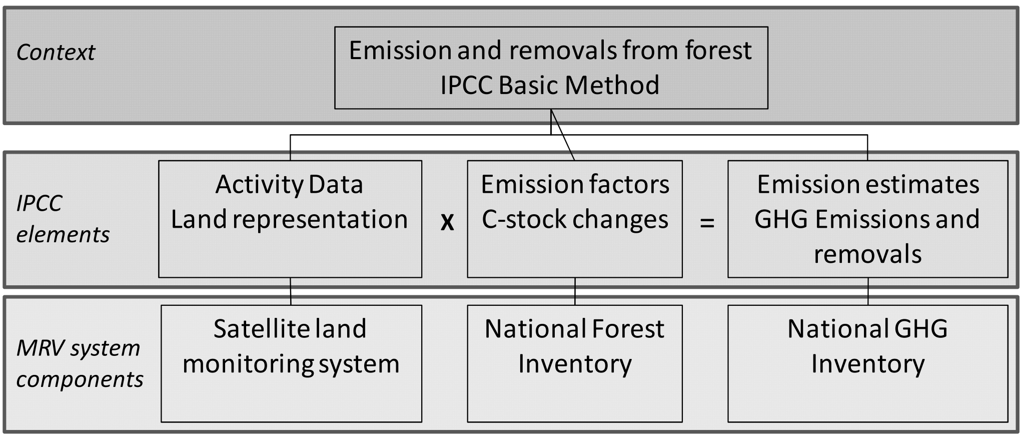


Figure 5. Relationship between IPCC elemenst and MRV components (Girardin, 2010).

IV. APPROACH FOR THE MERU BETIRI NATIONAL PARK

The study in Meru Betiri National Park would focused on how should measurable, reportable and verifiable mitigation commitments be made comparable, and how it related to technology, finance and capacity-building support. In other words, a sub national MRV that meet international standard and cost effective need to be developed. To do this, a break MRV down into its components, i.e., measurable, reportable, and verifyable and focus what is meant by measurable, reportable and verifiable would be undertaken to better understood the details of technical parameters. At this sub national level, The outcome of the MRV system will be a Sub National forest GHG Inventory to report on REDD+ activities to the national, and UNFCCC Secretariat.

To measure 'deviations from baseline' and recognize relative emission reductions, one effectively needs to establish baselines, supported by fundamental data, from forest inventory, and institutional capacity building. While the unit of measurement is tonnes of CO_2-equivalent. In general the necessary elements needed for MRV can be seen in Table 7.

Table 7. Mitigation action for MRV

MRV on	Supported by	Activity needed
Baseline ($CO_{2\text{-}e}$)	Data (Satelite and Ground base), Communities and institutional Capacity Building	Permanent Sample Plots (PSP) and Inventory, Consultation, Training
Deviations from Baseline	Data (Satelite and ground base), Communities, Public and Private Participation	Policies, zone enforcement laws
Reportable emmisions	Regular Communication	Updated Inventory and`report

Reportable. Under UNFCCC convention, all parties have existing reporting commitments, such as national communications, which provide an obvious profile for reporting. Mitigation action undertaken by non Annex 1 countries, including GHGs inventory need to be reported through National Communication as mandated by Article 12.1 (b) for every 2 years based on COP decision. Changes in inventories would reflect not only mitigation supported from multilateral sources, but also unilateral action. MRV would require separate tracking of domestically financed and internationally supported action. Changes in inventories would reflect reductions only if all actions are considered. The question of whether such inventories would be reviewed must be addressed under the verification procedures. Another format for reporting might be considered, for example sustainable development policies and measures (SD-PAMs) to give recognition to mitigation actions.

Verifiable. If emission reductions are to be real, long-term and measurable, then verification is crucial. The necessary questions are then, what can be verified, how, and by whom? These questions would be explained below, starting from approach for MRV in MBNP.

4.1. Overview of Meru Betiri National Park

MBNP was established through the enactment of Ministerial Decree No 277/Kpts-VI/1997. Based on this decree, the area of MBNP covered about 58000 ha, as can be seen in Tabel 9 and Figure 6. Within the area, nucleus zone is the largest proportion of the MBNP, amounting to 48.13 percent, followed by forest zone, accounting to 39 per cent and rehabilitation zone, amounting to 6.94 per cent. While intensive use zone and buffer zone, which have already been used by communities inside MBNP, amounting to 5, 94 per cent. Nevertheles, this figure was established in 1999, more than ten years ago. A changed must have occurred during this period that need to be examined. This would be undertaken through a series of analyses using historical and remote sensing anaysis. As can bee seen in Figure 7.

In this study, a land zoning system within MBNP would take into consideration. The zoning system within MBNP can be seen in Figure 6. Zoning systems in MBNP consists of Nucleus zone, Forest zone, Rehabilitation zone, Buffer zone, and intensive utilization zone. Each zone has its own characteristics and function. Based on Ministerial Decree No. 56/2006, nucleus zone is a pristine and denses forest, characterised by indegenous flora and fauna of thea area. While forest zone is a buffer for nucleous zone, and situated between nucleous zone and utilization zone. Rehabilitation zone is a degraded area that need to be rehabilitated. Buffer zone is zone managed specially for accomodating protection and conservation of natural park, including ecotourism. Utilization zone, is a zone to be utilised for ecoutorism and other environemental services purposes. For MBNP, the area of zoning system can be seen in Table 8.

Table 8. Forest Types by Zonation in MBNP, 1999

No	Forest Ecosystem	Zone (Ha)					Total Area
		Nucleus	Forest	Intensive Utilization	Buffer	Rehabili-tation	
1	Mangrove	-	7 (0.03)	-	-	-	7 (0.01)
2	Coastal	620 (2.22)	675 (2.98)	925 (71.98)	-	-	2.220 (3.83)
3	Swamp	-	25 (0.11)	-	-	-	25 (0.04)
4	Tropical Rainforest	23.870 (85.51)	20.340 (89.91)	-	2.155 (100.00)	3.573 (88.81)	49.938 (86.10)
5	Bamboo Forest	3.425 (12.27)	1.575 (6.96)	360 (28.02)	-	450 (11.19)	5.810 (10.02)
Area (Ha)		27.915 (48.13)	22.622 (39.00)	1.285 (2.22)	2.155 (3.72)	4.023 (6.94)	58.000 (100.00)

Source: Based on Directorate Jenderal Decree No.185/99.
Note : Number in parantheses is percentage from total.

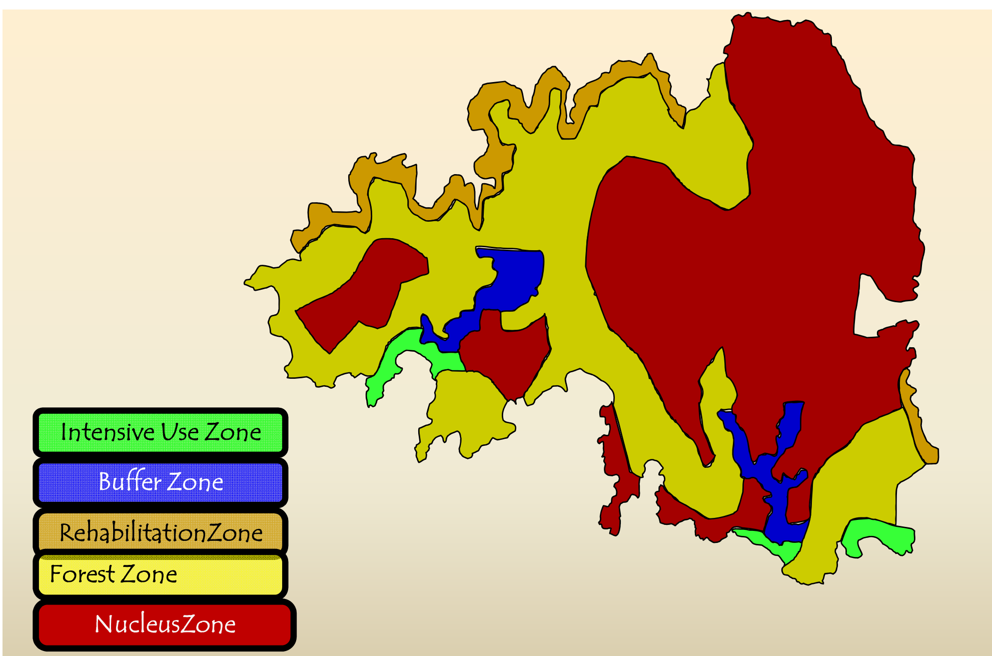


Figure 6. Zoning System within MBNP.

