Analysing REDD+

Challenges and choices

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Chapter 14

Baselines and monitoring in local REDD+ projects

Manuel Estrada and Shijo Joseph

- Over the past few years, robust standards and methods have been developed to estimate emissions from deforestation at the project level.
- Because the first full-fledged REDD+ baseline and monitoring methodologies were adopted only recently, many pioneering projects might not comply with them, running the risk of losing opportunities in carbon markets.
- The next generation of projects should learn from this experience by identifying or developing suitable methodologies *before* investing in the development of their baselines and measurement, reporting and verification (MRV) systems.

14.1 Introduction

Accurate and transparent estimates of greenhouse gas (GHG) emissions from deforestation and forest degradation and carbon stock enhancements are critical for assessing the mitigation benefits of REDD+ projects. The precise estimation of such benefits is required to guarantee the integrity of climate change mitigation schemes where they are used to comply either with legally binding

emission reduction commitments or with voluntary goals. At the same time, the quality of such estimates affects the potential for a project to access funds (high-quality carbon credits are more likely to be attractive to a wider range of potential buyers and investors in the carbon market than are those estimated using less robust methods) as well as the amount of funds they attract (credits created following good methods and practices are usually sold at higher prices).[1]

This chapter identifies common challenges faced by project developers when establishing baselines by assessing the capacities and availability of data in ongoing projects against internationally recognised standards and methods. The results of this assessment provide some guidance to project developers, donors and the international REDD+ community on how these challenges might be overcome and the areas where investments should be prioritised to improve the estimation of credible baselines.

This analysis is based on information gathered through CIFOR´s Global Comparative Study on REDD+ (GCS) and represents the experience of 17 pioneering REDD+ projects from Brazil, Cameroon, Indonesia, Peru, Tanzania and Vietnam (see Appendix). As can be seen in Table 14.1, these projects focus on reducing emissions from deforestation and forest degradation. Some projects also include carbon stock enhancement activities, such as improved forest management and afforestation, reforestation or regeneration of forests.

The scope of the analysis is defined by two facts: first, the projects are at the initial stages of development (only two of the nine projects for which information was available have already engaged in the preparation of Project Descriptions[2]), which implies, among other things, that the information currently available on project monitoring plans and techniques does not allow their quality to be assessed. Second, most of the projects – 10 out of 17 – are seeking validation under the Verified Carbon Standard (VCS)[3] - currently the most commonly used standard in the voluntary forest carbon market. Accordingly, the analysis takes the requirements set by the VCS for REDD+ projects as the basis for evaluating the methods and data used to estimate the carbon benefits of the GCS projects. [4] Moreover, given the lack

1 Although it must be noted that, increasingly, the value of such credits considers not only their 'methodological' robustness, but also the contribution of the projects from which they originate to the generation of wider environmental and social benefits.

2 The Project Description details a project's GHG emission reduction or removal activities and is required to register the project under the VCS.

3 Formerly Voluntary Carbon Standard (VCS).

4 It must be noted that all of the projects were assessed against the VCS guidance, even if the project developers have not yet decided which standard they will apply or if they intend to use another standard altogether (e.g. the Plan Vivo).

of data on monitoring systems, the assessment is limited to the estimation of project baselines.

This chapter introduces the methods available for estimating emissions in REDD+ (Section 14.2), as well as the general VCS requirements for REDD+ projects and the recognised project types (Section 14.3). It describes critical steps and the data that are needed to comply with provisions for constructing baselines according to VCS methodologies (Section 14.4). The chapter then evaluates the current status of GCS projects with regard to these requirements (Section 14.5). Finally, based on this assessment, Section 14.6 provides preliminary conclusions and recommendations.

14.2 Methods available for estimating the mitigation benefits of REDD+ projects

The creation of real, long-term, additional and measurable greenhouse gas emission reductions and enhancements in carbon stocks through REDD+ projects requires the establishment of credible baselines (the without-project scenario), precise monitoring and reporting of project results and robust standards and institutional frameworks to verify them impartially and consistently.

