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Building Forest Carbon Projects

REDD Guidance

Technical Project Design

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Established in 1995 by Jacob Olander and Marta Echavarria, EcoDecision is based in Quito, Ecuador, and works throughout Latin America with a broad array of clients and partners, including international and national non-governmental organizations, businesses, and government institutions.

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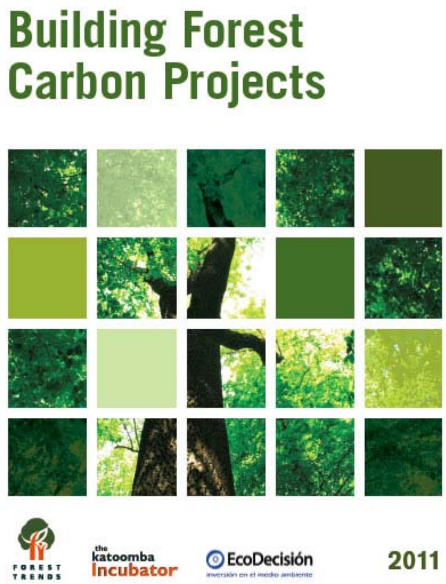

This guidance document is part of a Forest Trends series *Building Forest Carbon Projects*
Available at http://www.forest-trends.org/publications/building_forest_carbon_projects.

Other documents in this series, referred to throughout this document, include:

Step-by-Step Overview and Guide
Jacob Olander and Johannes Ebeling

AR Guidance: Technical Project Design
Johannes Ebeling and Alvaro Vallejo

Carbon Stock Assessment Guidance: Inventory and Monitoring Procedures
David Diaz and Matt Delaney

Community Engagement Guidance: Good Practice for Forest Carbon Projects
Tom Blomley and Michael Richards

Legal Guidance: Legal and Contractual Aspects of Forest Carbon Projects
Slayde Hawkins

Business Guidance: Forest Carbon Marketing and Finance
Phil Covell

Social Impacts Guidance: Key Assessment Issues for Forest Carbon Projects
Michael Richards

Biodiversity Impacts Guidance: Key Assessment Issues for Forest Carbon Projects
John Pilgrim, Jonathan Ekstrom, and Johannes Ebeling

Acronyms

ACoGS	Avoided Conversion of Grasslands and Shrublands
ACR	American Climate Registry
ALM	Agricultural Land Management
APD	Avoiding Planned Deforestation
AR	Afforestation and reforestation
A/R	Afforestation and Reforestation (CDM Category)
ARR	Afforestation, Reforestation and Revegetation (VCS Category)
AUFDD	Avoiding Unplanned Frontier Deforestation and Degradation
AUMDD	Avoiding Unplanned Mosaic Deforestation and Degradation
AWG-KP	Ad-hoc Working Group on Further Commitments of Annex I Parties under the Kyoto-Protocol
AWG-LCA	Ad-hoc Working Group on Long-term Cooperative Action
BAU	Business as usual scenario
CAR	Climate Action Reserve
CCB	Climate, Community & Biodiversity [Alliance or Standards]
CDM	Clean Development Mechanism
COP	Conference of the Parties
CER	Certified Emission Reduction
CUPP	Conservation of Undrained or Partially Drained Peatland
EO	Earth observation
ESA	European Space Agency
FPIC	Free, prior, and informed consent
FRA	Forest Resources Assessment
GCF	The Governors' Climate and Forest Task Force
GHG	Greenhouse gas
GIS	Geographic Information System
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
IFM	Improved Forest Management
IPCC	Intergovernmental Panel on Climate Change
IR	Information request
JI	Joint Implementation
LtHP	Conversion of low-productive forests to high-productive forests
LtPF	Conversion of logged forests to protected forests
LULUCF	Land Use, Land-Use Change, and Forestry
MMU	Minimum mapping unit
MRV	Measurement, reporting, and verification

NASA	National Aeronautics and Space Administration
NDFI	Normalized Difference Fraction Index
NTFP	Non-timber forest product
PRD	Peatland Rewetting and Conservation
RDP	Rewetting of Drained Peatland
REL	Reference emissions level
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing Emissions from Deforestation and Forest Degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks
R-PIN	Readiness-Project Idea Note
R-PP	Readiness Preparation Proposal
RIL	Conversion from conventional logging to reduced impact logging
SAR	Synthetic Aperture Radar
SBSTA	Subsidiary Body on Scientific and Technological Advice
TRD	Time release discount
UNFCCC	United Nations Framework Convention on Climate Change
UN-REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
VCS	Verified Carbon Standard
V&V	Verification and validation in programming and engineering (≠ V/V)
V/V	Validation and verification in certification

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Introduction

Forest carbon project proponents face an environment of rapid change and uncertainty for many technical aspects of project design.[1] For those with an eye on an eventual compliance market under the UNFCCC, it is expected that emerging national REDD+ policies ultimately will provide the framework for project-based or other subnational REDD+ activities, though the technical requirements are yet to be agreed. For the voluntary market, the Verified Carbon Standard (VCS) has been further consolidated, and several VCS Agriculture, Forestry, and Other Land Use (AFOLU) methodologies have been approved, providing detailed, project-level guidance.[2] This document focuses on VCS since this standard generates the most widely accepted type of REDD credit. VCS Version 3.0 provides the most comprehensive working guidance aiming at a high level of consistency with the emerging UNFCCC REDD+ framework, increasing the likelihood that projects complying with this standard may eventually be able to nest within or reconcile with emerging national and international systems.

This guidance document takes the reader through the technical options for various stages of REDD+ project development. It offers guidance on choosing eligible activities, VCS compliant methodologies, and technologies and tools to implement a REDD project accounting framework. However, it is not meant to--nor can it--replace the use of VCS documents, templates, or approved methodologies. The chapter begins by discussing the issues associated with defining eligible activities (Section 2), setting project boundaries (Section 3 and 4), assessing relevant drivers, agents, and underlying causes, (Section 5) and designing corresponding project interventions (Section 6), while Sections 7 to 10 deal with methodological issues related to remote sensing, baseline, leakage, and risk assessment. Each section contains specific recommendations and external resources for project developers. These recommendations are not intended to be comprehensive and, to a certain extent, reflect the preferences of the author. References to complementary chapters in the step-by-step guide are included in the text, while links to relevant methodologies, tools, and publication are provided at the end of each single step.

The scope of this chapter is limited to the technical design of REDD projects. The VCS Version 3.0 AFOLU framework currently covers four other project categories in addition to REDD: Afforestation, Reforestation and Revegetation (ARR), Agricultural Land Management (ALM), Improved Forest Management (IFM), and Peatland Rewetting and Conservation (PRC).[3] Although this chapter touches on options for complementary activities from other AFOLU categories and common underlying technical requirements where appropriate, it does not detail the other categories. ARR activities, however, are covered separately in the AR Guidance document of this series.

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[1] In this series, the term *project proponents* is used to refer to those individuals or organizations generally responsible for the overall organization, management, and legal representation of the forest carbon project. *Project developers*, on the other hand, is used to refer specifically to entities tasked with the technical design aspects of the project as required by the carbon and/or co-benefit standard(s).

[2] The new VCS program, VCS Version 3.0, can be found at http://v-c-s.org/program-documents; documents specific to AFOLU projects can be found at http://v-c-s.org/develop-project/agriculture-forestry-projects, and relevant methodologies can be found under Sectoral Scope 14 (AFOLU) at http://v-c-s.org/methodologies/find.

[3] The inclusion of Avoided Conversion of Grasslands and Shrublands (ACoGS) as new AFOLU category is currently being discussed.

1. Standards, Markets, and the Policy Environment

1.1 The Emerging REDD+ Policy Environment

Before delving into the more technical issues of how to quantify emissions reductions, project proponents should decide whether their project will aim to be eligible under a future compliance scheme, a current voluntary scheme, or a combination of the two. This decision is not clear-cut, as the accounting rules of a future UNFCCC REDD+ compliance scheme have not yet been negotiated. The variance between fully-established voluntary, market-based accounting standards and the emerging UNFCCC compliance mechanism might create future incompatibilities in carbon accounting across different implementation levels. For example, the parameters for establishing a national reference emission level are being discussed intensely in international negotiations; a project that has opted for an increasing projected baseline under a voluntary scheme might run into problems if the national reference emission level were to be based on historic deforestation patterns and rates only.

Before starting to design a REDD+ project, it is advisable to analyze the policy environment to clearly define the options. Many tropical countries have signed agreements with the Forest Carbon Partnership Facility (FCPF), the UN-REDD Programme and/or the REDD+ Partnership and, in parallel, are at different stages in establishing national REDD+ frameworks. Project proponents should be aware of ongoing REDD strategy development in their host country, as the elements of this strategy may restrict the eligibility of project activities or may implicitly establish specific legal or technical requirements for stratification, biomass inventory design, or land use change (LUC) monitoring for an eventual compliance regime (although projects may still be eligible under VCS).[4] Standard documents like the FCPF's Readiness-PIN (R-PIN), the Readiness Preparation Proposal (R-PP), and the UN-REDD's National Joint Program Documents submitted by each country can provide information on what type of data and methodologies are already available.

In addition, it is essential to understand what other subnational or project-based activities are already underway.[5] Proponents operating in neighboring sites may want to consider sharing monitoring tasks or developing a joint reference emission scenario (as long as this is allowed by the chosen GHG program standard). Even if project proponents prefer to keep design and implementation independent of other projects, they will have to coordinate the zoning of subnational or project areas to avoid overlaps that could affect emissions accounting (see Section 4.4).

1.2 Voluntary Market Standards: Strategic Choices

In the absence of legally-binding regulatory frameworks on carbon emissions in most jurisdictions, a number of voluntary standards and programs present an array of options for REDD+ project development. Project proponents should ensure that the following key aspects, among others, are explicitly considered when choosing the appropriate certification scheme. First, the scheme has to be sufficiently comprehensive to cover the type(s) of REDD+ activities proposed by the project (see Section 2). Second, the UNFCCC negotiations on REDD+ have placed a strong emphasis

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4 See the Carbon Stocks Assessment Guidance for an overview of these issues.

5 Although several COP decisions on REDD address issues related to implementing REDD at subnational levels, no legal definition of the subnational level has been agreed upon. While some countries relate it to jurisdictional entities (federal states, regions, provinces, or municipalities) others consider all potential implementation scales below the national level, including projects or sector-based approaches, to be "subnational." In this chapter, the term "subnational" refers to implementation schemes at the jurisdictional or sectorial level. A discussion on technical, legal, and policy aspect of nested REDD+ implementation across different levels can be found in Chagas (2011).

on socioeconomic and environmental impacts; projects aiming to eventually enter a UNFCCC REDD+ scheme should ensure that these impacts are assessed and verified. Third, any certification scheme should be consistent with the Good Practice Guidance and Guidelines of the IPCC (2003; 2006).

Recent market surveys clearly point to a preference among buyers and investors for projects validated under the VCS. The VCS is the most comprehensive standard, covering all relevant AFOLU activities, and is based on IPCC guidelines. VCS is commonly combined with CCB Standards to address other environmental and socioeconomic impacts, and a combined certification currently provides the best option for addressing carbon accounting and social and environmental concerns. VCS credits have been particularly sought-after by buyers and investors preparing themselves for forthcoming compliance schemes beyond the UNFCCC, e.g., in the context of US national and regional climate legislation and other national programs (e.g., Japan). Besides the VCS, several other carbon standards provide regulations, methodologies, or protocols for REDD+ activities (Box 1).