4.2. Approach for MRV in MBNP

Approach and steps for measuring, reporting, and verifying (MRV) which is an underlying condition for REDD+ would be explained as follows:

(i) determining the boundary of activity;

(ii) developing baseline;

(iii) stratifying the area;

(iv) identifying relevant carbon pools and non-CO2 GHGs;

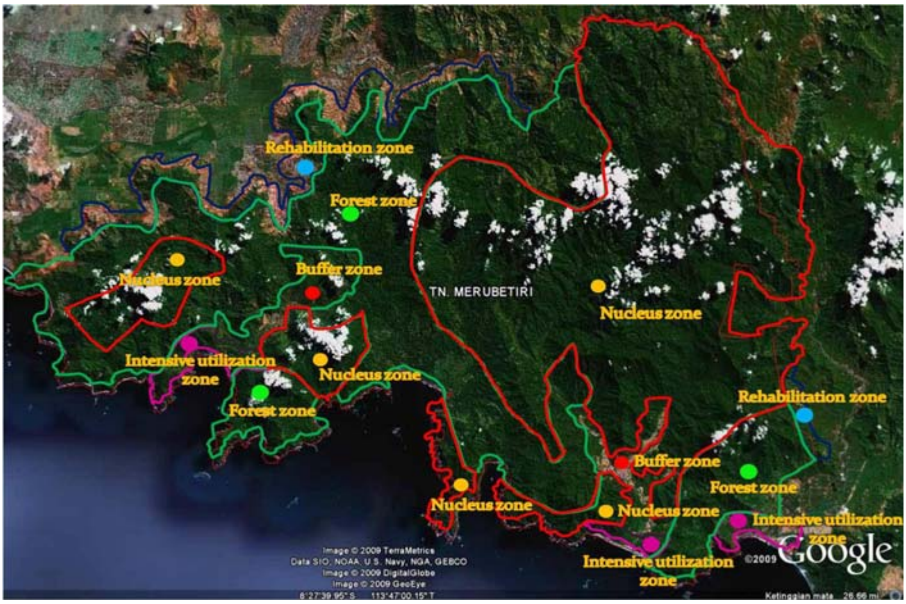
(v) designing the sampling framewok;

(vi) assessing and managing leakage or displacement of activity;

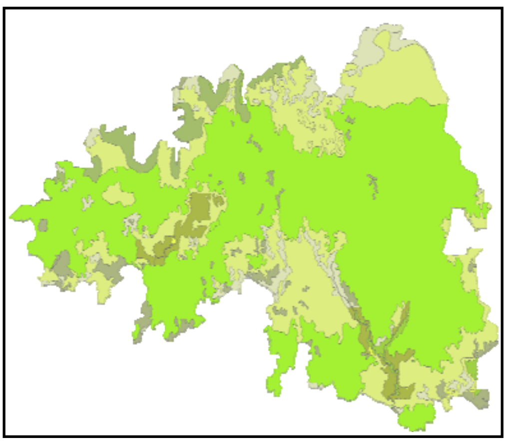
(vii) identifying the methods for estimating and monitoring including quality assurance and quality control plan.

4.2.1. Determining boundary of activity

Determining boundary of activities can be seen in terms of geographical location, duration of activities, and in terms of the activities and practices responsible for greenhouse gas emissions and removals that are significant and reasonably attributable to the activities undertaken. There amny tools for identifying physical boundary in MBNP. The easiest one, is to use national recognized system such as Ministry of Forestry decree. In 1997, the area was appointed as a national park through the Ministry of Forestry Decree No 277/Kpts-VI/1997, covers area of 58.000 hectares which located in two districts: Jember and Banyuwangi (GoI MoF, 1997). Therefore a boundary of activity for MBNP would be 58 000 ha. In addition, a remote sensing analysis and ground bases surveyed have also been undertaken to support and mark the boundary of the area as can be seen in Figure 7.



(a)



(b) **(c)**

Figure 7. Aerial photo of MBNP in 2009 (a), vegetation map (b) and land use map (c)

4.2.2. Developing baseline

IPCC GPG (2003) mention that the baseline is the scenario that reasonably represents the anthropogenic emissions by sources and anthropogenic removals by sinks of greenhouse gases that would occur in the absence of the proposed activities. Which implies the need to assess potential greenhouse gas emissions and removals in a manner consistent with those associated with the activities within the project. In addition, it is related to which pools, gases, and activities the baseline shall include, how the baseline will be established, and choices of a baseline methodology.

Changes in the carbon stocks in the relevant carbon pools and the non-CO2 greenhouse gas emissions associated with the project need to be measured and monitored and then compared to those of the project's baseline. REDD+ intervention need to show reduced emission or increase enhancement from baseline (Figure 8).

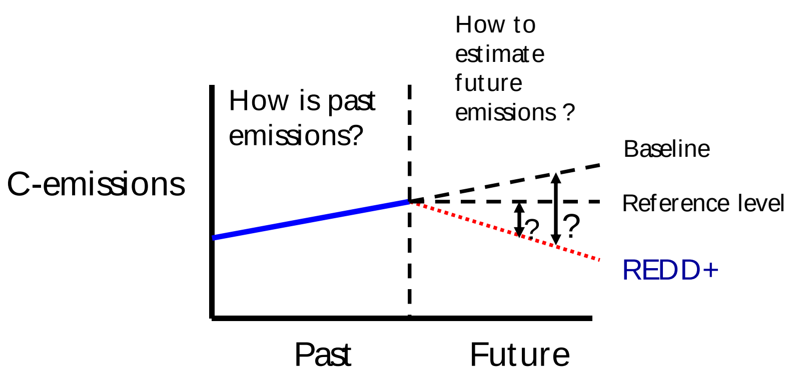


Figure 8. REDD+ Intervention

The development of a baseline is a crucial step in the implementation of demonstration activities, to ensure accurate crediting of their carbon impacts or reference level. Reference scenario of GHG benefits are computed as the gap in carbon stocks and other GHG emission levels of the activity and the baseline. A key issue therefore, is how to develop a baseline that would represents the net emissions in the absence of activity.

There are currently no standard practices for developing baselines for conservation activities. However, a baseline has two major components, which is (i) the projected land-use or land-cover change, and (ii) the associated carbon stocks in the pool. Brown (2007) argues, the projections of land use change are the most important and yet the most difficult to address because many socioeconomic and environmental factors affect the way people use land and these are difficult to predict. Existing estimate changes in land use and baselines were determined on a project-by-project approach using simple logical argument that assumed continuation of observed past trends for the limited project area or a region. Brown (2007) argues to use analytically rigorous and transparent agreed methods. For the carbon stocks, it would be measured at that local from the PSP, to produce a more specific baseline.