The scientific and methodological basis for estimating GHG emissions and removals due to activities in the agriculture, forest and other land uses (AFOLU) sector are provided by the '2006 Guidelines for National GHG Inventories' (IPCC 2006) and the '2003 Good Practice Guidelines for Land Use, Land Use Change and Forestry' (GPG-LULUCF), produced by the Intergovernmental Panel on Climate Change (IPCC 2003). The IPCC Guidelines are intended to be used at the national level, but may be adapted, based on guidance provided by the IPCC GPG-LULUCF, and applied at the project level. A more comprehensive overview of the IPCC Guidelines is provided in Chapter 15 of this volume.

The IPCC Guidelines set the foundation for the development of a number of robust standards that establish essential requirements for the quantification and generation of GHG emission reductions and removals and for the creation of their associated carbon credits. These include the VCS and the American Carbon Registry (ACR), which are considered to represent the best practices in the voluntary carbon market.

In practice, the standards are applied through baseline and monitoring methodologies, which set out detailed procedures and equations for quantifying the mitigation benefits of a project, including methods to determine project boundaries, assess additionality (i.e. whether the initiative only took place

Table 14.1 Overview of projects collaborating with GCS

Country	Principal project developer and site	Selected standard	Main pressures on forests	Activities	Likely VCS project types
Brazil	*Instituto Centro de Vida* (ICV), Mato Grosso.	VCS	Small to large-scale cattle ranching; illegal timber harvest	REDD + IFM + O	AUDD
	Instituto de Pesquisa Ambiental da Amazônia (IPAM), State of Para	N.A.	Cattle ranching and beef production; small-scale traditional agriculture; illegal timber harvest	REDD +IFM+ARR	AUDD
	Biofílica Investimentos Ambientais and Fundação Orsa, Amapá	N.A.	Small-scale agriculture; illegal logging; infrastructure development; government-approved logging	N.A.	AUDD APD
	The Nature Conservancy, São Felix do Xingu	N.A.	Ranching; illegal logging	REDD + ARR + IFM	
	Fundação Amazonas Sustentável (FAS), *Bolsa Floresta*	VCS	Illegal logging; infrastructure development; mining commercial plantations; small-scale agriculture	REDD	AUDD APD
Peru	*Bosques Amazonicos S.A.C.* (BAM), Madre de Dios	N.A.	Cattle ranching and beef production; mining; infrastructure development; small-scale subsistence agriculture	N.A.	
	Conservation International (CI), San Martin	N.A.	Shifting cultivation; illegal logging; infrastructure development; cattle ranching and beef production; small-scale agriculture	N.A.	AUDD
Cameroon	*Centre pour l'Environnement et le Développement* (CED), South and East regions	Plan Vivo	Small-scale traditional agriculture/frontier agriculture; illegal timber harvest; subsistence fuelwood/charcoal collection	REDD + ARR	AUDD
	GFA-Envest, Southwest Province	N.A.	Oil palm and other commercial plantations; small-scale traditional agriculture/frontier agriculture; illegal timber harvest; subsistence fuelwood/charcoal collection	REDD + IFM	N.A.

Tanzania	Tanzania Traditional Energy Development and Environmental Organization (TaTEDO), Shinyanga	VCS	Small-scale traditional agriculture/frontier agriculture; illegal timber harvest; subsistence fuelwood/charcoal collection; overgrazing	REDD + IFM	N.A.
	Tanzania Forest Conservation Group (TFCG), Lindi	VCS	Mainly shifting agriculture; timber harvesting; building poles; (maybe production of charcoal); firewood	REDD + IFM	AUDD
	Tanzania Forest Conservation Group (TFCG), Kilosa.	VCS	Encroachment for small-scale/subsistence farming; shifting cultivation; timber harvesting; charcoal production; fire	REDD + IFM	
	Care International, Zanzibar	VCS	Timber harvesting; charcoal production; infrastructure development	REDD + O	
	Mpingo Conservation and Development Initiative (MCDI), Kilwa	VCS	Fire	IFM	
Indonesia	Fauna and Flora International Indonesia (FFI-Indonesia), West Kalimantan	VCS	Oil palm; small-scale subsistence farming; illegal logging	REDD+IFM+ARR	
	The Nature Conservancy (TNC), East Kalimantan	N.A.	Oil palm; timber harvesting; pulp plantations; mining	REDD + IFM	
Vietnam	Netherlands Development Organization (SNV) Cat Tien, Lam Dong District	VCS	Small-scale traditional agriculture; illegal timber harvesting	REDD + IFM	AUDD