Box 1. Other Standards for International REDD+ Projects

American Carbon Registry (ACR) Forest Project Standard

http://www.americancarbonregistry.org/

The ACR is an enterprise of Winrock International and publishes standards, methodologies, protocols and tools for project accounting. The ACR's Forest Carbon Project Standard is available for AR, IFM and REDD projects globally. It largely follows an approach similar to the VCS, and so far mainly uses tools and methodologies based on CDM and VCS, although it is implementing an innovative alternative risk non-permanence insurance approach. It issues Emission Reduction Tons (ERTs) to projects.

Climate Action Reserve (CAR)

http://www.climateactionreserve.org/

The CAR program emerged from the California Climate Action Registry (CCAR), a California-based non-profit organization overseeing emissions reporting and offsets in that state. CAR's Forest Protocol covers AR, IFM and REDD. It is currently only applicable to projects in the U.S., though efforts are underway to adopt protocols for all of North America, including Mexico. Projects are issued Climate Reserve Tonnes (CRTs).

Plan Vivo Standards

http://www.planvivo.org/

Plan Vivo accepts a range of land-use projects, including AR, agroforestry, restoration, and REDD. These are developed with small-scale farmers based on a broader "Plan Vivo" livelihood strategy. Unlike other standards, Plan Vivo does not generally provide methodologies, and each project must instead devise its own technical specification (which can use elements of existing methodologies, e.g., from the CDM, or develop own approaches) adapted to the specific realities of the project, which is reviewed by external experts. Projects are issued Plan Vivo Certificates on an ex-ante basis in order to ensure sufficient start-up funds for farmers (though payments are only disbursed gradually).

Other standards may be applicable to REDD projects though they do not result in carbon credits:

ISO 14064

http://www.co2offsetresearch.org/policy/ISO14064.html

ISO 14064 is a greenhouse gas project accounting standard developed by the International Organization for Standardization (ISO). The standard does not lead to the issuance of carbon credits but might be used provide some additional assurance of integrity of climate benefits for projects that do not aim to sell carbon credits. It does not apply restrictions on project types, size, location or other aspects. Unlike standards approving scientific methodologies, ISO 14064 offers only general guidance, with tools defined by the greenhouse gas program or standard under which the standard is used. See Stockholm Environment Institute, "ISO 14064-2," Carbon Offset Research & Education.

SOCIALCARBON

http://www.socialcarbon.org/

SOCIALCARBON is a standard designed to demonstrate social and environmental co-benefits of carbon offset projects, as well as to increase active participation of local stakeholders, and is in some ways comparable to CCB. This standard is always used in conjunction with another approved carbon-accounting standard (VCS, CDM, etc.) and therefore does not define its own project type or methodologies. Similar to the CCB Standards, it does not issue carbon credits.

The market and policy environment is still in early stages, and other standards such as these may continue to rise in prominence in the voluntary and pre-compliance markets. For projects located in North America, CAR standards may hold the greatest market potential, particularly once they expand to include other international jurisdictions as sources of offsets.[6] Plan Vivo may be particularly well-suited to projects focusing on small-holder, community-based activities with a diversity of project activities, especially where initial project areas are of limited size but expected to expand organically.

Bearing in mind that VCS Version 3.0 requires evidence that project-based emissions reductions will not be double-counted at the jurisdictional level,[7] it is important to discuss options for coordination of accounting with the governmental authorities in charge of REDD negotiations or the host country's Designated National Authority (DNA) of the Clean Development Mechanism (CDM). Several governments are already evaluating the option of creating a national registry for project-based or subnational REDD activities.

6 CAR protocols for Mexico are currently under development.

7 The *VCS Standard* (2011, 16) states, "Where projects reduce GHG emissions from activities that are included in an emissions trading program or take place in a jurisdiction or sector in which binding limits are established on GHG emissions, evidence shall be provided that the GHG emission reductions or removals generated by the project have not and will not be used in the emissions trading program or for the purpose of demonstrating compliance with the binding limits that are in place in that jurisdiction or sector." In cases where a REDD+ country or jurisdiction may enter into a binding REDD(+)commitment or participate in a trading program (e.g., between some GCF member states) project proponents would be required to present some form of approval of project activities by (sub)national authorities.

Box 2. REDD Projects: One Eye on Voluntary Markets and One Eye on UNFCCC Post-2012

While the outcome of the UNFCCC negotiations on REDD+ remains uncertain and other carbon market schemes are emerging all around the world, projects have to seek common ground between competing, or even mutually exclusive, schemes to keep their options open. The following strategic consideration should guide developers in maximizing consistency between their activities and a changing policy environment.

Projects validated by both the VCS and the CCB Standards have a good chance of meeting the technical requirements and safeguards of a future UNFCCC REDD+ compliance regime. Projects located in countries adopting the national-level REDD+ Social and Environmental Standards (released in 2010 by the CCB Alliance and CARE International) may consult these standards for important additional guidance and on potential requirements for subnational activities. See Box 3 for more on these standards and where to find the list of participating countries.

Most standards make explicit reference to IPCC guidance and guidelines, though this does not necessarily mean that their protocols and methodologies are 100% IPCC compliant. An early discussion with national CDM or GHG inventory authorities could help to identify gaps or inconsistencies.

Achieving consistency between national reference emissions levels (RELs) and project baselines will become a challenge. UNFCCC negotiations are still far from a conclusion. To avoid overestimating the financial viability of a project, developers should consider the most conservative baseline approach (see Section 8) as one of the potential scenarios.

A consistent implementation of REDD+ activities across different levels (although at different speeds) provides an opportunity to share the burden of implementation and MRV costs. Nesting projects into higher implementation levels could avoid leakage discounts, reduce risks, and increase project performance maintaining consistency with national policy approaches to reduce deforestation and forest degradation. Consistency with national approaches is already an important eligibility criterion for private and public donors and investors considering supporting REDD+ projects.

Box 3. Recommendations and Key Resources for Navigating Standards, Policies, and the Market Environment

- Review the national REDD+ Strategies.
- Identify neighbouring subnational and project-based activities.
- Elaborate a Project Idea Note (PIN) and present the PIN formally to the DNA for a letter of endorsement and inscription in registries, where applicable.
- Discuss the project or program idea with the DNA and/or other relevant government representatives.

Project proponents may wish to consult the following websites:

Country R-PINs and R-PPs submitted to the Forest Carbon Partnership Facility can be accessed at:
http://www.forestcarbonpartnership.org/fcp/node/203

UN-REDD National Programs are detailed at:

www.un-redd.org/AboutUNREDDProgramme/NationalProgrammes/tabid/584/language/en-US/Default.aspx

A list of Designated National Authorities for the CDM is at:
http://cdm.unfccc.int/DNA/index.html.

The BioCarbon Fund's PIN template for LULUCF projects is available at:
http://wbcarbonfinance.org/Router.cfm?Page=DocLib&CatalogID=7110.

Comprehensive information and programmatic documents for the REDD+ Social and Environmental Standards released in 2010 by the CCB Alliance and CARE International can be found at:
http://www.redd-standards.org.
Here, project proponents can also identify which countries are adopting the standards.

2. Technical Guidance and Methodologies

2.1 Eligible Activities: A Preliminary Synthesis of VCS, UNFCCC, and IPCC

All AFOLU activities eligible under VCS, as well as LULUCF reporting of Annex I countries and REDD+, are based on IPCC guidance and guidelines. However, the independent development of voluntary forest carbon standards, the split in negotiating tracks under the UNFCCC, and the ongoing reporting of GHG inventories by Annex I countries all combine to yield a confusing panorama of eligible activities and terminology. While the technical specifications of LULUCF activities were consolidated under the Marrakesh Accords in 2001 and confirmed at COP 16 in 2010, there is no such clarity for eligible activities under REDD+. Nevertheless, technical specifications of activities eligible under UNFCCC REDD+ will be established in the near future and and might frame the use of voluntary market standards and GHG programs. Under VCS, AFOLU activities have been segmented into a diversified set of eligible project categories. Table 1 introduces the relation between IPCC key categories, VCS AFOLU project activities, and REDD+[8].

[8] According to IPCC (2006, Vol. 1, Chapter 4.1.1), a "key category" is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases. In the domain of Agricultural, Forestry, and Land-Use Change, key categories refer to land-use changes significant in terms of their absolute level, the trend, or the uncertainty in emissions and removals.

Table 1. Eligible Activities Under REDD+, the VCS,[9] and the IPCC

UNFCCC REDD+ (COP 16)	VCS AFOLU Requirements (Version 3.0)	IPCC 2006 Key Categories
Reducing Emissions from Deforestation	Avoiding Planned Deforestation (APD)	Forest land converted to cropland / grassland / wetlands / settlements / or other lands
	Avoiding Unplanned Deforestation and/or Degradation (AUDD)	
Reducing Emissions from Forest Degradation	Avoiding Unplanned Deforestation and/or Degradation (AUDD)	Forest land remaining forest land (managed land)
Conservation of Forest Carbon Stocks		Forest land remaining forest land (managed and unmanaged land)
Sustainable Management of Forests	IFM: Reduced Impact Logging (RIL)	Forest land remaining forest land (managed land)
Enhancement of Forest Carbon Stocks	Afforestation, Reforestation, and Revegetation (ARR)	Cropland / grassland / wetlands / settlements / or other lands converted to forest land
	IFM: Logged to Protected Forest (LtPF)	Forest land remaining forest land (managed land)
	IFM: Extended Rotation Age / Cutting Cycle (ERA)	
	IFM: Low-Productive to High-Productive Forest (LtHP)	
	ALM: Improved Cropland Management (ICM)	Cropland remaining cropland
	ALM: Improved Grassland Management (IGM)	Grassland remaining grass land
	ALM: Cropland and Grassland Land-use Conversions (CGLC)	Cropland converted to grassland
		Grassland converted to cropland
	PRC: Rewetting of Drained Peatland (RDP)	Wetlands remaining wetlands, wetlands converted to other lands
	PRC: Conservation of Undrained or Partially Drained Peatland (CUPP)	

In practice, multiple VCS activities can be combined in one project. Particularly, Peatland Rewetting and Conservation (PRC) activities can be combined with REDD and IFM activities. Sections 3.2 and 4.2.10-13 of the VCS *AFOLU Requirements* (2011) provide specific guidance on potential activity combinations. Project proponents may achieve economy and synergy where the determination of baseline and project scenarios and the demonstration of additionality can be combined. However, the VCS does require an independent risk assessment for every project activity (see VCS, *VCS Standard*, 3.2).

Projects seeking to implement activities to *avoid degradation* face particular methodological challenges. Although several approved VCS methodologies are already available,[10] these are mainly limited to commercial logging operations and certain

VCS Version 3.0 uses these (IPCC-compliant) definitions of deforestation and degradation:

Deforestation: The direct human-induced conversion of forest land to non-forest land.

Degradation: The persistent reduction of canopy cover and/or carbon stocks in a forest due to human activities such as animal grazing, fuel wood extraction, timber removal or other such activities, but that does not result in the conversion of forest to non-forest land, and falls under the IPCC 2003 Good Practice Guidance land category of forest remaining forest.

[9] VCS is currently considering the addition of new AFOLU project types, such as Avoided Conversion of Grasslands and Shrublands (ACoGS). This table refers to activities already approved under VCS Version 3.0.