There are several approached for baseline, i.e (i) historical approach, (ii) modelling approach, and (iii) other approach. Historical approach range from relatively simple model of extrapolation of historical trend in land use based on simple drivers of degradation and deforestation such as population growth, to more complex extrapolation of past trend using spatial explicit model of land use change driven by biophisical and socio-economic factors such as the Forest Area Change (FAC) model, the Land Use and Carbon Sequestration (LUCS) model, and Geographical Modeling (Geomod) model (Brown, et.al., 2007). In general, FAC model produce the highest amount of forest loss projection, while LUCS provide the least amount of loss. They proposed three main steps to develop baseline. First, In the first step, an historic land-use change and deforestation estimate is made by determining the size of the region relative to the size of proposed project, obtaining historic data, analyzing candidate historic baseline drivers, and identifying three to four major drivers. Second, produce a potential land-use change (PLUC) map using for example a spatial model such as GEOMOD that uses the key drivers from step one. Then rates of deforestation are projected over a 10-year baseline period using any of the three models. Third, the baseline assumptions about baseline drivers be re-assessed. This step reviews the viability of the 10-year baseline in light of changes in one or more key baseline drivers (e.g., new roads, new communities, new protected area, etc). Brown (2007) further mentioned that the baselines should be projected over a 10 year period to be more realistic. Griscom, et.al. (2009) also suggest that the most credible approach for estimating baseline linked to historic emission data such as that from FAO-FRA.

There are two aspects that have to be considered: (i) The relevant carbon pools and non-CO_2 greenhouse gas emissions prior to the project activity need to be estimated (historical). This estimation should preferably be based on measurements made on the same site where the project will be established. It is possible to use alternative ways for estimating carbon stocks and non-CO2 greenhouse gas emissions, including for example, measurements on sites that are considered to reproduce, as far as possible, the initial condition of the project site (i.e., sites with similar soil type, vegetation cover and land-use history).

In addition, Gibb, *et al*. (2007) provide guidelines on advantage and disadvantage for estimating carbon stock as can be seen in Table 9.

Tabel 9. Advantage and disadvantage of several estimation methods for forest carbon (Gibbs *et al.*, 2007)

Method	Description	Benefits	Limitations	Uncertainty
Biome averages	Estimates of average forest carbon stocks for broad forest categories based on a variety of input data sources	Immediately available at no cost Data refinements could increase accuracy Globally consistent	Fairly generalized Data sources not properly sampled to describe large areas	High
Forest inventory	Relates ground based measurements of tree diameters or volume to forest carbon stocks using allometric relationships	Generic relationships readily available Low-tech method widely understood Can be relatively inexpensive as field-labor is largest cost	Generic relationships not appropriate for all regions Can be expensive and slow Challenging to produce globally consistent results	Low
Optical remote sensors	Uses visible and infrared wavelengths to measure spectral indices and correlate to ground-based forest carbon measurements Eg: Landsat, MODIS	Satellite data routinely collected and freely available at global scale Globally consistent	Limited ability to develop goods models for tropical forest Spectral indices saturated at relatively low C stocks Can be technically demanding	High
Very high resolution Airbone optical Remote sensors	Uses very high resolution (10-20 cm) images to measure tree height and crown area and allometry to estimate carbon stocks Eg: Aerial photos, 3D aerial imagery	Reduces time and cost of collecting forest inventory data Reasonable accuracy Excellent ground verification for deforestation baseline	Only covers small areas (10.000s ha) Can be expensive and technically demanding No allometric relations based on crown area are available	Low to medium

Tabel 9. (Advantage)

Method	Description	Benefits	Limitations	Uncertainty
Radar remote sensors	Use microwave or radar signal to measure forest vertical structure Eg: ALOS PALSAR, ERS-1, JERS-1, Envisat	Satellite data are generally free New systems launched in 2005 expected to provide improved data Can be accurate for young or sparse forest	Less accurate in complex canopies of mature forests because signal signatures Mountainous terrain also increase errors Can be expensive and technically demanding	Medium
Laser remote sensors	LIDAR uses laser light to estimate forest height/ vertical structure Eg: Carbon 3-D satellite system combines Vegetation canopy LiDAR (VCL) with horizontal imager	Accurately estimates full spatial variability of forest carbon stocks Potential for satellite-based system to estimate global forest carbon stocks	Airplane-mounted sensors only option Satellite system not yet funded Requires extensive field data for calibration Can be expensive and technically demanding	Low to medium

4.2.3. Stratifying the area

Stratification of the area aims to increase the accuracy and precision of the measuring and monitoring in a cost-effective manner. The stratification decreases the costs of measuring and monitoring because it is expected to diminish the sampling for forest inventories effort necessary to achieve a given level of confidence caused by smaller variance in each stratum than in the project area itself.

The stratification should be carried out using criteria that are directly related to the variables to be measured and monitored, e.g., type of vegetation (completely cleared versus cleared with patches or scattered trees), soil type, elevation, and slope etc.

There is a trade-off between the number of strata and sampling intensity. The goal is to balance the number of strata identified against the total number of plots needed to adequately sample each stratum. There is no hard and fast rule, and project developers need to use their expert judgement in deciding on the number of strata to include.

In MBNP, stratification would be undertaken, using 3 main criteria, i.e, zoning system, type vegetation, and type of land use. The sub criteria would be the area within each category, that would be representatively sampled.

As a national park, zoning system is used to manage through different approach. Within core zone area, human-interventions are prohibited, since it will causes change in the national park ‘s ecosystem; while in utilization zone it is possible for human-intervention. Nucleus or core zone is the largest area within the national park, accounting for more than 48 per cent. Within this zone, the largest ecosystem is the tropical rainforest, amounting to 85.5 per cent, followed by bamboo and coastal ecosystems, amounting to 12.3 per cent and 2.2 percent, respectively. Rehabilitation and utilization zone amounting to about 6.9 percent and 2.2 per cent, respectively. In 1999, most of the rehabilitation zone is covered by tropical rainforest, amounting to 88.8 per cent and bamboo forest amounting to 11.2 per cent. At the current condition, changes might had occurred to facilitate the need of local communities, as can be seen in land cover changed described in the analysis.

4.2.4. Determining the carbon pool

Ground check involves measuring 5 pool of carbon of:

- Aboveground living biomass
  - Tree and Non-Tree
- Belowground living biomass
  - Tree and Non Tree
- Woody necromass (dead organic matter)
- Litter (non woody necromass)
- Soils
  - Minerals
  - Organic

Not all pools are likely to be acceptable as sources of enhancement, and not all pools need to be measured at the same level of precision or accuracy or at same frequency during the life of the project. In the initial inventory, the relevant carbon poools must be measured (Brown, 2001).

Three general methods for evaluating cahnges in carbon stocks and their`respective baseline exist (Vine et al. 1999, Bron, 2002), computer modelling, remote sensing and field/site measurements. Modelling is a convenient way of estimating the size of carbon pools in periods between inventories to minimise the cost of doing field measurements. Sampling of PSP would be combined with these models to validate the changes in carbon stocks predicted by the model.

4.2.4.1. Above Ground Biomass

Tree Component. The simplest procedure for measuring aboveground biomass consists of measuring a sample of trees in PSP and using allometric equations to estiamte biomass. Allometric methods have been shown to be robust among species and genera, and can predict biomass of closed-canopy forests to within about 10%. The assumption that biomass contains 50% carbon (on a dry weight basisi) is well accepted (Hamburg, 2000; Brown 2002), so it is straight forwarded to convert measured biomass to carbon units. The popular allometric equation for tropical trees is that proposed by Brown (1995):

$$B = 0.049\ \rho\ D^2H \quad \text{.. (i)}$$

Where B is biomass (kg per tree), D is diameter at breast height (cm), ρ is wood density (g/cm^3) and H is tree height (m). Ketterings *et al.* (2001) proposed the allometric equation:

$$B = 0.11\ \rho\ D^{2+c} \quad \text{.. (ii)}$$

Where c is a parameter that can be estiamted for the site. Ketterings *et al.* (2001) estimated c = 0.59 for forest in Sumatra.