Notes:
VCS: verified carbon standard REDD: reduced emissions from deforestation and forest degradation; AUDD: avoided unplanned deforestation and degradation; APD: avoided planned deforestation; IFM: improved forest management; ARR: afforestation, reforestation and revegetation; O: other.

due to the generation of carbon credits), determine the most plausible baseline scenario and quantify the GHG emissions that were reduced or removed due to project activities. Before being applied, the methodologies – elaborated by project proponents – must be validated by a third party against the requirements established by the standard. The validating party must be authorised by the entity in charge of the standard in order to audit the proposed methodologies. To date, there are five VCS-approved methodologies for REDD[5] projects (see Table 14.2). Each methodology is designed to match specific baseline and project scenarios and, once validated, the methodology becomes public[6] and can be applied to any project that complies with its applicability conditions. Project developers are free to use any methodology matching the characteristics of their projects or to develop a new methodology if none of the existing approaches is suitable.

14.3 General VCS requirements and REDD+ project types

The VCS requirements contain general rules for all REDD+ projects. They cover issues such as eligibility conditions for the project area, definition of project boundaries (geographic boundaries, crediting period and GHG emission sources and carbon pools), demonstration of additionality and the treatment of non-permanence risks (i.e. the risks that carbon removals are reversed after the credits have been created). In the context of the VCS, REDD+ activities are divided into two types: REDD+ projects, which relate to deforestation (legal and illegal, see below) and degradation (illegal) and improved forest management

Table 14.2 VCS approved methodologies for REDD* projects as of March 2012 (VCS 2012)

VM0004 – Methodology for Conservation Projects that Avoid Planned Land Use Conversion in Peat Swamp Forests, v1.0
VM0006 – Methodology for Carbon Accounting in Project Activities that Reduce Emissions from Mosaic Deforestation and Degradation, v1.0
VM0007 – REDD Methodology Modules (REDD-MF), v1.1
VM0009 – Methodology for Avoided Mosaic Deforestation of Tropical Forests, v1.1
VM0015 – Methodology for Avoided Unplanned Deforestation, v1.0

* It should be noted that in the VCS context, the '+' activities qualify as improved forest management and are not considered in the Table.

5 We use REDD without the '+' when projects only deal with deforestation and forest degradation.

6 The developers of methodologies approved under the VCS Programme on or after 13 April 2010 are eligible to receive compensation. This compensation amounts to US $0.02 per verified carbon unit (VCU) issued to projects using the methodology or a revision of the methodology.

projects, which include initiatives addressing 'legal' degradation due to poor management, sustainable forest management and carbon stock enhancement. Two main requirements are that the project area for REDD projects shall meet an internationally accepted definition of forest, such as those based on UNFCCC host-country thresholds or FAO definitions (FAO 2006) and shall have qualified as forest for a minimum of 10 years before the project begins.

The general rules on REDD projects are complemented by provisions addressing a subset of these projects: i) avoiding planned deforestation (APD), i.e. projects that reduce net GHG emissions by stopping or reducing deforestation on forest lands that are legally authorised to be converted to non-forest lands; and ii) avoiding unplanned deforestation and/or degradation (AUDD), i.e. projects that reduce net GHG emissions by stopping the deforestation and/or degradation of forests that would have occurred as a result of socioeconomic forces promoting alternative uses of forest land. This distinction is necessary because the drivers, agents and dynamics of deforestation associated with each project type have different methodological implications, for example, with regard to the establishment of baselines and estimates of leakage. In deforestation projects, the area where deforestation is expected to occur is delimited by a government permit and the rate of deforestation is set by this permit or by the common practice observed in similar concessions. In unplanned deforestation projects, the determination of the area of expected deforestation depends on the decisions of a relatively large number of people over a region similar to the project area and the expected rate of deforestation derives from, for example, the historical evolution of drivers, agents and socioeconomic circumstances affecting the region, as well as from its geographical characteristics.