[10] The VCS homepage (www.v-c-s.org) provides an updated overview on proposed and approved methodologies.

cases of fuelwood collection, while comprehensive methodological guidance on avoided unplanned degradation (as in AUDD) is still missing. One of the impediments to these projects is the challenge of suitably capturing current and future degradation patterns under a baseline, or without-project scenario, especially for unplanned and/or illegal activities (see Section 8). Furthermore, operational remote-sensing technologies can are limited in their capacity to detect the broad range of degradation impacts caused by illegal logging, fuel wood extraction, charcoal production, grazing, or edge effects of deforestation. Factoring out natural effects (e.g., droughts, fires, floods) causing similar degradation patterns is also a challenge in practice.[11]

The reference within REDD+ to *conservation of forest carbon stocks* is potentially misleading for projects seeking VCS validation. As Table 1 indicates, the VCS does not provide for a corresponding activity, as the conservation of forest carbon stocks cannot be considered an activity that sequesters or reduces GHGs. Nevertheless, conservation activities focusing on protected areas, species, or ecosystem functions might be eligible under the REDD project category if they concern areas threatened by (planned or unplanned) deforestation and degradation.

Of course, the choice of eligible activities for subnational or project-based activities does not depend solely on the eligibility criteria defined by standards and methodologies. Processing and monitoring costs, the technical feasibility of establishing an activity-specific baseline, and the political feasibility of potential mitigation options (e.g., improved forest governance or new incentive schemes) play important roles as well. Project interventions are further discussed with regard to technical design in Section 6 here, and other aspects that must be taken into consideration when designing project interventions are discussed throughout this series. Readers may consult the Step-by-Step Overview for a general discussion, and may see the Social Impacts, Community Engagement, and Business guidance documents in particular for a discussion of key issues affecting the feasibility and socioeconomic sustainability of proposed project interventions.

2.2. Technical Guidance and Methodologies for VCS Projects

The high-level requirements of the VCS, contained in several key documents, provide generic, though comprehensive, technical guidance for project developers. These documents are cross-referenced and updated frequently:

- The ***VCS Standard*** provides generic requirements for all projects and methodologies covered under the VCS Program. It also establishes validation and verification procedures and contains the rules on combining multiple activities and grouping projects, which are of particular importance for REDD+ projects. It is essential to consult the VCS Standard in addition to the VCS *AFOLU Requirements*.
- The ***VCS AFOLU Requirements*** define eligible activities and specific rules for these activities on baselines, leakage, and monitoring. This document is a must-read for project proponents and developers and is the main document for understanding the VCS framework on REDD.
- The VCS provides ***methodology elements*** (including methodologies, methodology revisions, modules, and tools, see box) that have been approved through a double-auditing process by accredited auditors. In addition, the VCS recognizes tools and methodologies of the CDM (which are partly referenced in VCS REDD methodologies). Generally, the choice of methodologies is bound to specific applicability and eligibility criteria to be met by the project.

[11] While projects under VCS have to address potential risks due to catastrophic reversal with their AFOLU risk assessment and contribute buffer credits (see Section 10), Parties to the Kyoto Protocol are currently discussing to what extent *force majeure* should be factored out from accounting for anthropogenic emissions.

- **A methodology** is a specific set of criteria and procedures, which apply to specific project activities, for identifying the project boundary, determining the baseline scenario, demonstrating additionality, quantifying net GHG emission reductions and/or removals, and specifying the monitoring procedure. In addition, VCS recognizes tools and methodologies of the CDM (which are partly referred to in VCS REDD methodologies). Generally, the use of methodologies is bound to specific applicability and eligibility criteria to be met by the project.
- A **module** is a component of a methodology that can be applied to perform a specific methodological task.
- **Tools** are types of modules that provide procedures for performing a specific analysis (e.g. AFOLU Non-Performance Risk Tool).

VCS documents (requirement documents, procedural documents, templates and forms) are subject to adjustments and updates. Changes are published on the VCS website and flagged through version numbering, and it is essential that project (and methodology) developers regularly consult the VCS website so that they reference the most recent version of these documents. Methodology numbers incremented using the "v3.x" format will still form part of VCS Version 3. As of June 2011, four REDD methodologies and five approved IFM methodologies have been approved, with four more REDD, five ALM, and two IFM methodologies undergoing the VCS Methodology Approval Process.[12]

So, how does one choose the right methodology that fits the project idea, eligible project activities (see Table 1), the site characteristics, and the socioeconomic or policy environment? Of course, the first entry point is the approved methodologies themselves. These are hugely complex documents at first glance, and instead of getting lost in hundreds of pages it is advisable to first check the methodology summary and the applicability criteria provided in the introductory section of each methodology. If the project idea and activities fit into the scope of the methodology, then its spatial boundary requirements and baseline approach (see Sections 4 and 8) should be carefully reviewed. In some cases, a project might fit into the requirements of different methodologies. If that is the case, the next step is to carefully check the complexity of each possible methodology, paying particular attention to the data and human resources required to establish the baseline under each in order to understand which methodology might be easier to handle in a given context.

Box 4. Scope for New Methodologies

Although the number of VCS methodologies is constantly growing, at the time of writing there are still some potential REDD activities which have not yet been fully covered.

- Only one approved methodology (VM0006) currently addresses unplanned degradation due to illegal logging.
- REDD in coastal wetland forests, such as mangroves, has not yet been covered by any methodology, though a large-scale CDM AR methodology (AR-AM0014) is now available. The VCS Association is seeking to expand the standard's scope for wetlands, partly through developing guidance specific to mangroves and coastal and tidal marshes. Reducing both illegal logging and deforestation and degradation of tidal forests hold great potential for co-benefits in biodiversity conservation and will play an important role in several REDD+ countries.

[12] Approved VCS methodology elements can be found at http://www.v-c-s.org/methodologies/find, and methodology elements under development are listed under http://www.v-c-s.org/methodologies/in-development.

- Several countries face specific challenges regarding the links between the forest definition and eligible activities. While the VCS categories of eligible AFOLU activities (see Table 1) are straightforward, UNFCCC parties are still struggling with the roles of forest plantations and agroforestry systems within REDD+. Under certain conditions, these systems could provide substantial carbon and socioeconomic benefits while contributing to forest restoration and even forest conservation by reducing the pressure on natural forests. However, the UNFCCC and voluntary mechanisms have to be careful not to create perverse incentives for forest conversion by making these systems eligible without any constraints. Safeguards and new methodologies are required to define the role of tree crops (e.g., cocoa, citrus, latex-producing plants, cashew, oil palm, coconut, mango, and tea) at the interface between agricultural land management (ALM) and REDD.

At this stage it should become clear whether a project idea fits into an approved methodology or not. If it does not, it is worth screening the methodologies under development in the VCS Methodology Approval Process. Developers should bear in mind that these methodologies might undergo substantial changes, as some of them will not have passed the double-audit process yet. They should also check the public comments, if any, to better understand the perceived limitations of methodologies in development. The VCS website also notes at what stage of the approval process (first assessment, second assessment, or VCS review) the methodology is in, and an updated version of a methodology in development is posted after it passes the first assessment.

In case the project idea fits neither an approved methodology nor one currently under validation, the project proponent must adjust the project's planned activities or spatial boundaries (see Section 4), submit a methodology revision, or develop a new methodology. This last option is, however, not one to choose lightly, since it will almost certainly imply significant additional time and expense. Where project proponents have difficulty identifying an applicable methodology this may be a reflection of fundamental difficulties in quantifying the GHG benefits of this type of activity in a verifiable way (e.g. the case of emissions from unplanned degradation), and project developers should not simply assume that this hurdle can be overcome. Not all activities that might produce GHG benefits can quantify and document these in commonly accepted ways (see Step-by-Step Overview and Guide).

While the VCS has established procedures for the auditing and approval of new methodologies, it has also built in requirements to safeguard against an unnecessary proliferation of methodologies. First, developers must show that "no approved or pending methodology under the VCS Program or an approved GHG program could reasonably be revised to meet the objective of the proposed methodology" (Section 5.2.1).[13] Second, a new methodology requires passing the process of double assessment outlined in the VCS *Methodology Approval Process* (2011), the costs of which are borne by the developer. Finally, experience indicates that the development and double assessment of a new methodology is complex and could take from several months up to two years depending on the complexity, length, and quality of the methodology and the management of the process by developers and auditors.

Alternatively, project developers may be convinced that an approved methodology needs to be adjusted, and in this case revising an existing methodology may provide a more reasonable path. It is not uncommon for project developers to see the need to revise methodologies to make them fit to site-specific characteristics. VCS Version 3.0 provides procedures for the revision and deviation of methodologies (outlined in VCS *Standard*, Section 4.2, and VCS *Methodology Approval Process*, Section 6.2), which must be followed. Revising approved methodologies in the process of project design requires initiating the methodology approval process again, as validation and verification

[13] According to VCS *Methodology Approval* Process (2011, Section 5.3.1), methodology revisions are appropriate where a proposed activity or measure is broadly similar to an activity or measure covered by an existing approved methodology such that the proposed activity or measure can be included through reasonable changes to that methodology.

bodies are authorized only to audit a project against approved standards and methodologies, not to approve revisions. In cases falling short of a revision, "deviations" may be accepted during project validation. In these limited cases, methodology deviations are allowed only insofar as they refer to "criteria and procedures relating to monitoring or measurement (but not quantification) of GHG emission reductions or removals" (VCS, Standard, Section 3.5).

If none of these options really satisfies the project's needs and circumstances then, in principle, project proponents may consider negotiating to nest activities into a (sub)national compliance framework[14] based on a legally-binding agreement assigning future financial REDD+ benefits to the activity and/or its proponent. In this case, project proponents and regulators would have to agree on eligible activities and on how to use the emerging (sub)national measurement, reporting, and verification (MRV) approach at the project level. Although there are currently no examples of this nested approach being applied, it is likely that performance-based benefit sharing will become a building block of future REDD+ compliance frameworks under the UNFCCC. Given the nascent nature of national REDD+ legislation and procedures in many countries (e.g., regarding accounting, MRV, revenue allocation), the risks of this uncharted approach must be weighed against the risks of developing a voluntary project which may ultimately be "stranded" if it does not integrate into national REDD+ frameworks.

The VCS Association has already established an Advisory Committee on nested REDD+ options to provide strategic input and guidance into the conceptual development of the VCS Jurisdictional and Nested REDD Initiative, which will set criteria and procedures for operationalizing jurisdictional and nested REDD. Eventually, this process might lead to a greater integration of VCS-based and compliance-based REDD+ accounting. An ongoing exchange between project proponents, national and jurisdictional authorities on domestic technical requirements might be an opportunity for project proponents to influence project eligibility criteria at the national or jurisdictional level.

Box 5. Recommendations and Key Resources for REDD Project Developers on Methodology Selection

- Focus on activities with the greatest viability under current conditions, including those
    - Which can address deforestation and degradation pressures;
    - For which approved or submitted methodological elements are already available; and
    - Which achieve (co)benefits at an early stage during implementation phase.
- Check VCS guidance and announcements frequently during project development to ensure that most current documents are being used. Sign up for the VCS e-mail list to receive news and notifications.
- Coordinate as closely as possible with government agencies to increase likelihood of projects' being recognized or nested into national systems as these emerge
- The combination of multiple activities within one project does not necessarily lead to economies of scale in terms of costs. Carefully estimate future monitoring and implementation costs before taking a decision in favor (or against) including certain activities.
- Review VCS methodologies' scope and applicability conditions to determine which may be appropriate for proposed project activities. Consider developing a new methodology only as a last resort, and try to make it fit into the national and jurisdictional framework.

[14] In fact, any project (including those developed under current VCS rules/requirements) may also seek to nest activities into (sub)national frameworks.

Project developers may also want to consult these key resources:

Pearson, Timothy, Sarah Walker, and Sandra Brown. Sourcebook for Land Use, Land-Use Change and Forestry Projects. Winrock International and World Bank BioCarbon Fund, 2005. Available at: http://www.winrock.org/ecosystems/files/winrock-biocarbon_fund_sourcebook-compressed.pdf.