The biomass of a tree equal the product of its volume and its density, so it is also possible to estiamte the carbon content of trees when their volume is known. This is useful for commercially important timber species for which measurements are available. Biomass is estimated from volume by first estimating the biomass of the measured trees and the expanding this value to take into account the biomass of the other aboveground components (leaves and branches):

$$B = \rho\ V\ \delta \quad \text{...(iii)}$$

Where V is timber volume (m^3), and δ is the biomass expansion factor, and B is now measured in tonnes. If it is known that the stem represents ¾ of the tree biomass, for example, then $\delta = 4/3$. Density (ρ) generally ranges between 0.5 and 0.7.

In Vademicum Kehutanan (Direktorat Jenderal Kehutanan, 1976) is widely used to estimate volume from diameter and heights data. D and H are measured in metres.

$V = (\pi).(D/2)^2 \rho H$..(iv)
$B = 4/3 V\rho$
$C = 0.5\ B$

Modelling of biomass accumulation can be based on simple single-equation models, or on process based models of different level of complexity. Two common mathematical functions for predicting tree growth are the Richards-Chapman equation (v) and the Gompertz equations (vi).

$$C_{P,t} = \alpha\left(1 - \exp(-\beta \cdot t)\right)^{\gamma} \quad \text{..............................(v)}$$

$$C_{P,t} = \beta\left(\frac{\alpha}{\beta}\right)^{\exp(-\gamma \cdot t)} \quad \text{...................................... (vi)}$$

Where α, β, and γ are parameters to be estimated for a particular species and site, and t represents time generally measured in years. These equations generally represents only aboveground biomass. Belowground biomass (roots) is difficult to measure so this pool of carbon is often estimated from root/shoot ratios (Brown, 2002). Mean root/shoot ratios from a number of studies are 0.26, with an inter-quartile range of 0.18-0.30. Therefore, multiplying the above equations by 1.26 can provide a rough estimate of total biomass. In addition IPCC (2006) also provide a default value of several types of forest in tropics.

Non-Tree Component. Shrubs and other large non-tree vegetation biomass is measured by destructive harvesting techniques. A small sub-plot depending on the size of the vegetation is established and all the shrub vegetation is harvested and weighed. An alternative approach, if the shrubs are large, is to develop local shrub allometric equations based on variables such as crown area and height or diameter at base of plant or some other relevant variable (e.g., number of stems in multi-stemmed shrubs). The equations would then be based on regressions of biomass of the shrub versus some logical combination of the independent variables. The independent variable or variables would then be measured in the sampling plots.

4.2.4.2. Below Ground Biomass

Tree Component. The belowground biomass (roots) is difficult and time-consuming to measure and estimate in most ecosystems, and methods are generally not standardized (IPPC, 2003). This guideline provides the average belowground to aboveground dry biomass ratios based on these studies was 0.26, with a range of 0.18 (lower 25% quartile) to 0.30 (upper 75% quartile). The belowground to aboveground dry biomass ratios did not vary significantly with latitudinal zone (tropical, temperate, boreal), soil texture (fine, medium, coarse), or tree type (angiosperm, gymnosperm).

Ritson and Sochacki (2003) reported that belowground to aboveground biomass ratios of plantations of *Pinus pinaster* varied between 1.5 and 0.25, decreasing with increasing tree size and/or age. use an estimate for belowground biomass by using the average belowground to aboveground biomass ratios, such as those in Annex 3A.1, Table 3A.1.8.

Non Tree Component. Direct measurement of belowground biomass requires collecting soil samples, usually in the form of cores of known diameter and depth, separating the roots from soil, and oven-drying and weighing the roots. The following steps for direct measurement of belowground biomass in the field are recommended (IPPC, 2003):

- Because a large proportion of non-tree root biomass is usually present in the upper soil layers, in most situations sampling to a depth of 0.3-0.4 m should suffice. In cases where samples are collected at deeper depths, it is recommended to split the sample into two or more layers, clearly recording the depth of each layer.
- Separation of roots from soil can be performed by using root washing devices for maximum recovery. If these devices are not available, simpler procedures (e.g., placing soil samples on a sieve and washing roots with high pressure water) may yield recovery of a relatively large proportion of root biomass.
- Non-root belowground biomass (e.g., rhizomes and tubers) should be considered as part of the belowground biomass pool.
- Roots should be oven-dried at 70°C until dry and then weighed. The resulting weight should be divided by the cross sectional area of the sample core to determine belowground biomass on a per-area basis.

4.2.4.3. Dead organic matter (woody necromass)

IPCC (2003) categorized dead wood as all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country.

Methods for estimation can be follow IPCC (2003) as follows:

$$\Delta \mathbf{CFFDOM} = \Delta \mathbf{CFFDW} + \Delta \mathbf{CFF\ LT}$$

ΔCFFDOM	=	annual change in carbon stocks in dead organic matter (includes dead wood and litter) in forest land remaining forest land, tonnes C yr-1
ΔCFFDW	=	change in carbon stocks in dead wood in forest land remaining forest land, tonnes C yr-1
ΔCFFLT	=	change in carbon stocks in litter in forest land remaining forest land, tonnes C yr- 1

4.2.4.4. Litter (non woody necromass)

IPCC (2003) described "litter as all non-living biomass with a diameter less than a minimum diameter chosen by the country (for example 10 cm), lying dead, in various states of decomposition above the mineral or organic soil. This includes fumic, and humic layers. Live fine roots (of less than the suggested diameter limit for below-ground biomass) are included in litter where they cannot be distinguished from it empirically".

Litter can be sampled using a small frame (either circular or square) and is placed in the sample plot and all litter within the frame is collected and weighed. A well-mixed sub-sample is collected to determine oven dry-to-wet weight ratios to convert the total wet mass to oven-dry mass.

An alternative approach for systems where the litter layer is well-defined and deep (more than 5 cm), is to develop a local regression equation that relates depth of the litter to the mass per unit area. This can be done by sampling the litter in the frames as mentioned above and at the same time measuring the depth of the litter. At least 10-15 such data points should be collected, ensuring that the full range of the expected litter depth is sampled (IPCC, 2003). Methods for estimation can be seen above, similar to those for dead wood.

4.2.4.5. Soil

The organic C content of mineral forest soils (to 1 m depth) typically varies between 20 to over 300 tonnes C ha^{-1} depending on the forest type and climatic conditions. Globally, mineral forest soils contain approximately 700 Pg C (IPCC, 2006).

Inventories can be developed using Tier 1, 2 or 3 approaches, and countries may choose to use different tiers for mineral and organic soils.

In spite of a growing body of literature on the effect of forest types, management practices and other disturbances on soil organic C, the available evidence remains largely site- and study-specific, but eventually may be generalized based on the influence of climatic conditions, soil properties, the time scale of interest, taking into consideration sampling intensity and effects across different soil depth increment (IPPC, 2003).

Due to incomplete scientific basis and resulting uncertainty, it is assumed in the Tier 1 method that forest soil C stocks do not change with management. Furthermore, if using Approach 2 or 3 activity data, it is not necessary to compute C stock changes for mineral soils (i.e., change in SOC stocks is 0).

Soil C inventories include estimates of soil organic C stock changes for mineral soils and CO_2 emissions from organic soils due to enhanced microbial decomposition caused by drainage and associated management activity.