As can be seen in Table 14.1, most of the GCS projects that submitted information on the drivers of deforestation qualify mainly as AUDD; therefore the following assessment will focus exclusively on AUDD projects and methods.

14.4 Key VCS requirements for estimating REDD+ baselines

14.4.1 Provisions for setting baselines for REDD projects

The baseline for a REDD project is the scenario that reasonably represents the anthropogenic changes in carbon stocks in pools and emissions of GHGs that would occur *in the absence* of the project. Baselines are estimated *ex ante* and must be reassessed and revalidated every ten years in order to reflect changes in the project context that might affect the rate of deforestation. REDD baselines include two main elements: a land use and land cover change component

(the activity data) and the associated carbon stock change component (the emission factor).

Requirements for the land use/land cover component of the baseline scenario: For AUDD projects, the activity data component of the baseline scenario is based on historical trends observed in a reference region over at least the previous ten years;[7] these are used to make future projections about deforestation. Table 14.3 summarises some of the key data and tasks needed to estimate the land use and land cover change component of an AUDD project's baseline scenario under each of the VCS REDD+ methodologies that apply to AUDD. Table 14.4 presents remote sensing data requirements for the construction of baselines across the approved VCS AUDD methodologies.

Table 14.3 Key data and tasks needed to establish an AUDD project's baseline deforestation/degradation rate and/or location

Data / Task	VM0006	VM0007	VM0009	VM0015
GIS analysis to apply criteria demonstrating similarity of the reference to the project area	Required	Required unless using population driver approach	Required	Required
Rate modelling of deforestation (from historic forest cover change analysis)	Simple historic average or trend	Simple historic average or trend or population drive	Logistic model based on historic averages and covariates (drivers)	Simple historic average or trend or based on covariates
Spatial modelling of deforestation and GIS coverage (i.e. shape files) of spatial drivers (e.g. digital elevation models, road networks, etc.)	Required	Required if unplanned frontier deforestation or if < 25% of project boundary is within 120m of recent deforestation	None (not spatially explicit)	Required

Source: Adapted from Shoch *et al*. (2011)

7 The reference region is the analytical domain from which information on historical deforestation is extracted and projected into the future to spatially locate the area that will be considered deforested in the baseline scenario.

Table 14.4 Remote sensing data requirements for historic (baseline) forest cover change analysis for AUDD methodologies

Data / Task	VM0006	VM0007	VM0009	VM0015
Remote sensing/ imagery resolution	≤ 30m	≤ 30m	≤ 30m	≤ 100m
Remote sensing/ imagery time series needs for reference area	Imagery from four time points from the period 0-15 years prior to project start	Imagery from three time points from the period 2-12 years prior to project start	Imagery from at least two time points prior to project start; at least 90% of the reference area must have coverage from at least two time points	Imagery from at least three time points from the period 10-15 years prior to project start, with one taken within two years of project start
Remote sensing/ imagery minimum classification accuracy (forest/ non-forest)	70% of sampled pixels (with uncertainty discounts)	90% of sampled pixels	Not pixel-based; quality control guidelines to minimise point interpretation error	90%
Remote sensing/ imagery minimum classification method	Review high resolution imagery or database of known classes at locations	Review high resolution imagery or ground truthing	N/A	Review high resolution imagery or ground truthing
Remote sensing/ imagery minimum cloud free	80%	90%	Unspecified -shifting sample point approach flexible in regions with significant and variable cloud cover	Unspecified

Source: Adapted from Shoch *et al.* (2011)

14.4.2 Requirements for the carbon stock component of the baseline

A baseline scenario should cover both significant carbon stock changes in all relevant pools and emissions by sources of the GHGs that would occur within the boundaries of the project area. According to the VCS AFOLU requirements, AUDD projects should always include the aboveground tree biomass carbon pool. The inclusion of other carbon pools is required only when there is the chance that project activities may significantly reduce the pool.