GOFC-GOLD. A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals caused by deforestation, gains and losses of carbon stocks in forests remaining forests, and forestation. Report version COP16-1, Alberta, Canada: Natural Resources Canada, 2010. Available at: http://www.gofc-gold.uni-jena.de/redd/.

3. Temporal Boundaries

3.1 Project Start Date

Project proponents are requested to define the project start date. Proxies for the start date may be the starting dates of certain project activities, such as "preparing land for seeding, planting, changing agricultural or forestry practices, or implementing management or protection plans" (VCS, *Standard*, 2011, Section 3.2.1). These project activities must be demonstrated to be additional using the *Tool for the Demonstration and Assessment of Additionality in VCS AFOLU Project Activities* (Tool VT0001) or another approved additionality tool for other standards.

Project Start Date: The date on which the project began generating GHG emission reductions or removals.

Source: VCS Standard (2011)

The choice of the project start date triggers the definition of the crediting period, the baseline period, the monitoring period, and the validation period. In case of REDD, the availability of suitable activity data, the availability of project finance, and the level of pre-agreements with project participants and stakeholders will influence the start date definition.

3.2 Project Crediting Period

Under the VCS, the crediting period for REDD, IFM, and PRC activities "shall be a minimum of 20 years up to a maximum of 100 years, which may be renewed at most four times with a total project crediting period not to exceed 100 years" (VCS*, Standard*, 2011, Section 3.9). AFOLU projects are required to have a "credible and robust plan for managing and implementing the project over the project crediting period" (VCS, *AFOLU Requirements,* Section 3.3.1). The renewal of the project crediting period is subject to reassessment of the validity of the original baseline scenario (VCS, *Standard*, Section 3.9.1).

3.3 Historical Reference Period

In order to establish future projections of the baseline scenario, all VCS AFOLU methodologies require an analysis of historical rates and patterns of deforestation and/or degradation. Methodologies vary in their approach to using this data for establishing the baseline (see Section 8 for further discussion), but it may be used for the development of a model to estimate future deforestation. If project developers use a modeling approach to establish a reference emission scenario, historic earth observation data will be required for at least four points in time (including project start, 10 years prior, and two other points prior to project start). It is good practice to use at least three years (or two periods) to calibrate a model and one period to validate it prior to project start. However, data quality (hindered by, for example, clouds) and availability might impose restrictions on the definition of temporal boundaries.

3.4 Baseline Period

The VCS has established specific requirements for the temporal boundaries of the baseline period under each of the AFOLU activity categories (ARR, REDD, ALM, IFM, and PRC). In the case of Avoided Unplanned Deforestation and/or Degradation (AUDD) projects, the baseline analysis has to be "based on historical factors over at least the previous 10 years that explain past patterns and can be used to make future projections of deforestation" (VCS, *AFOLU Requirements,* Section, 4.4.8.2a). The case of Planned Deforestation (APD) differs, as the baseline has to be based on official conversion plans demonstrating that the project area was intended to be cleared (VCS, *AFOLU Requirements*, Section 4.4.8 1).The *AFOLU Requirements* stipulate that project proponents must reassess the baseline every 10 years. This reassessment will cover the drivers and agents of deforestation in addition to the baseline approach itself; the reassessment will be validated at the same time as the subsequent verification. This baseline update may, in the future, provide the most appropriate time to reconcile with a (sub)national baseline, if one has been developed.

3.5 Monitoring Period

The VCS encourages projects to seek external verification every five years by stipulating that non-permanence risk buffer credits may be released or held based on this period (see Section 10). Proponents have to define the appropriate monitoring period and the monitoring frequency for activity data and modeling parameters. Deviations from the monitoring plan are generally permitted, provided the project remains in compliance with the applied methodology.

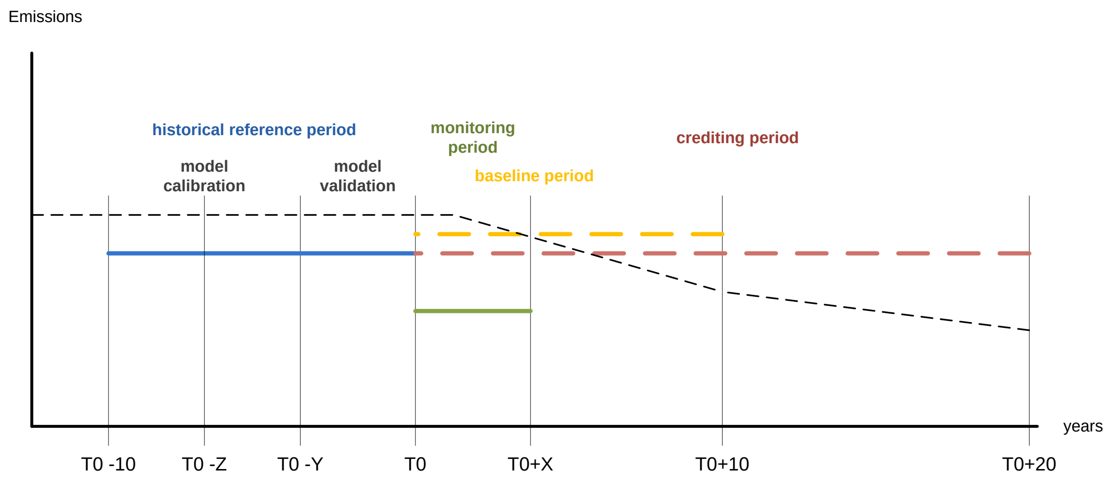
Project proponents may wish to have more frequent monitoring and verification events to maximize carbon revenues and integrate monitoring results into project management to improve performance (see Step-by-Step Overview). Project proponents should ideally synchronize the monitoring period with future verification milestones, anticipating time lags due to seasonal limitations of data acquisition and data processing. If there is an emerging national or jurisdictional REDD+ scheme, it is advisable to synchronize the monitoring periods with the MRV activities of this scheme to make use of national data sets and to avoid temporal inconsistencies in GHG accounting across different levels (as long as these data sets are compatible with the applicable methodology). More frequent verification events may also be chosen for earlier or more frequent delivery of VCUs, entailing more frequent monitoring. While more frequent monitoring and verification comes at a cost (up to ~$20,000-$40,000 for verification, depending on project characteristics) this additional expense may be justified if project scale allows this cost to be distributed across a significant volume of emissions reductions (see Business Guidance).

3.6 Validation Period

Validation is the independent assessment of the project by a validation/verification body that determines whether the project complies with the VCS rules. In version 3.0, VCS specifies that AFOLU projects must complete validation within five years of starting activities. This rule will set the validation terms for most of the currently ongoing REDD activities.[15]

Project developers should note that the term "validation" is used differently in the context of modeling and computational science, where it refers to a process of determining "whether a model represents and correctly reproduces the behaviors of a real-world system" (North and Macal 2007, 226).

Figure 1. Temporal Boundaries of a Project-Based Approach



Box 6. Recommendations for Defining Temporal Boundaries

- Look for alignment with the temporal structure of national and jurisdictional forest monitoring and inventory approaches. Synchronicity and agreements on data sharing might provide significant cost savings.
- If no suitable data is available, or can only be obtained by combining different data source at a high cost, proponents might want to consider adjusting the temporal boundaries according to data availability or choosing a less data-demanding baseline approach (see Sections 7 and 8).
- Consult the national REDD+ planning documents (referenced in Box 3) and the remote sensing data archives (Box 11).

[15] This rule is limited to those projects that will complete validation on or after March 8th, 2013. Separate validation rules for projects that started before 2002 are laid out in *VCS Standard* (2011, Chapter 3.8.2).

4. Spatial Boundaries, Stratification, and Zoning

4.1 Eligible Lands

The VCS has established several binding criteria affecting the choice of project sites, including requirements on the forest definition and control over the area as well as criteria specific to particular AFOLU categories and particular methodological elements.

Forest definition: The VCS stipulates that boundaries of REDD projects may only encompass areas qualifying as forest,--including mature, secondary, or degraded forests--for a minimum of 10 years before the project start date. Projects must apply an internationally-recognized forest definition, such as the official national definition submitted to the UNFCCC[16] or a FAO definition.[17] This point should be emphasized because while many projects may include activities that take place on non-forest lands (e.g., improving agricultural productivity or woodlots for fuelwood), these areas cannot be included within the REDD project boundaries. (They may, however, be part of the leakage belt or reference area, or could be included in the project boundary if multiple project activities (e.g., ALM) are implemented and the appropriate methodologies applied).

Proof of control: Under the VCS, project proponents must "demonstrate control over the entire project area with proof of title with respect to one or more rights of use accorded to the project proponent as set out in the VCS Standard."[18] Experience has shown that this key requirement can be an obstacle if projects cannot provide the appropriate documents, approvals, contracts, or whatever is needed to establish proof of title or right of use. Thus, project proponents should assess early on whether the project can fulfill this requirement. It should also be noted that the VCS allows project proponents to postpone fixing the final, legally-binding project boundary until the first verification, providing specific rules for cases where less than 100% of the project area is under full control of the proponent at the time of validation (VCS, *AFOLU Requirements,* Section 3.4.2 1).

Specific criteria by AFOLU category: Eligible lands depend on the AFOLU category, too. For instance, project areas of Improved Forest Management (IFM) activities in logging concessions or plantations must be "designated, sanctioned, or approved for wood product management by a national or local regulatory body" (VCS, *AFOLU Requirements*, Section 4.2.3).

Specific criteria to each methodology: Once a potential forest area has been identified, proponents should carefully review the applicability criteria of the chosen approved methodology, as they might further limit the eligible potential project area.

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[16] UNFCCC parties have not yet agreed how to frame the forest definition to be applied by REDD+ activities. Several parties have chosen a definition based on the three threshold parameters (minimum crown coverage: 10 -30%, minimum tree height: 2 – 5m at maturity in situ, minimum forest area: 0.05 – 1 ha) agreed in the Marrakesh Accords for the CDM (see CDM Rulebook).

[17] FAO (2100) defined forest as "land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use."

[18] VCS, *AFOLU Requirements* (2011, Section 4.2.5), referring to *VCS Standard* (2011, Section 3.12.1).

4.2 Spatial Boundaries

Under the VCS, AFOLU projects must provide specific information on project location, using "geodetic polygons to delineate the geographic area of each AFOLU project activity," and this data should be provided in a KML file (VCS, *Standard*, Section 3.11 3).[19]

4.3 Stratification

Once a potential site has been identified, its land area needs to be stratified. In the context of GHG-accounting stratification aims at separating the forest in terms of carbon stocks into relatively homogenous units, "so that the variation within each forest type (stratum) is minimized at the expense of the variation between the forests (strata)" (Maniatis and Mollicone 2010) . Minimizing the variation of carbon stocks within each stratum increases the accuracy of the corresponding emission factors and, hence, reduces the risk of suffering discounts due to greater uncertainty.

IPCC (2006) recommends stratifying by climate, soil, ecological zone, and management practices (Vol. 4, Chapter 3.3.2.1), which has been broadly reflected by REDD methodologies approved under VCS.[20] Existing vegetation maps should be consulted to build an initial hypothesis. The primary purpose of stratification is to reduce monitoring efforts. However, there is a risk of over-stratifying a site, leading to unnecessary measuring and monitoring costs. An initial assessment might start using the IPCC tier 1 default stratification (IPCC 2006, Vol. 4, Annex 3A.5) in conjunction with default emission factors provided by the IPCC emission factor database. The Carbon Stocks Assessment Guidance contains a more detailed discussion of the options and requirements for stratification.

4.4 Zoning

Depending on the type of activity, spatial boundaries reach beyond the project area. A REDD project may typically include areas within project boundaries, a *leakage belt*, and a *reference area*. The overall sum of the project area, reference area, leakage belt, and leakage management area could easily reach double of the size of the project area, depending on the methodology.