Changes in soil C stocks associated with forests are computed using equation below, which combines the change in soil organic C stocks for mineral soils and organic soils; and stock change for soil inorganic C pools (Tier 3 only). Annual change in carbon stocks in soils

$$\Delta CSoils = \Delta CMineral - LOrganic + \Delta CInorganic$$

Where:

ΔCSoils	=	annual change in carbon stocks in soils, tonnes C yr-1
ΔCMineral	=	annual change in organic carbon stocks in mineral soils, tonnes C yr-1
LOrganic	=	annual loss of carbon from drained organic soils, tonnes C yr-1
ΔCInorganic	=	annual change in inorganic carbon stocks from soils, tonnes C yr-1 (assumed to be 0 unless using a Tier 3 approach).

For Tier 1 and 2 methods, soil organic C stocks for mineral soils are computed to a default depth of 30 cm. Greater depth can be selected and used at Tier 2 if data are available, but Tier 1 factors are based on 30 cm depth.

4.2.5. Designing the sampling framewok

Permanent sampling plots is plot to estimate changes of relevant carbon pools and non-CO_2 GHGs over time. Permanent sample plots are generally regarded as statistically more efficient in estimating changes in forest carbon stocks than temporary plots because typically there is high covariance between observations at successive sampling events (IPPC, 2003). Disadvantages of permanent plots are that their location could be known and they could be treated differently (such as by special attention), or that they could be destroyed or lost by disturbances over the project interval.

The sample size (number of sample plots) needed can be calculated based on the estimated variance in each stratum, area of each stratum, targeted precision level (based on sampling error only), and estimation error are known (IPPC, 2003).

The main considerations for determining PSP are: (i) Location, the plot must be representative of the system and easily relocated. Their location must be surveyed and marked on maps, their geographyical position need also to be identified, (ii) Demarcation, most of sample plots are rectangular, (iii) Plot size and shape, ideally all plots should be the same size. Various size of sample plots have been applied for measurement of carbon stock in forestry project, including 40 x 30 m as used by JICA-Forda Project in 2009, 100 m x 100 m (National Forest Inventory), 200 m x 200 m (PSP for monitoring of increment in mineral soil, Badan Litbang, 1993), 30 m x 30 m (Dahlan et al, 2005), and 20 m x 100 m (Asmoro, 2009, Hairiah and Rahayu, 2007, Hairiah *et al.*, 2001a and b), (iv) Tree identity, all trees should be labeled individually and their positions marked on a plot chart. Numbered aluminum tags fastened with an aluminum nail are effective, (v) Calculations, the form of calculations, analysis and summary must be decided. Usually this will include the determination of any volume equations to be used.(vi) Measurements, often all trees are measured for DBH. Other additional measurements will be needed for estimating volume, (vii) Check in, the previous records should be available to the field teams in order to spot and recheck inconsistent records.

The number of PSP need to be representative to the large area, existing land use, and other factors (topography, soil, etc). In MBNP, PSP would be selected based on three criteria, i.e., zoning system, type of vegetation, and type of land use. Based on GIS of this three criteria, the number of PSP that would be established around 40 plots. The aim of PSP are as follow, i.e., (i) Forest change monitoring, (ii) Growth and yield (increment), (iii) To estimate timber volume, dan (iv) Species distribution and biodiversity.

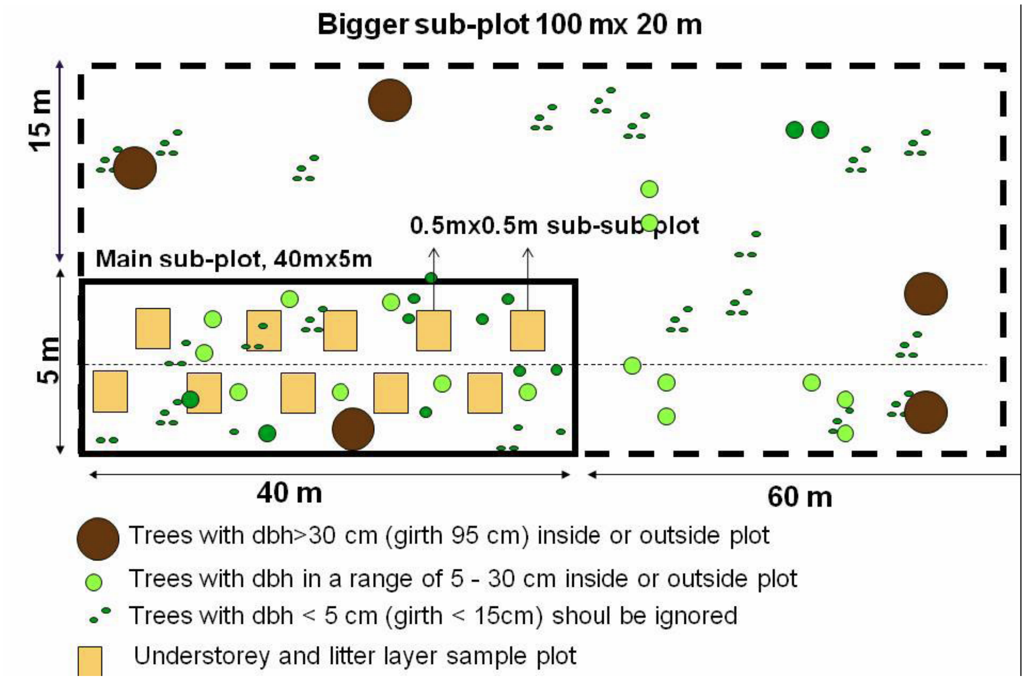


Figure 9. Example of Cluster from PSPs

Table 10. The amount and Number of PSP in Each Zone in MBNP

Zone	Area (Ha)	Jumlah dan Nomor PSP
Nucleus	27,915	17 (4,5,7,8,9,11,17,18,22,23,24,25,26,33,34,37,38)
Forest	22,622	14 (2,6,13,14,15,16,19,20,27,28,29,30,39,40)
Rehabilitation	4,023	3 (3,21,36)
Utilization	2,155	4 (1,12,32,35)
Special Utilization	1,285	2 (10,31)
Total	58,000	40

Forest inventory refer to the inventory methodology determining growth by repeated measurement of permanent sample plots (PSP). A series of periodic measurements give a complete historical record of stand growth. It provides information of individual trees and their relationship to their environment. Periodic and continues forest inventory are the tool of management at the forest level providing information on the result of treatment applied and the growth of the trees in order to compare the field results with predictions made from yield tables or other form of growth model such as allometric model.

The purposes of forest inventory are as follows: (i) Provide volumes by species, tree grades, and size classes for the different timber types considered significant, (ii) Assess relative economic availability of trees and areas of varying qualities, (iii) Provide growth information for the different timber types that will give a basis for calculating allowable cut, (iv) Evaluate results of silvicultural practices, including planting, in terms of survival, quality, and growth of regeneration, (v) Evaluate need for timber stand improvements, (vi) Provide a basis for determining areas to be planted, area of non-productive land, and ratio of mortality to cut, and (vii) Provide values, volumes and growth rates for depletion and other purposes in accounting for timberlands. The concept of utilizing a continuous forest inventory system provides more than growth and volume data, it also provides a means of periodically assessing change in the forest so that management decisions can be adaptive in nature and consistent with continuous improvement of resource management. Field plot would provide baseline data including type of vegetation, diameter and height of tree. Other data that need to be recorded are type of tree inventory, condition of the location, such as topography, soil, land use system, etc. By doing this, baseline data would be able to determine. Based on the area and existing type of forest, the number and amount of plot in each zone can be seen in Table 10.