Most approved methodologies require that forest carbon stock estimates be based on a direct inventory of the project area or on measurements taken from forests that are representative of the project area. Some methodologies also allow the use of conservative estimates from the literature or IPCC defaults. For baseline (post-forest conversion) land uses, all VCS REDD methodologies permit the use of default carbon stock values from local studies or literature or, where these are not available, from direct sampling of proxy sites. The use of data from the literature or IPCC defaults will usually have different implications for uncertainty, thus some methodologies require the lower and upper ranges of the values to be used for forest and non-forest classes respectively. Where spatial modelling is not included in baseline construction, and thus emission factors are not matched to specific pixels on a map, methodologies generally employ an area-weighted average emission factor from a stratified sample or assume that the strata with the lowest average carbon stocks will be deforested first (Shoch *et al.* 2011). Table 14.5 summarises the methods used in each approved methodology to measure carbon stocks, as well as the frequency with which they should be reassessed.

14.5 Preliminary assessment of GCS projects

The general requirements introduced in section 14.3 and the tasks and data required by VCS methodologies presented in section 14.4.1 were compared to available GCS project data to identify data gaps and capacity needs. This comparison revealed that:

General requirements: the available data are not sufficient to determine whether the project areas were entirely covered by forest at the start of the projects or whether forest in these areas had been in place for at least ten years, as required by the VCS.

Project and reference area similarity: most GCS projects limit the scope of their monitoring to the project area, which implies that they do not consider

Table 14.5 Required sources of carbon stock estimates in baseline scenarios

Stock estimate	VM0006	VM0007	VM0009	VM0015
Project area forest carbon pools	Forest biomass inventory of each identified forest stratum with permanent sample plots	Forest biomass inventory with fixed area or variable radius sample plots (must take place within +/-5 years of the project start date)	Forest biomass inventory with fixed area plots (must take place in the first monitoring period, i.e. prior to first verification)	Forest biomass inventory with temporary or permanent plots or conservative default
Post conversion	Default factors from literature or measurements from temporary plots on representative areas	Default factors from local studies or literature or measurements from temporary plots on representative areas	Not needed if project area is semi-arid tropical forest. Otherwise requires soil carbon sampling from proxy farms in the reference area to parameterise the soil carbon loss model	Default factors from literature or measurements from temporary plots on representative areas

Source: Adapted from Shoch *et al*. (2011)

a reference region (or a leakage belt[8]), indicating non-compliance with VCS requirements. In spite of this, five out of the nine project developers that submitted information on this topic have already developed baseline scenarios, three are in the progress of developing scenarios and one has not yet started the process.

Modelling the rate of deforestation: nine out of 17 project developers have modelled the historical rate of deforestation in the project area and three more are in the process of doing so. Five project developers used a simple historic average or a linear projection to estimate the deforestation rate, four used GIS-based modelling with covariates of deforestation agents and one relied on the opinion of experts. Two projects did not specify the approach they used to estimate the historical rate of deforestation. The project that is

8 The 'leakage belt' is the area outside project boundaries where any deforestation above the baseline projection will be considered leakage.

relying simply on expert knowledge could face problems in complying with VCS requirements.

Spatial modelling to project the location of deforestation: only three of the 17 projects have used spatial models to project the location of future deforestation, which is in line with the VCS requirements. The other 14 projects relied mostly on expert knowledge or on basin-wide (or national scale) modelled outputs.

Remote sensing imagery time series for the reference region: as previously noted, most projects do not consider a reference region when estimating their baselines, so it is not clear if the remote sensing images they possess would cover such a region. The available information indicates that about ten of the 17 projects have sufficient data for estimating the historical rate of deforestation over a period of ten years and 13 of them have remote sensing images for more than three points in time during that period (Figure 14.1).

Remote sensing resolution: only seven of the 17 projects report having high resolution data (<10m), while all of them possess medium resolution data (10–60m). Consequently, it could be expected that at least seven projects would be able to meet the VCS requirement regarding remote sensing.