Activities avoiding unplanned deforestation and/or degradation (AAUDD*)* "require the project proponent to develop a baseline by determining and analyzing a reference area (which need not be contiguous to the project area), that shall be similar to the project area in terms of drivers and agents of deforestation and/or degradation, landscape configuration, and socio-economic and cultural conditions" (VCS, *AFOLU Requirements*, Section 4.4.8.2c). Reference areas are measured and monitored in order to establish and update baseline rates of deforestation or degradation expected to affect the project area. [21] Methodologies differ on requirements for delineating the reference area. Commonly, they define quantitative parameters (e.g., driver constellation, socioeconomic conditions, landscape

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[19] Actually, the term *geodetic* refers to geometric accuracy levels higher than one meter. Providing geodetic polygons requires contracting topographers, which would increase project design costs tremendously where no rural cadaster is available. Personal communication with VCS indicates that this accuracy level is not intended to become mandatory.

[20] VCS does not explicitly prescribe stratification. However, approved REDD methodologies provide for specific requirements and approaches to establish a relevant stratification which frames the size and location of the reference region as well.

[21] The definition of the spatial boundaries of the reference area might appear to be a bit confusing and, in fact, depends on the selected methodology. VCS Version 3.0 requests methodologies to define a *reference area*, while some methodologies use *reference area* and *reference region* as synonyms. In fact, both refer to the same idea of having a spatial entity providing for the land-use change dynamics, rates, and patterns in the with-project case.

configuration, vegetation types) to be assessed to demonstrate the structural similarity between the reference area and the project area to delineate the spatial boundaries of the reference area using simple spatial models within a Geographic Information System (GIS). While some VCS methodologies request the reference area to be contiguous with the project area, others do not.[22] Methodologies also differ in their criteria on how to determine the size of the reference area, which could become much larger than the project area.[23] Sometimes project developers will face challenges in finding a reference area sufficiently similar to project areas (e.g., in terms of driver constellation or ecological characteristics) that meets the size requirements of the methodology. In such cases it might be advisable to consider using other methodologies which might be more flexible regarding the minimum size, or to provide the validator with evidence showing that the requested size cannot be achieved. To avoid the risk of failing validation it is advisable to discuss this issue upfront with the project validator.

Box 7. Recommendations for Key Resources on Spatial Boundaries, Stratification, and Zoning

- Be wary of small projects, especially those with low baseline deforestation rates or areas. Experience shows that REDD projects are likely to suffer reductions in eligible emission reductions during design and validation, and this can impact the project's financial feasibility.
- Verify if a national REDD stratification scheme has already been predesigned, and, if so, embed the site within the national stratification. Keeping in mind that biomass measurements are expensive, start with a simple stratification scheme following the guidelines of IPCC (2006). A complex stratification could cause high monitoring costs in the future.
- Delineate the reference area in a way that is most consistent with the driver constellation and socioeconomic characteristics of the project area.
- Check earth observation data quality and availability before making any decisions on sites, zoning, temporal boundaries, and modeling technology. Besides the USGS Landsat archive, ground stations all around the world provide additional Landsat data.

Project developers may want to consult, in particular:

IPCC. *2006 IPCC Guidelines for National Greenhouse Gas Inventories.* Hayama, Japan: Intergovernmental Panel on Climate Change, 2006.

See, in particular, Volume 4, Chapter 3: Representation of Land.

IPCC Emission Factor Database, available at: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php.

International Ground Station (IGS) Network, available at: http://landsat.usgs.gov/about_ground_stations.php.

Provide lists of Landsat receiving stations and their coverage.

USGS Global Visualization Viewer. Available at: http://glovis.usgs.gov/

Provides a USGS map interface for earth observing data search.

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[22] VMD0007 distinguishes a reference region for projecting the rate of deforestation, "which doesn't need to be contiguous with and shall not encompass the project area or the leakage belt," from a reference region for projecting location of deforestation contiguous with the project area. VM0006 offers a different approach. Here, the reference area includes the project area and leakage area before project start (that is, for the historic part of the baseline period; see Figure 1), but excludes them from the projected baseline period (T0, T0+10 in figure 1).

[23] While VMD0007 introduces a specific formula to define the minimum size of the reference area other methodologies are more flexible regarding the size.

In addition, some methodologies establish specific rules for defining leakage management areas, or leakage belts exposed to activity shifting (see Section 9 for a discussion of leakage). While methodologies do not prescribe a minimum size of the leakage area or belt, some request a spatial analysis to determine the potential movement of agents in shifting their activities (mobility analysis) or the analysis of the economic potential that agents might continue market-related activities outside the project area (opportunity cost analysis). Both approaches require socioeconomic and spatial data to be processed in a GIS.

5. Analysis of Drivers, Causes, and Agents

5.1 The Importance of Drivers, Causes, and Agents Analysis

REDD is fundamentally about tackling the drivers, causes, and agents of deforestation and degradation. Without a coherent analysis of these elements, it will be difficult or impossible to define project interventions that can effectively lower emission rates and achieve lasting (permanent) success (see Section 6). Moreover, this analysis contributes to many other essential aspects of project development, starting with an assessment of on-the-ground project feasibility (see Step-by-Step Overview) and designing project interventions. It is also necessary for the definition of the reference areas and leakage belt (see Section 4.4) as well as for deciding on a baseline modeling approach (see Section 8) and monitoring baseline assumptions. Moreover, the definition of agents and drivers will have implications for the risk assessment (see Section 10). Finally, developing a causal model of drivers, causes, and agents—especially, understanding the motivations of agents and benefits derived from deforestation—is an integral part of assessing the social impacts of a project (see Social Impacts Guidance) and engaging communities (see Community Engagement Guidance).

While it is obvious that the drivers, causes, and agents analysis triggers several important methodological decisions, the conceptual foundations are quite vague. Due to the variety of potential drivers and agents on the ground, neither the *VCS Standard* nor the VCS *AFOLU Requirements* address them beyond mentioning their importance for re-assessing the validity of the baseline in the future and for establishing the spatial boundaries of the reference area. Consequently, the approved methodologies frame these concepts differently.[24] However, a conclusive understanding of tangible drivers, underlying causes partially beyond the direct control of project proponents, and agents is pivotal for project success and the credibility of its baseline, and this guide encourages project developers to thoroughly assess and document them.

5.2 Conceptual Foundations

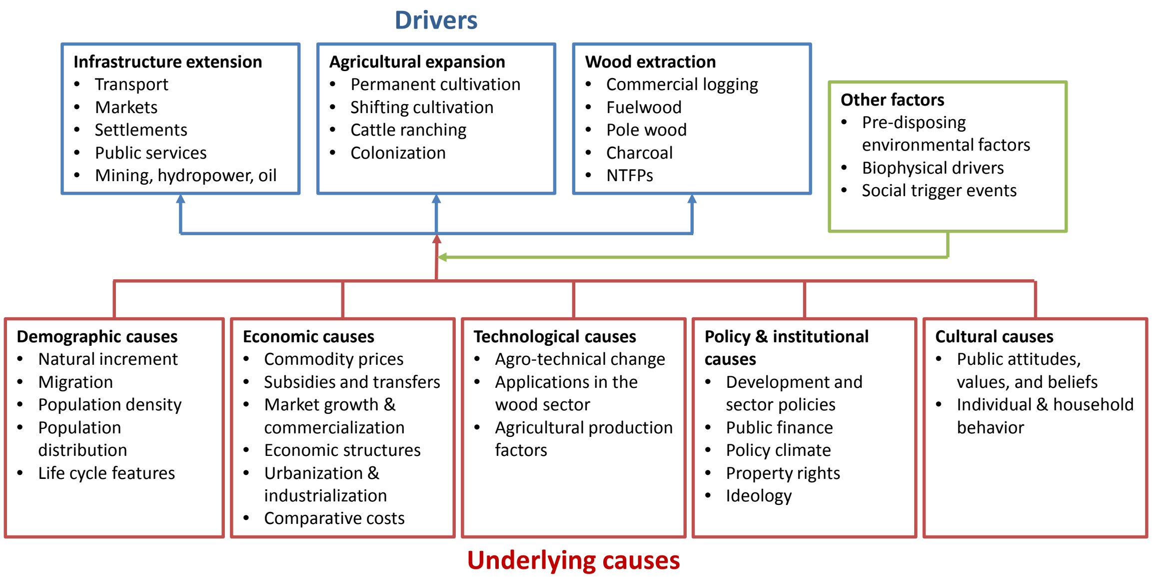
Geist and Lambin (2002) developed a framework to systemize possible proximate causes (the so-called "drivers") and underlying driving forces ("underlying causes").[25] Within this framework, *immediate human actions directly*

[24] VM0009 doesn't distinguish between underlying causes and drivers. Instead, it outlines a broad scope of potential drivers in the broadest sense (p. 28). VM0006 introduced a distinction between geographically constrained and unconstrained drivers (p. 10) and defines "driver" more along the eligible activities stating, that a "driver of deforestation is the immediate activity executed by agents of deforestation/degradation that leads to deforestation/ degradation" (p. 11 footnote 5), listing different types of logging, land conversion and fuel wood extraction. VM(D)007 focuses almost exclusively on the behavior of deforestation agents.

[25] This chapter follows the distinction between drivers and underlying causes anticipated in UNFCCC negotiations.

impacting forest cover (infrastructure extension, agricultural expansion, wood extraction, and other factors) are considered as drivers; while demographic, economic, technological, cultural, policy, and institution factors form a specific set of fundamental social processes considered as underlying causes, which a project could only partially control.

Figure 2. Drivers and Underlying Causes of Deforestation



Adapted from Geist and Lambin (2002).

Initially, a project developer will establish a hypothesis about the specific driver constellation and the relevant agents affecting the project's forests. Project developers will frame the drivers and agents on the basis of available information and potentially identify data gaps and questions to be addressed ahead. The relative importance of underlying causes is far more difficult to assess at an early stage, as it requires knowledge of how certain causes frame the behavior of different agents. Ignoring them would, of course, lead to misconceptions. Thus, developers have to be conscious that their initial framework will certainly change. Consequently, VCS requires the baseline to be reassessed every 10 years.

Under optimum conditions, project developers would be capable of quantifying the weight of different drivers and transform a fully understood driver and underlying causes constellation into a modeling and policy framework, which would provide a reliable business-as-usual (BAU) scenario and outline effective project interventions to reduce deforestation and forest degradation. This is rarely the case. In the initial phase of project design, developers have to rely mostly on preliminary deforestation and degradation assessments,[26] published reports, or expert judgment. In most cases, reliable data is not readily available to track the importance of certain drivers in the past. Furthermore, feedback patterns between drivers and underlying causes are usually not fully understood and/or subject to high

[26] The drivers, causes, and agents analysis would significantly benefit from a reliable analysis of past deforestation patterns and rates. However, most projects will consider investing in a thorough change detection analysis (see Section 7.2.2) only once the overall emission reduction or sequestration potential has been estimated, based on the driver and agents' analysis as well as on the design of project interventions (see Section 6).

uncertainties. Thus, developers are encouraged to start with the change detection analysis (see Section 7.2.2) during the preliminary assessment (see Section 11.3) to reduce uncertainties regarding the quantitative and structural aspects of deforestation. Once the information has been compiled, the analysis of the drivers and agents constellation could follow a two-step approach:

- Depending on the eligible activities, project developers may want to start with a *description of the agents of deforestation* (and degradation), either by doing a desktop review of available information, a visual analysis of the spatiotemporal deforestation pattern,[27] socioeconomic field work, or a comprehensive participatory mapping exercise.
- Once the agents are identified, available information on drivers and underlying causes should be comprehensively documented. This could take the form of a matrix linking the drivers and their underlying causes with agents and available data sources; such documentation can be usefully integrated with the assessment of social impacts (as described in Social Impacts Guidance, particularly Stages 1 and 2).