4.2.6. Assessing and managing leakage or displacement of activity

Leakage or displacement of activity is defined as loss or gain of net greenhouse gas benefits outside a project boundary (Boer *et al.*, 2006). Leakage refers only to the increase of all greenhouse gases outside the project boundary, measurable and attributable to the project. CIFOR (2001) mentioned that leakage occur when one of the following phenomena occurs outside the project boundary: (i) Unallocated forested lands are harvested, (ii) Protected areas are converted into production forest areas, (iii) Illegal logging increases in protected and production forests, and (iv) Land is converted to lower C stocking rates due to emissions reductions elsewhere. Furthermore, establishment of boundary, may result from protection of an area which previously was the source of timber and woodfuel for communities.

In order to predict whether leakage will occur or not, Boer *et al.* (2006) stated that baseline drivers, baseline agents, causes and motivations, and indicators that exist in the project sites should be well understood. Baseline drivers are defined as activities predominantly taking place in the absence of the project, and that the project will replace. Baseline agents are actors who are engaged in those activities. Causes and motivations refer to factors that drive the baseline agents to do the activities and these can be represented by indicators. By knowing the interrelationship between these factors, we can predict whether leakage would occur or not. The following example illustrates the definitions mentioned above.

In this case identifying potential leakage, and adress the socio-economic factors that could drive degradation in the other side need to be undertaken. These can be done by providing for example economic opportunities for communities within and beyond the boundary of activities that encourages protections to the land resources, such as agricultural based proccesing industry, agriculture tourism, ecotourisme, and developing medicinal plant industry.

To minimise leakage, risk assessment would be undertaken, followed by determining the appropriate buffer reserve based on guidance provided in this document. This self risk assessment must be clearly documented and substantiated where possible. During verification, the VCS verifier will evaluate the project's leakage assessment and adjust it as appropriate before Voluntary Carbon Units (VCUs) can be issued. Assessment for leakage can be outlined as follows (Table 11).

Table 11. Reducing potential leakage in MBNP

Leakage	Driver	Location	Prevention
General	Unclear land tenure and potential for dispute	Rehabilitation zone	Land legally granted and Enforcement
	Financial failure Technical failure Management failure	All zone	• Income security • Fund management • Regular monitoring and reporting
Economic	Land encroachment	Rehabilitation and rimba zone	Education and communication
	Income shortage	Communities	Alternatives income
	Wood theft	Communities and others party	Communities self punishment
	Biodiversity theft	Communities and others party	Communities self punishment
Regulatory and social	Unclear role and responsibilities	All zone	Robust and clear guidelines
	Lack of monitoring and enforcement	All zone	Robust and clear guidelines
Natural disturbance	Forest fire	All zone	Monitoring and developing early detection system
	Pest and disease attacks	Rehabilitation and other zone	Technique for combating pest and disease
	Risk of extreme climatic events (e.g. floods, drought, winds)	All zone	Education and prevention activities
	Geological risk (e.g. volcanoes, earthquakes, landslides)	All zone	Safety training

4.2.7. Estimating and monitoring greenhouse gas emision and removal

IPCC 2006 GL provides tool for for estimating emission reduction or removal. To do this, ones need to determine activity data from representative land use change and associate carbon changes. In this regard, a matrix of land use change due to human activities need to be filled. A Land Change Matrix (LCM) can be made started with: i) visual analysis of remote sensing data, ii) ground truthing, iii) accuracy assessment, re-interpretation, iv) re-analysis of remote sensing data based on ground truthing, and v) determine land change matrix. Activity data is made in *worksheet* format Excel IPCC amounting to 39 Table, as can be seen in Tabel 6 above.

Ones need to have figure on coeficient of emission and removal of factor emission to estimate on reduction of GHG emission and removal. This data could be provided by series of research undertaken in the field, for example from measuring data from permanent sample plot.

Guidance for estimating CO_2 emission, including recommendation for accounting for emissions of non-CO_2 gas, quality assurance, quality control, and uncertainty analysis is provided in the IPCC 2006 GL. Reporting format of GRK inventory in general can be seen in Tabel 12.

Tabel 12. Reporting Format for GRK Inventory for LULUCF

GHG Source and sink categories	Net CO_2 Emission/ removals	CH_4	N_2O	NO_x	CO
	(Gg/ha)				
Total Land Use Categories					
A. Forest Land					
A.1. FL remaining FL					
A.2. Land converted to FL					
B. Crop Land					
B.1. CL remaining CL					
B.2. Land converted to CL					
C. Grass Land					
C.1. GL remaining GL					
C.2. Land converted to GL					
D. Wet Land					
D.1. WL remaining WL					
D.2. Land converted to WL					
E. Settlements					
E.1. Set. Remaining Set.					
E.2. Land converted to Set.					
F. Other Lands					
F.1. OL. Remaining OL.					
F.2. Land converted to OL.					
G. Other (*specify*)					
Biomass burning					
Liming					

V. INSTITUTIONAL ARRANGEMENT FOR MONITORING AND REPORTING

Institutional arrangements for carbon accounting, monitoring, and reporting need to be established within the MBNP. Role and responsibilities for potential institutions, including communities, public and private stakeholders need to be identified and engaged. Based on stakeholders consultation, organisation responsible that can be identified for each zones in MBNP can be explained in Table 13.

Table 13. Institutional Arrangement for Monitoring and Reporting in MBNP

No		Zone				
		Nucleus	**Forest**	**Special Utilization**	**Buffer**	**Rehabili-tation**
1	Main agency	National park officer	National park officer	Estate and Communities	Communities	National park officer and communities
2	Supporting agencies	Communities, Local Government, State Forestry Corporation (Perhutani),	Communities, Local Government, State Forestry Corporation (Perhutani),	National park officer, Local Government, State Forestry Corporation (Perhutani)	NGO, National park officer, Local Government, State Forestry Corporation (Perhutani)	NGO, National park officer, Local Government, State Forestry Corporation (Perhutani)

Table 13 shows that for nucleous and forest zone, domination role of MBNP official is needed, however, for rehabilitation, intensive utilization and special utilization zone, partnership with communities and estate crops are required.

Institutional structure in general can be seen in Figure 10. Starting from sub national level at MBNP to national level. Law No. 41/1999 about forestry, Regulation No. 6/2007, Regulation No. 3/2008, and Ministerial of Forestry Decree No. 30/2009 about Mechanism for REDD in Indonesia provides a general answers to institutional matters. Where it mentiones the requirements for independence, acceptability of the verifying institutions, accuracy, and building on existing capacity and experience. With this regards, domestic institutional capacity in developing countries to undertake both measurement and verification will be significant. Within the Ministry of Forestry, Directorate

General of Forest Planology (DG Plan) would be the responsible agency for setting activity data, supported by LAPAN and Bakosrutanal. The DG Plan will be supported by others sectoral institution, i.e, ministry of agriculture, ESDM, Public Work, which need to coordinate with provincial government, and unit implementation, in this case MBNP. DG Plan is backed up by Research Institutions and University for scientific data and technical guidance to develop emission factor and carbon stock change. The Ministry of Forestry would then coordinate with Ministry of Environment and Council for Climate Change as a national coordination. Ministry of Environment or Council of Climate Change, then, communicate with UNFCCC Secretariat for validation.