The analysis shows that 13 of the 17 GCS projects studied have started to measure aboveground biomass, thus potentially complying with VCS

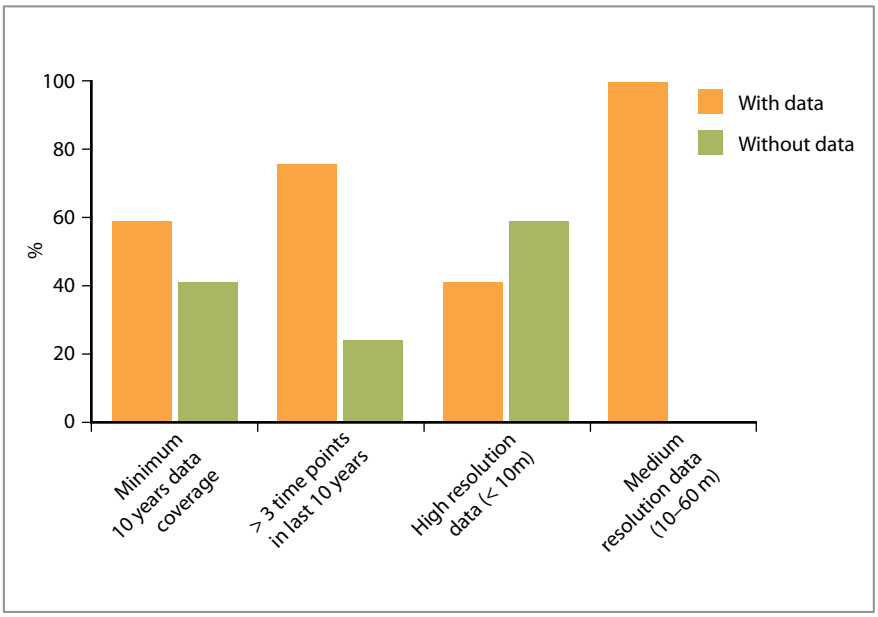

Figure 14.1 Historical remote sensing data available for GCS project sites

requirements. In many cases, the projects plan to use the root:shoot ratio as an alternative to measuring belowground biomass. The projects will use the ratio cited by the IPCC or obtained through local level studies. It is worth noting that nine of the 17 projects use site-specific allometric equations[9] to estimate forest carbon stocks, only three have carbon conversion coefficients and the rest of the project sites plan to use general allometric equations and default carbon conversion values available in the literature. The projects did not specify what methods and data they will use to estimate carbon stock changes from other land uses in their baseline scenarios.

With respect to carbon stock sampling methods, eight projects are using stratified random sampling and two are using simple random sampling. Only one project uses permanent sampling, despite the fact that permanent sampling is required by the VCS methodologies. In addition, three projects use a systematic sampling technique.

14.6 Conclusions and recommendations

The analysis described in this chapter shows that most of the projects participating in the GCS study might face problems in complying with some of the basic VCS requirements. This is mostly due to the methods used to predict future deforestation, the lack of data for constructing historical deforestation rates and the use of non-permanent carbon stock sampling plots.

It can be argued that most of the methods currently available for baseline development and MRV had not yet been developed when these pioneer projects started, thus project developers could not use them to guide their initial efforts (although it must be recognised that, in some cases, the projects were not primarily designed to generate tradable emission reduction credits or to use project-level methodologies). This situation may have led to an ineffective use of time and resources, since some of the project activities that had already been completed would have to be repeated to ensure VCS compliance. Moreover, in AUDD projects there could arise a cart before the horse situation, whereby a project site is selected before the true extent of future deforestation in the area has been modelled. This could result in the initial site being less at risk than previously thought, which could have financial and impact implications for project developers.

It must be kept in mind that the experiences described in this chapter relate to some the first REDD+ projects in the world, thus the challenges they face are likely to more daunting than the problems that will be faced by projects in

9 Allometric equations express the quantitative relationship between the dimensions of a tree and the biomass. They are used to estimate the biomass of trees based on easy measures, such as tree height or diameter at breast height (DBH).

future, especially considering the trend to move from project-level baselines and MRV systems to subnational and national baselines. Nevertheless, some recommendations may serve to facilitate the development of methodologically robust projects (under the VCS or any other scheme) and to guide REDD+ policy and funding decisions, particularly for AUDD projects.

- It is advisable to apply the best MRV practices and standards available, i.e. those based on IPCC guidance
- Before developing project baselines and designing monitoring plans, project developers should seek a suitable methodology to guide their MRV planning and technology and data-related investments; where no suitable methodologies are available, relevant elements of existing methodologies may be used as a basis for constructing new ones
- Baseline modelling should be used to determine the location of the project area in order to ensure that project activities will focus on deforestation hot spots and can ensure additionality.