Box 8. Recommendations and Key Resources for Analysis of Drivers, Causes, and Agents

- Develop the agents and driver analysis in an iterative, participatory, and explicit way. Future program staff, stakeholders, or partners might differ in their perception of the agents, drivers, underlying causes--and of their relative importance. Making the analysis's fundamental assumptions clear helps to keep interventions and management on track.
- Keep the agents, causes, and drivers analysis consistent with the conceptual model of the baseline modeling framework, the definition of the socioeconomic baseline, and, if appropriate, the (sub)national reference scenario.

Project proponents and developers may also wish to consult the following resources:

Chomitz, Kenneth M., Piet Buys, Giacomo De Luca, Timothy S. Thomas, and Sheila Wertz-Kanounnikoff. At Loggerheads: Agricultural Expansion, Poverty Reduction, and Environment in the Tropical Forests. Washington, DC: The World Bank, 2007. Available at: http://siteresources.worldbank.org/INTTROPICALFOREST/Resources/2463822-1161184206155/3060670-1161608416166/PRR-AL_SAOverviewwebnonembargo.pdf.

Participatory Mapping Toolbox, available at: http://www.iapad.org/toolbox.htm.

Geist, H., and E.F. Lambin. "Proximate causes and underlying driving forces of tropical deforestation." Bioscience, 2002: 52(2): 143.

The Social Impacts Guidance of this series also discusses relevant resources and tools for elaborating a project's theory of change, which is (for REDD+ projects) largely based on a detailed drivers, causes, and agents analysis.

Discussions on the UNFCCC level are also informed by the importance of this issue. In its decision on REDD, the Parties at COP15 requested countries to identify drivers of deforestation and degradation (UNFCCC, 4/CP.15, 2009). Clearly, understanding the drivers and underlying causes in a given national context is essential for establishing the reference

[27] If no preprocessed spatial data is available, Google Earth might provide a first glance on what is actually going on in the reference region.

emission level and for shaping policy measures and national strategies. However, subnational and local circumstances might frame the agents' behavior in different ways.

6. Defining Project Interventions

6.1 Transparent, Conservative, Inclusive, and Adaptive Planning

Once the site, reference region, agents, drivers, and underlying causes have been identified, it is time to define realistic options for tackling the existing or projected causes of deforestation. Although it may seem obvious, measuring and monitoring carbon stocks is not what will make REDD succeed. As is frequently the case in drivers-and-agents analyses, many projects seem not to invest sufficient effort into working out realistic and effective interventions targeted towards the key deforestation drivers. Arguably, what has hampered efforts to tackle tropical deforestation to date is not just a lack of finance – which one hopes may be addressed through REDD – but, to a perhaps even larger degree, the lack of effective and pragmatic measures to counter complex socio-economic drivers on a policy and project level.

How does the project want to reduce deforestation? What options are technically, financially, politically, or legally feasible? Shall the program create new direct incentive schemes, improve forest governance, or stimulate poverty reduction? Will it involve all agents or only a subset of stakeholders? What are the low-hanging fruits that might provide the most beneficial mitigation potential on short-term? These are only some of the questions that need to be asked at the project assessment, design, and planning stage (see Step-by-Step Overview). It has to be clear whether a proposed subnational or project based intervention is worth the effort. Under certain conditions, reducing deforestation and forest degradation may simply be too expensive or politically unfeasible.

There are also formal reasons for addressing these questions at an early stage. The VCS requires proponents to present conservative *ex-ante* estimations of the net anthropogenic GHG emissions reductions of the REDD project activity. It has to be clear how this emission reduction potential can be achieved.

The development and natural resources management community has developed many tools to support project developers in understanding the causal relationships between socioeconomic, environmental, or natural resources problems, development objectives, potential intervention strategies, and activities. Although the current reality of developing countries, unfortunately, cannot be considered resounding proof of success, these tools help to identify and assess potential intervention strategies upfront. The Community Engagement Guidance contains a specific discussion of these tools and strategies.

Once the intervention strategy and the activities of the with-project scenario have been identified, they must pass the additionality test, and their emission reduction potential has to be conservatively estimated. It goes without saying that policy shifts and socioeconomic adjustments require time. It is advisable to conservatively underestimate the emission reduction potential to avoid a situation where a project becomes unviable because of overambitious targets or unrealistically tight planning.[28]

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[28] The time requirements for validation/verification can be anywhere from 2 to 6 months and should be considered when planning for the sale of credits to fund project activities, or if commitments to credit purchasers have been made.

Box 9. Recommendations and Key Resources on Defining Project Interventions

- Use project cycle planning tools, i.e., the Logical Framework Approach, or problem tree analysis to scope different options of project interventions.
- Revise the policy options of the national REDD strategy to identify the potential for synergies, complementary approaches or potential conflicts between national and subnational policy priorities.
- Evaluate the options in a participatory manner involving agents and different stakeholders.
- Carefully define project management system. Roles and responsibilities must be clearly defined, and management systems must be established in order to ensure the project functions well and in a timely manner consistent with the anticipated chronological plan outlined using the planning tools. Factor in adaptive management mechanisms.

Project proponents and developers may also wish to consult the following resources:

The EU Project Cycle Management Guidelines introduce tools like the Logical Framework Approach, Problem Tree Analysis, among others, available at: http://www.acp-programming.eu/wcm/dmdocuments/pcm_manual_2004_en[1].pdf.

The Participatory Mapping Toolbox, available at: http://www.iapad.org/toolbox.htm.

Project management software can support project planning, budgeting, and controlling. Besides commercial packages like MS Project there are several freeware tools available, e.g., Project-Open (http://www.project-open.com/index.html) and GanttProject (http://www.ganttproject.biz/).

7. Detecting Deforestation and Degradation Rates

7.1 The Role of Forest Cover Monitoring in Emissions Accounting

Essentially, estimates of forestry GHG emission reductions and removals are based on two types of data. **Emission factors** provide the carbon densities capturing either carbon stocks or stock changes for different forest or other land use classes (see Step-by-Step Overview and Carbon Stock Assessment Guidance). **Activity data**, on the other hand, refers to data on the magnitude of human activity resulting in emissions or removals taking place during a given period of time (IPCC 2003). In the case of REDD, activity data is usually generated by processing remote sensing products to quantify the magnitude and fate of land use change.[29] VCS methodologies request up to four different products to be elaborated using remote sensing:

29 Strictly linking the determination of emission factors to forest inventories and activity data to remote sensing is, of course, an over-simplification. Forest inventory approaches have been widely used to statistically determine deforestation rates (GOFC-GOLD 2010). And polarimetric radar imaging is already capable of approximating above-ground biomass in homogenous stands (Lee and Pottier 2009). Efforts are already underway to combine radar and other remote sensing techniques to quantify above-ground biomass in an operational mode (Saatchi et al. 2007, 2011). The European Space Agency is currently preparing the BIOMASS mission scheduled for 2017, to determine the distribution and temporal changes of forest biomass at a global scale. Thus, in the near future, activity data and emission factor monitoring might

- An initial **forest mask** based on an official forest definition indicating the forest boundary ten years prior to project start (see Section 4.1);
- The detection of **spatial deforestation or degradation patterns** over a given period; and
- The **historic land-use change matrix** indicating changes (or key categories, in IPCC terms) from forest to different land use categories.
- Additionally, it might be necessary to provide a **classification of the forest types** if no reliable forest stratification is available.

Basically, these products will be used to establish and calibrate the baseline; to monitor project performance inside the project area, the leakage belt, and the leakage management area; and to project the future deforestation dynamics inside the reference area.

The choice of activity data depends on the type and scale of the activities to be mitigated. Measuring the impacts of small-scale deforestation requires higher resolution products than estimating the impacts of crop production at an agro-industrial scale. The choice of the monitoring frequency depends on the temporal boundaries, the type of activity to be assessed,[30] and existing or planned efforts to monitor forest cover within (sub)national REDD+ activities. It is not uncommon for historic temporal boundaries to have been chosen according to the availability of historical cloud-free optical data, especially in areas that experience regular cloud coverage. Spatial and temporal boundaries of the project impose certain restrictions, too.

A discussion of earth observation methods, data, tools, and processing steps is outside the scope of this chapter. However, it should be noted that some VCS methodologies establish additional requirements which have to be considered. GOFC-GOLD (2010) provides comprehensive guidance on all of these aspects, but processing and analyzing remote sensing data is a specialized area of expertise which will need to be conducted by a professional trained in this field. Many project proponents will not have this skill set available in-house and will need to secure the required expertise from outside professionals or institutions. The following paragraphs are meant to complement available information and flag some key issues for the application of these methods in REDD+ projects.

7.2 The Choice of Sensor Products and Processing Methodology

7.2.1 The Initial Forest Mask

Generally, the initial forest mask is based on imagery processed to detect historic deforestation. Following the requirements for temporal boundaries (see Section 3) the forest mask must be established to delimit the area with forest cover from ten years prior to project start. Most projects choose Landsat 2000 Global Land Cover as it has been optimized using the extensive Landsat 5 TM and Landsat 7 ETM coverage, getting as close as possible to global cloud-free 30m resolution coverage. Forest mask processing has to be based on a specific forest definition (see Section 4.1). While tree height cannot be detected using medium-resolution multispectral optical data, the minimum forest area and crown coverage can be estimated using supervised or unsupervised classification. It is good practice to define the minimum mapping unit (MMU) of the final product. In the case of Landsat TM's 30m pixel resolution, an MMU of 0.8

converge. However, VCS as well as IPCC guidance and guidelines still follow the distinction of activity data and emission factors.

[30] Direct degradation assessments require a higher monitoring frequency than deforestation monitoring. Depending on the logging practices and seasonal effects, it might be even necessary to monitor degradation patterns twice a year.

ha is achievable, at best,[31] which sets the practical threshold for a detectable minimum forest area. Operational medium- to large-scale forest monitoring systems typically operate at a MMU of 1 to 6.5 ha depending on the system specifications. However, the deforestation and degradation patterns in the project area have to be considered in defining the targeted MMU. For example, tracking small-scale slash-and-burn activities requires smaller MMUs than deforestation monitoring focusing on industrial cattle ranching.

7.2.2 Deforestation Monitoring

The majority of REDD project activities build on orthorectified[32] Landsat data compiled by USGS' Global Land Cover (GLC) initiative for the years 1990, 2000, and 2005. Cloud cover and reduced data availability for the period 2003 – 2013 (see Box 10) force developers to combine different sensor products and processing methods. Future sensor technologies should be anticipated in the monitoring design. Polarimetric[33] radar imaging already provides operational space-borne (and airborne) sensor technology as well as processing technology to detect forest cover and forest cover changes. But it has been largely neglected by REDD activities to date, probably because of the perceived challenges of employing a technology completely distinct form optical image processing. Fortunately, several training tools are now available to reduce the hurdles, which are listed at the end of this chapter.

While almost all standard remote sensing software packages support pre-processing with built-in functions, cloud masking still remains a challenge. Of course, (un)supervised classification can be used to mask out clouds. But this comes usually at the price of losing shadowed forest areas with radiometric characteristics similar to cloud shadows. More sophisticated procedures take account of the sensor and sun geometry to automatically detect clouds and cloud shadows (Martinuzzi, Gould and Ramos Gonzalez 2007). Image segmentation[34] combined with rule-based classification also provides solutions, but is only partially supported by standard software (e.g., SPRING and ENVI).