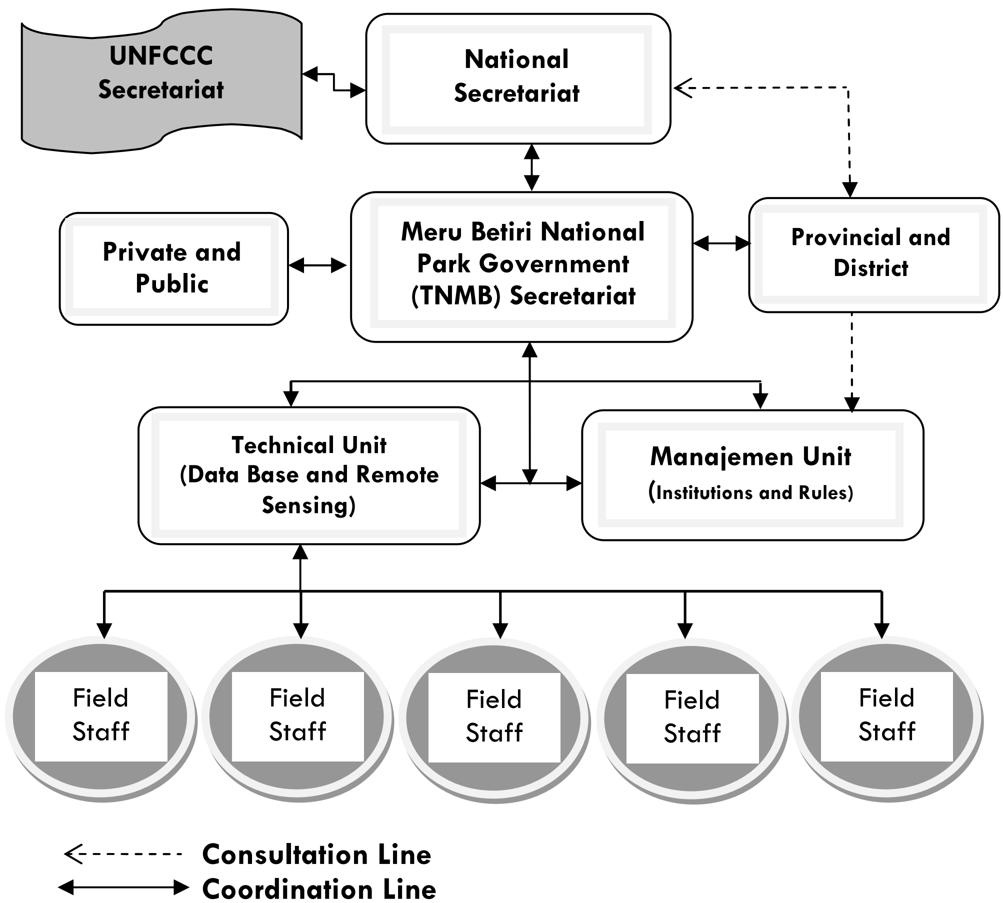


Figure 10. Institutional Structure for MRV in MBNP

VI. CONCLUSION

This paper explores general research framewok for measuring, monitoring and reporting carbon, including how to engaged communities, public and private partnership sustainably. Measuring and monitoring of carbon involved technical guidance, and starting from designing and establishing PSP.

As mandated ini Decision 1/CP.13 of the Bali Action Plan, the study would focused on how to develop a national MRV that meet international standard and cost effective need to be established. As a starting point, Ministerial of Forestry Decree No. 30/2009 about Mechanism for REDD in Indonesia provides a general answers to this questions.

It is obvious that to establish MRV system, combination of methods such as IPCC 2006 GL, and taking into consideration step wise procedure for MRV in Voluntary Carbon Standard (VCS) is needed to provide simpler, high certainty, and verifyable. VCS explained in great detail steps by steps guidelined for designing MRV involving communities and relevant stakeholders, while IPCC 2006 GL provide guideline on how to undertake forest inventory and estimate emission reduction or removal of GHGs.

MRV system need to undertake steps as follows: (i) determination boundary of activity, including carbon pool that would be measured, (ii) established baseline, (iii) identification and assessment on how to manage potential leakage, particularly from potential socio and economic driven factors, and (iv) estimation, monitoring and reporting emission reduction or enhancement of removal GHG. To determine boundary of activity, a visualisation of medium and high resolution of remote sensing data need to be undertaken. In addition, a representative amount of permanent sample plot need to be established for ground truthing to check the accuracy, and increase reliability of data. Approached to determine baseline vary from the simplest to the complex methods. However they are linked to historic emission. Potential risk for leakage need to be assessed and managed. While estimation and reporting of emission reduction or removal are guided by IPCC 2006 method.

REFERENCES

Asmoro, J.P.P. 2009. Quantification of Carbon Sequestration on Production, Conservation and Protected Forest. Balai Penelitian Kehutanan Manokwari.

Badan Litbang Kehutanan. 1993. Pedoman Pembuatan dan Pengukuran PUP Untuk Pemantauan Pertumbuhan dan Riap Hutan Alam Tanah Kering Bekas Tebangan. Badan Litbang Kehutanan. Jakarta. Baumert, K.A, T. Herzog and J. Pershing. 2005. Navigating the Numbers : Greenhouse Gas Data and International Climate Policy. World Resource Institute.

Boer, R., A.N. Gintings, A. Wahyudi., I. Setiawan, A. Bey, M.B. de Rozari dan J.S. Baharsjah. . 1998. 'Economic assessment of GHG abatement options for forestry sector', in A. Sugandhy, A. Bey., R. Boer and Gunardi (eds.). Proceedings ALGAS-Final National Workshop. Jakarta.

Boer, R., Upik R. Wasrin, Perdinan, Hendri, Bambang D.Dasanto, Willy Makundi, Julius Hero, M. Ridwan, and Nur Masripatin. 2006 Assessment of Carbon Leakage In Multiple Carbon-Sink Projects: A Case Study In Jambi Province, Indonesia.

Bowman, A.F. 1990. Exchange of greenhouse gases between terrestrial ecosystem and the atmosphere. In: soils and the greenhouse effect. A.F. Bowman edited by Wiley, Chichester, U.K.

Brown, S. 1997. Estimating biomass and biomass change of tropical forests: A primer. FAO Forestry paper 134.

Brown, S. 1997. Estimating biomass and biomass change in tropical forests: A primer. FAO Forestry Paper 134, FAO, Rome.

Brown, S. 2002. Measuring carbon in forests: curent status and future challenges. Environmentla pollution. 116:363-372.

Bowman, A.F. 1990. Exchange of greenhouse gases between terrestrial ecosystem and the atmosphere. In: soils and the greenhouse effect. A.F. Bowman edited by Wiley, Chichester, U.K.

Brown, S. 1997. Estimating biomass and biomass change of tropical forests: A primer. FAO Forestry paper 134.

Brown, S. Myrna Hall, Ken Adrasko, Fernando Ruiz, Walter Marzoli, Gabriela Guererro, Omar Masera, Aaron Dushku, Ben Dejong, and Joseph Cornell. 2007. Baselines for Landuse Change in the Tropics: Aplication to Avoid Deforestation Project. Mitigation Adaptation Strategies Global Change. Winrock International, VA.

Budiharto. 2009. Penentuan Rujukan Dan Skenario Pengurangan Emisi Karbon Dari Deforestasi Dan Degradasi Hutan Di Indonesia. [tesis]. Pasca Sarjana Institut Pertanian Bogor. Bogor

CIFOR. 2001. Developing a Shared Research Agenda for LUCF and CDM; Research Needs and Opportunities after COP 6', Centre for International Forestry Research, Bogor.

Castillo-Santiago, M.A., Hellier, G., Tipper, R., de Jong, B.H.J., in press. Carbon emissions from land-use change: a regional analysis of causal factors in Chiapas, Me´xico. Mitigat.Adapt. Strategies Global Change.

Cowie, A., Pingoud, K., Robertson, K., Schlamadinger, B., et al., 2005. Key terms used in greenhouse gas reporting andaccounting for the land use, land use change and forestry sector. IEA Bioenergy Task 38.

Dahlan, I.N. Surati Jaya and Istomo. 2005. Estimasi Karbon Tegakan Acacia mangium Willd Menggunakan Citra Landsat ETM+ dan SPOT-5: Stusi Kasus di BKPH Parung Panjang KPH Bogor. Pertemuan Ilmiah Tahunan MAPIN XIV "Pemanfaatan Efektif Penginderaan Jauh Untuk Peningkatan Kesejahteraan Bangsa" Gedung Rektorat lt. 3 Kampus Institut Teknologi Sepuluh Nopember Surabaya, 14 – 15 September 2005.

DeFries, R., Asner, G., Achard, F., Justice, C., Laporte, N., Price, K., Small, C., Townsend, J., 2005. Monitoring tropical deforestation for emerging carbon markets. In: Moutinho, P., Schwartzman, S. (Eds.), Tropical Deforestation and Climate Change Belem. Instituto de Pesquisa Ambiental da Amazonia and Environmental Defense, Brazil.

DeFries, R., Achard, F., Brown, S., Herold, M., Murdiyarso, D., Schlamadinger, B., de Souza, C., 2007. Reducing greenhouse gas emissions from deforestation in developing countries: Considerations for monitoring and measuring. Environ. Sci. Policy 10, 385–394.Dutschke, M., 2007. CDM.

Fahrizal. 2002. Pendugaan Biomasa Pohon Bagian Bawah Tanah di Hutan Primer dan Hutan Bekas Tebangan (Studi Kasus di Hutan Tri Dharma IPB Dusun Aro Jambi). [skripsi]. Jurusan Manajemen Hutan. Fakultas Kehutanan. Institut Pertanian Bogor. Bogor

FAO. 1996. Forest resources assessment 1990, Survey Of Tropical Forest Cover And Study Of Change Processes. [online]. [Dikutip: 14 Februari 2009]. http://www.fao.org/document.

FAO. 2006. Global Forest Resource Assessment 2005: Global Assessment of Growing Stock, Biomass and Carbon Stock. Rome.

FAO. 2008. National Forest Monitoring and Assessment – Manual for integrated field data collection. National Forest Monitoring and Assessment Working Paper NFMA 37/E. Rome

First National Communication. 1999. The Indonesia First National Communication to the UNFCCC. KLH. Indonesia.

Garsetiasih R. dan Heriyanto N.M. 2007. Keanekaragaman Jenis Tumbuhan Bawah an Potensi Kandungan Karbonnya pada Hutan Agahis di Baturraden. Jurnal Penelitian Hutan dan Konservasi Alam Vol. IV No. 2 Tahun 2007. Bogor

Gibbs et al. 2007. Monitoring and estimating tropical forest carbon stocks: making REDD a reality. Environment Research Letters IOP Publishing. Available at http://www.sage.wisc.edu/pubs/articles/F-L/Gibbs/gibbsERLarticle 2007. pdf.

Girardin, Cecile. 2010. Reports and Analysis UN-REDD/FAO to Publish National Forest MRV System Recommendation. Available at http://www.unredd. org/Newsletter8_MRV_System Recommendations/tabil/4551/language/ enus/Default.aspx.

Griscom, B., David Shcoh, Bill Stanley, Rane Cortez, Nicole Virgilio. 2009. Implications of REDD baseline methods for different country circumstances during an initial performance period. The Nature Conservancy, VA.

Hairiah K, Dewi S, Agus F, van Noordwijk M and Rahayu S. 2009. Measuring Carbon Stocks Across Land Use Systems: A Manual. Bogor, Indonesia. World Agroforestry Centre (ICRAF), SEA Regional Office, Brawijaya University and ICALRRD (Indonesian Center for Agricultural Land Resources Research and Development). 127 p. DRAFT VERSION.

Hairiah K, Rahayu S. 2007. Pengukuran 'karbon tersimpan' di berbagai macam penggunaan lahan. Bogor. World Agroforestry Centre - ICRAF, SEA Regional Office, University of Brawijaya, Unibraw, Indonesia. 77 p.

Hairiah,K., Sitompul, SM, van Noordwijk, M. and Palm, C.A., 2001 (a). Carbon stocks of tropical land use systems as part of the global C balance: effects of forest conversion and options for 'clean development' activities. ASB_LN 4A. In: Van Noordwijk, M, Williams, S.E. and Verbist, B. (Eds.) 2001.Towards integrated natural resource management in forest margins of the humid tropics: local action and global concerns. ASB-Lecture Notes 1 – 12. International Centre for Research in Agroforestry (ICRAF), Bogor, Indonesia.

Hairiah, K., Sitompul, SM, van Noordwijk, M. and Palm, C.A., 2001 (b). Methods for sampling carbon stocks above and below ground. ASB_LN 4B. In: Van Noordwijk, M, Williams, S.E. and Verbist, B. (Eds.) 2001.Towards integrated natural resource management in forest margins of the humid tropics: local action and global concerns. ASB-Lecture Notes 1 – 12. International Centre for Research in Agroforestry (ICRAF), Bogor, Indonesia.

IPCC. 2001. IPCC Third Assessment Report. Available at http://www.grida.no/ publications/other/ipcc_tar/

IPCC. 1996. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. IGES, Japan. IPCC

IPCC. 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Intergovernmental Panel on Climate Change. IPCC National Greenhouse Gas Inventories Programme. IGES. Japan.

IPCC. 2006. IPCC Guidelines for National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme. IGES, Japan.

IPCC. 2007. Fourth Assessment Report. Available at http://www.ipcc.ch/ publications_and_data/publications_ipcc_fourth_assessment_report_wg3_ report_ mitigation_of_climate_change.html

IPCC. 2007. Box 13.7. The Range of difference between emissions in 1990 and emissions allowances in 2020/2050 for various GHG concentration levels for annex 1 and non annex 1 countries as a group. Available at http:// www.ipcc.ch/publications_and_data/ar4/wg3/en/ch13-ens13-3-3-3.html

Masripatin, N. 2007. APA ITU REDD ?. [Online] [Dikutip: 10 Maret 2009] http://www.forda-mof.org/uploads/File/climate%20change/isi%20 buku %20apa%20itu%20REDD.pdf

Ketterings, Q.M., Coe, R., van Noordwijk, M. Ambagau, Y. and Palm, C.A. 2001. Reducing uncertainty in the use of allometric biomass equations for predicting above-ground tree biomass in mixed secondary forestr. Forest Ecology and management, 146:199-209.

Lopes, Paulo. 2009. Review of Forestry Carbon Standards – Development of a tool for organizations to identify forestry carbon credits. Imperial College London, Centre for Environmental Policy. Available from:http: //reducecarbon.wordpress.com/"

Skutsch, M.N., Bird, E. Trines, M. Dutschke, P. Frumhoff, B.H.J. de Jong, P. van Laake, O. Masera h, D. Murdiyarso. 2007. Clearing the way for reducing emissions from tropical deforestation. Environmental science & policy 10 (2007): 322-334. Available at www.sciencedirect.com

Soares-Filho, B.S., Nepstad, D.C., Curran, L.M., Cerqueira, G.C., Garcia, R.A., Ramos, C.A., Voll, E., McDonald, A., Lefebvre, P.,Schlesinger, P., 2006. Modelling conservation in the Amazon basin. Nature 440, 520–523.

Vine, E. Sathaye, J., and Makundi, W. 1999. Guidelines for the monitoring, evaluation, reporting, verification and certification of forestry projects for climate change mitigatin, prepared for the US EPA Environment by Lawrence Berkeley National Laboratory.

VCS. 2008a. Guidance for AFOLU Projects. [Online] Available from: http://www.v-c-s.org/docs/Guidance for AFOLU Projects.pdf. [Accessed 04/08/2010].

VCS. 2008b. Tool for AFOLU Methodological Issues. [Online] Available from: http://www.v-c-s.org/docs/Tool for AFOLU Methodological Issues.pdf. [Accessed 04/08/2010].

VCS. 2008c. Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination. [Online] Available from: http://www.v-c-s.org/docs/Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination.pdf. [Accessed 04/08/2010].