Although various change detection and classification methods are available, it is good practice to interpret or classify co-registered and stacked multi-temporal images. [35] The selection of appropriate radiometric bands depends on the characteristics of the targeted land uses. Once the forest area changes have been detected, the new land use can be classified to establish the historic land-use change matrix. Detecting the change areas first, before classifying land use has the advantage that the range of potential signatures to be classified can be substantially reduced.[36]

31 An MMU is defined as the smallest size areal entity to be mapped as a discrete entity. It depends on the geometric accuracy of the source image and the accuracy of image processing methods applied. Generally, the MMU is at least the size of 3x3 pixels of the source image to compensate for potential misallocation of terrestrial features in a pixel-based image. In the case of Landsat TM (30m pixel resolution), the MMU could reach 90 x 90m = 0.81ha (Knight and Lunetta 2003).

32 Orthorectification is a rectification method that corrects planar images for terrain displacement, e.g., due to rough topography.

33 Polarimetry refers to the control of the coherent spatial orientation of the electrical oscillation plane (vertical, horizontal, or at any other angle) of optical and microwave data. It is one of several fundamental concepts of radar processing.

34 Segmentation is a processing method (semi)automatically delineating features with similar radiometric or other (e.g., texture) characteristics.

35 Readers may wish to consult Table 2.1.3 in GOFC-GOLD (2010) for an overview of existing methods for detecting and classifying forest changes. Layer stacking is the process of overlaying different images or radiometric bands covering the same geographic area within one image file. Certain band combinations of images stemming from different years support deforestation detection.

36 Spatial entities tend to differ in their radiometric reflectance. Satellite sensors capture the radiometric reflectance and store them in different layers (bands) representing a defined reflectance range. Signatures are reflectance patterns specific to materials (e.g., rocks, soil, plants) and/or spatial entities (land cover, land use). Signatures can be statistically clustered to build spectral libraries for certain features, which can be used as a reference in classifying land cover and land use.

While most of the standard classification procedures are still pixel-based, object-based[37] segmentation and classification shows promise. However, the conversion between spatial raster and vector data comes at the price of a larger minimum mapping unit (MMU).[38] While specific commercial software tools like eCognition are still expensive, there are already a few free solutions available (e.g., SPRING combined with Random Forest) providing similar functionality.

7.2.3 The Land-Use Change Matrix

Once the deforestation pattern has been determined for a given period, the fate of land-use change has to be assessed, classifying the final land use in the changed areas. This requires knowledge about common land use patterns in the project area and reference area. Ground-truthing, field observation, or spectral libraries support the classification. Usually, satellite imagery being used in the change detection analysis is classified to identify the final land use in the deforested areas. However, some sensor products which might be suitable for deforestation monitoring (e.g., CBERS 2, coarser SAR data), do not provide the radiometric characteristics required to distinguish different land uses or land cover. Although other sensor data could be used to detect the fate of land-use change, combining the deforestation pattern with other data sources would potentially decrease the MMU and/or the accuracy.

7.2.4 Degradation Monitoring

While technologies for deforestation detection can be considered fully operational, degradation detection remains challenging. Regrowth dynamics in tropical forests require a high temporal frequency in image acquisition covering the beginning and the end of a harvesting season, as logging gaps might close within a couple of months. Some degradation activities like charcoal production, animal grazing, and fuelwood extraction cannot be assessed using remote sensing technologies. Furthermore, the effects of natural degradation (storm damage, natural fires, and droughts) have to be distinguished from anthropogenic impacts and factored out.[39]

Guidance in this field has typically distinguished between two approaches for monitoring selective logging: direct and indirect (GOFC-GOLD 2010). The direct approach maps canopy damage using Spectral Mixture Analysis implemented either as a Normalized Difference Fraction Index (NDFI) within the programming environment of ENVI (Souza, Roberts and Chochrane 2005) or as CLASLite,[40] an easy-to-use, stand-alone application providing all the processing steps and spectral libraries required (Asner, et al. 2005). The indirect approach uses spatial criteria (distance to roads, settlements, forest edge, etc.) to distinguish intact and non-intact forest as a management category within the

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37 Object-based segmentation identifies spatial entities combining their radiometric with non-radiometric characteristics. Within such an approach, a humid forest could appear as a spatial entity appearing distinct within a predefined range of near-infrared reflection, showing a rough texture, located between areas classified as non-forest, and intersecting with a predefined spatial precipitation pattern.

38 Here, raster data refers in the broadest sense to pixel-based products (e.g., satellite images), while vector data encompasses geographic features such as points (e.g., settlements), lines (e.g., streets), and polygons (e.g., project area).

39 Including or factoring out non-anthropogenic emissions due to *force majeure* is still controversial among UNFCCC parties. The VCS *AFOLU Non-Permanence Risk Tool* requires project proponents to assess natural risks, including fire, pests, extreme weather, geological events, affecting the project boundary as one set of elements for determining the non-permanence risk buffer (see Section 10).

40 The Carnegie Landsat Analysis System – Lite (CLASlite) developed by Gregory Asner maps forest disturbances using different multispectral optical sensors. CLASlite software and capacity building are available to non-commercial institutions in the Andes-Amazon Region on request at: http://claslite.ciw.edu/en/index.html.

stratification (Archard et al. 2007, Maniatis and Mollicone 2010).[41] Following this approach, management plans, cadastral information, and other sources (not necessarily remote sensing) must provide relevant activity data to distinguish degradation from other eligible activities. Consequently, potential emission reductions have to be assessed at the inventory level, tracking changes in carbon stocks and fluxes.

Both approaches have advantages and disadvantages. NDFI and CLASLite have an impressive track record in the Amazon, where timber extraction rates tend to be high. However, their performance depends on the density of harvesting patterns and the feasibility of factoring out the impacts of seasonality and extreme weather events on canopy closure. Another challenge relates to the need to relate the range of the detected disturbance signal to the continuum between intact forest, degraded forest, regrowth, deforestation, and revegetation based on an agreed forest definition. This relation appears to be specific for different forest ecosystems. Thus, the effort to ground-truth the disturbance signal to establish its spatial extent is substantial. The indirect approach has the merit that it can be implemented easily using spatial ancillary data. However, once the non-intact boundaries have been established, they do not change easily. Consequently, performance gains can only be tracked at the level of emission factors, as the corresponding intact/non-intact boundary remains stable.

New remote sensing technologies focusing on combined processing of high-resolution radar (TerraSAR-X) and optical data (RapidEye) hold promise for detecting and automatically identifying logging of individual trees (Kuntz et al. 2010).[42] The cost implications and financial viability of data acquisition and processing has to be assessed case by case. One would also have to consider that although high-resolution imagery fits our visual perception of the earth's surface, it requires additional processing steps (e.g., texture analysis) and advanced classification methods (object-based image segmentation) to capture these information gains. Another problem arises on the side of validation. It is good practice to validate the image processing results using higher-resolution imagery, as requested by all approved VCS REDD methodologies. Choosing the highest resolution for the base products leaves the developer without an alternative for the higher-resolution validation source.

7.3 Validation of Change Detection Results

Some approved REDD methodologies define minimum threshold values for the accuracy of the forest mask and detected land-use change.[43] It is good practice to account and report the overall accuracy of image processing. Several types and sources of errors have to be considered. Two types of errors, the error of excluding an area from a category to which it truly belongs (*error of omission* or *producer's accuracy*), and the error of including an area in a category to which it does not truly belong (*error of commission* or *user's accuracy*) can be assessed building a so-called confusion matrix. While GOFC-GOLD 2010 provides an overview on the structure of the accuracy assessment, Strahler et al. (2006) describes the relevant tools in detail.

Accuracy assessments have to be based on independent, higher-resolution data sources, which might be a challenge if the product to be validated has already been derived from high-resolution data. High-resolution optical sensor products (Ikonos, QuickBird, RapidEye, GeoEye) are still expensive, though some of South America is partially covered by high-resolution CBERS data free of charge. The costs of using high-end earth observation data have to be carefully estimated and balanced with the marginal benefits of targeting higher resolutions in the processing chain.

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41 This approach considers degradation, being one of the four eligible UNFCCC REDD+ activities (excluding deforestation), as part of the IPCC key category "forest land remaining forest land" (Maniatis and Mollicone 2010).

42 GOFC-GOLD (2010, Chapter 2.9) provides an overview of evolving technologies.

43 The Avoided Deforestation Partners module for unplanned deforestation baselines (VMD0007) requests a minimum map accuracy of 90% for both the "forest" class and the "non-forest" class. VMD0006 requests discounts for lower accuracies.

Box 10. Choosing Remote-Sensing Products and Image-Processing Software

Ironically, the choice of appropriate sensor products has never been so easy and so complicated at the same time: the availability and quality of nearly all sensor products can now be verified on the fly using online access to data providers. But unfortunately, almost all the mid-resolution workhorses for monitoring land-use change are currently failing or are about to stop operations: CBERS 2 recently went offline, Daichi-ALOS has lost its power supply, a scan-line correction error compromises Landsat 7 ETM data collected since 2003, Landsat 5 TM is operating far beyond its projected lifetime, and SPOT 5 will probably stop operations in 2013. New sensor systems suitable for forest AFOLU monitoring are expected to become operational in 2013 -2014. Thus, REDD+ project developers must balance long-term consistency in measuring activity data by integrating historical, medium-resolution, multispectral optical data with interim solutions available until 2013, anticipating, to a certain extent, partially unknown new sensor technologies.

For the historic part of the baseline most REDD+ activities rely on Landsat data and, to a certain extent, on SPOT data. Fortunately, Landsat data is freely available now via several gateways (GLOVIS, New Earth Explorer), and SPOT images are freely provided to central African countries for REDD+ monitoring, facilitated by the French Development Agency (AFD). Apart from the data USGS provides, several Landsat ground stations all around the world store and distribute additional data worth exploring.

For the critical period of 2003 (marking the failure of Landsat 7 ETM) to 2012, project developers will have to find tailored solutions for their MRV needs. Generally, this will require mosaicking different multispectral optical sensor products (ASTER, SPOT, CBERS, DCM, AWIFS, ALOS AVNIR) to achieve (almost) cloud-free coverage. Remaining gaps have to be filled by processing radar data. Processing and combining different sensor products is not trivial as it requires radiometric correction and resolution matching, and it might increase uncertainty, which will have to be quantified.

An alternative might be the use of radar data (ALOS PALSAR--for data collected up to March 2011, Radarsat 1 and 2, IRS, ERS 1 and 2, Envisat ASAR) which requires different processing methods. With PolSARPro and the Next ESA SAR Toolbox (NEST), the European Space Agency (ESA) freely provides comprehensive toolboxes and tutorials for nearly all air and space-borne radar sensors. For the period 2007-2010, free 50 m resolution ALOS PALSAR data is available for Asia, Oceania, and sub-Saharan Africa.

Several space agencies are already committed to making available new high-resolution optical multispectral sensors suitable for AFOLU monitoring after 2012. ESA is launching Sentinel 2, NASA is developing the Landsat Data Continuity Mission, and Brazil's National Institute for Space Research (INPE) is designing CBERS 3 and 4. National and subnational authorities will have to consider these data sources when designing long-term MRV frameworks; likewise, project developers will need to anticipate using these technologies—and conforming to the relevant MRV frameworks—when planning their project's MRV approach.

Besides the powerful commercial image processing packages (ERDAS, ENVI, eCognition, PCI Geomatics) there are some low-cost suites available (e.g., IDRISI), which provide comprehensive functionality. Additionally, open source remote sensing software like GRASS, SPRING, and ILWIS are worth exploring.

Box 11. Key Tutorials and Software for Radar Processing

Tutorials

Henderson, Floyd M., and Anthony J. Lewis. *Principles and Applications of Imaging Radar: Manual of Remote Sensing, Volume 2.* New York, New York: John Wiley & Sons, 1998.

> *One of the most comprehensive (and unfortunately most expensive) textbooks on radar.*

Lee, Jong-Sen, and Eric Pottier. *Polarimetric Radar Imaging: From Basics to Applications.* Boca Raton, FL: CRC Press, 2009.

> *A cheaper, more condensed and more topical text book that includes chapters on terrain classification and forest mapping. This is a good entry point to the world of radar imaging.*

Lusch, David. *Introduction to microwave remote sensing.* East Lansing, MI: Basic Science and Remote Sensing Initiative, Michigan State University, 1999. Available at: http://www.trfic.msu.edu/products/profcorner_products/Intro_Microwave.pdf.

> *A good introduction to microwave remote sensing (available for free online).*

Canada Centre for Remote Sensing. *Tutorial: Radar Remote Sensing.* Natural Resources Canada, 2008. Available at: http://www.ccrs.nrcan.gc.ca/resource/tutor/gsarcd/downld_e.php.

> *Also a good compendium on radar remote sensing.*

Software

Polsarpro: Polarimetric SAR Data Processing and Educational Tool . Version 4.2, European Space Agency, 2011. Available at: http://earth.eo.esa.int/polsarpro/.

> *The European Space Agency has developed this free software toolbox with a comprehensive set of tutorials for experienced remote sensing practitioners. It is not meant for beginners but provides the tools and theory of advanced radar concepts.*

Array Systems Computing Inc. *Next ESA SAR Toolbox (NEST).* European Space Agency. Available at: http://nest.array.ca/web/nest.

> *Besides PolSARPro, ESA distributes this toolbox, which offers functionalities, having been provided in the past by expensive radar extensions of standard remote sensing software. NEST comes with extensive manuals and tutorials, too.*

MapReady. Version 2.3.17, Alaska Satellite Facility (ASF), 2010. Available at: http://www.asf.alaska.edu/downloads/software_tools/mapready/version_history.

> *MapReady is an excellent toolbox to pre-process, visualize, and geocode radar data. In addition, it calculates and masks out inherent relief distortions in radar images.*

SAR Training Processor. Version 1.1.10, Alaska Satellite Facility, 2009. Available at: http://www.asf.alaska.edu/downloads/software_tools/stp/version_history.

> *ASF has also published the SAR Training Processor, a software tool and tutorial focusing on the preprocessing getting from raw radar data via single look complex, to geocoded mapping products.*

8. Establishing the Baseline

8.1. The Concept

Project performance has to be measured against an agreed benchmark representing the emissions that would occur if the project were not implemented. Building from the foundations of the Kyoto Protocol, different variations of this "baseline" concept have emerged in the context of REDD+ and need to be distinguished. The first three of the following terms are most commonly used for project-level accounting, while the last three are more prevalent in the context of national or jurisdictional accounting (e.g., in UNFCCC negotiations) :

- The **baseline** for a CDM project activity is "the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity" (UNFCCC, *3/CMP.1 Annex*, 2005, paragraph 44). Baselines are described in similar fashion under the VCS. Although the term is widely used, many UNFCCC parties avoid applying CDM terminology to REDD+.
- The **business-as-usual** (BAU) scenario refers to the development path a system would follow if it were not subject to any external program or policy intervention; that is, it is the scenario in which historical and current practices continue. At the project level, baseline is synonymous with BAU.
- The **project scenario** (also referred to as the "with-project" scenario) represents a development path that occurs if the project intervention or policy measure is implemented.
- The **reference emissions level** (REL) is the amount of gross *emissions* from a geographical area, estimated within a reference time period under the BAU scenario. This concept relates to emissions from deforestation and forest degradation.[44]
- The **reference level** (RL) is the net/gross emissions and removals from a geographical area, estimated within a reference time period under the BAU scenario. It includes conservation, sustainable management of forests, and enhancement of carbon stocks that would have happened without the project.
- The **crediting baseline** refers to an agreed level of emissions, below which an entity may generate credits for emissions reductions to use in trading, compensation, or future compliance systems. The crediting baseline may be equal to or lower than the BAU reference level, but it should not be higher (which would generate so-called "hot air"). A crediting baseline below BAU or reference levels may be fixed to reflect a shared national responsibility for emissions and/or to reflect uncertainty with regards to the reference emissions level.

Under the VCS the term "baseline" is used for activities at the project level. However, some methodology elements already refer to (sub)national reference (emission) levels. The development of a baseline is challenging inasmuch as it requires counterfactual evidence. It has to provide a credible future development path which can never be observed or verified, as project activities are supposed to prevent this scenario from becoming reality. Modeling is a means to conceptualize this scenario. It could either cover the project domain (project and reference area) or refer to processes occurring at subnational or national levels.

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[44] Although UNFCCC parties consistently refer to *reference emission level* and *reference level*, these terms have not been defined yet. The definition presented above incorporates elements introduced by the Coalition of Rainforest Nations during a UNFCC workshop (UNFCCC, *Expert Meeting*, 2009).

8.2 The Role of Modeling

Just as the industrial statistician George Box once remarked that "all models are wrong, but some are useful," common sense and scientific discussion seem to tell us that our capacity to forecast short- or long-term systems behavior is limited. [45] The resulting distrust in modeling affects the discussion of how to establish credible, reliable, robust, and conservative scenarios of future land-use change and corresponding emission levels, against which emission reductions in implementing REDD+ activities can be determined. Skepticism has also been expressed at the only UNFCCC meeting on methodological issues related to reference emission levels, where a preference was expressed for establishing a reference scenario based on historical data (UNFCCC, *Expert Meeting,* 2009).

The perceived conflict between approaches based on modeling and those based on an extrapolation of historic trends has shaped the debate on baselines for years. Some auditors argue that land-use change models have reached a level of interdisciplinary complexity that makes it difficult to validate their performance. Other, more fundamentalist opponents of the use of models draw an antagonizing (and inconsistent) dichotomy between "modeling emissions" and "monitoring emissions."[46]

It is important to be clear about what modeling actually means and covers. In scientific terms, a model is a set of assumptions about some system (Hartmann 1996). As such, it is a simplified representation of a real world phenomenon (Gilbert and Troitzsch 2005). Following this line, all methods for projecting deforestation--whether they use a historical average, a statistical regression, or advanced simulation techniques--can be considered scientific modeling (North and Macal 2007, Gilbert and Troitzsch 2005). Thus, the discussion is not about pure modeling versus historical extrapolation, but rather about valid versus invalid modeling.

For unplanned avoided deforestation and/or degradation (AUDD) activities, the *AFOLU Requirements* establish that methodologies shall set out criteria and procedures to identify where deforestation would likely occur, using spatial analysis and projections based on historical factors of the last ten years.[47] The currently approved AUDD methodologies (VM0007, VM0006, VM0009) use statistical approaches to estimate the future deforestation rate based on detected deforestation drivers.[48] Once determined, the statistical model of the deforestation or degradation rate can be used to drive a spatial model to predict the suitability for deforestation and degradation for each location within the agreed domain.[49] Thus, the scope of land-use change modeling approaches prescribed by currently-approved methodologies is relatively narrow. Opting for other modeling techniques would require

45 The mathematician David Orrell provides some interesting insights into our (in)capacity to forecast the development of weather, human health, and the performance of economies in Orrell (2007).

46 In doing so, these critics ignore the fact that LULUCF emission measurements themselves rely almost completely on statistical modeling to establish allometric equations (see Carbon Stocks Assessment Guidance for a discussion of allometric equations).

47 In certain conditions of the mosaic deforestation pattern, vaguely defined in the VCS *AFOLU Requirements* (2011, Section 4.2.9) as those in which "no patch of forest in project areas exceeds 1000 ha and the forest patches are surrounded by anthropogenically cleared land, or where it can be demonstrated that 25 percent or more of the perimeter of the project area is within 120 meters of land that has been anthropogenically deforested within the 10 years prior to the project start date," projections do not have to be spatially explicit.

48 Terra Global Capital requires the use of beta-regression in their methodology (VM0006). The Avoided Deforestation Partners Module (VMD0007) offers three options (historical average, linear regression, or non-linear regression) to determine the future deforestation rate. WildlifeWorks (VM0009) uses a logistic regression model.

49 The role of spatial modeling differs in the approved methodologies. VM0007 promotes spatial modeling to predict the future deforestation patterns. VM0006 uses a spatial modeling approach only to calculate the land-use land cover class or forest stratum specific deforestation and forest degradation rates.

presenting a new methodology subject to double audit. Other AUDD methodologies currently being audited extend these options.[50]

Before choosing a baseline approach, it is strongly advised to analyze the (sub)national REDD+ environment. If a country or jurisdiction is currently developing its REDD+ framework, it will have to decide sooner or later how to establish the national reference (emission) level. While some governments might be in favor of anticipating development needs using a development adjustment factor or a modeling approach, others might strictly stick to the use of a historical average benchmark. Thus, the (sub)national REDD+ baseline approach eventually might limit the options in one way or another, and project developers would be wise to assess these options upfront.[51] Until countries or states establish a REL, projects may choose to move ahead with a VCS compliant, project-based baseline approach, adjusting their baseline to the REL in future revisions. For viable projects facing immediate deforestation pressures, waiting - perhaps years - for a jurisdictional framework to be established may clearly be unattractive, though proponents must realize there is a risk that when the project updates to (or complies with) a new (sub)national baseline, the number of emissions reductions may change significantly.

8.3 Modeling Tasks

Before deciding on the appropriate modeling technique, the purpose of modeling has to be clearly defined. The REDD+ baseline development must determine two products for the given area (covering the reference region, the leakage belt, and the project area): the future deforestation *rate* and the *spatial distribution* of future deforestation. Both tasks can be conducted using one of several modeling approaches. Commonly, the projected deforestation rate drives the spatial allocation. Thus, the baseline rate or level is the critical parameter, having the highest impact on the emission level. Reference emissions levels are likely to be negotiated politically at the international level (and possibly national and subnational levels), with some technical input. Even if the rate is determined politically, however, spatial modeling can play an important role in guiding political decisions on where to avoid deforestation.[52]

Deforestation rates can be numerically estimated using any one of a number of methods: statistical approaches (multivariate statistics, regression, time series analysis), System Dynamics, microanalytical simulation models, queuing models, multilevel simulation models, cellular automata, multi-agent models, optimization based on economy-wide general or sector-based partial equilibrium models, neural networks, or non-numerical interview techniques[53] (Delphi method, focal groups) and games.[54] The choice of the appropriate modeling technique depends on the constellation of drivers and agents, the availability of data to calibrate the model, the size of the domain, and the targeted level of integration of project-based into (sub)national accounting schemes.

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50 The mosaic methodology proposed by the BioCarbon Fund and the frontier methodology presented by the Amazonas Sustainable Foundation (FAS) do not limit the modeling options to certain statistical approaches. Developed by Carbon Decisions, the two methodologies have been merged into one.

51 Note that just because a country adopts a historical average benchmark does not mean that this will be uniformly distributed across the national domain. Even a national RL based on historical averages would require some formula for allocation across the remaining forest domain based on some criteria besides the historical average.

52 Indeed, the reduction commitments of the Annex I countries under the Kyoto Protocol are a result of political bargaining. However, the countries that negotiated their targets with a robust understanding of their potential development and emission pathways, based on comprehensive modeling, clearly had an advantage during the negotiations as they could avoid committing to overly-ambitious targets.

53 Before 2010, deforestation rates published in FAO's Forest Resources Assessment have been partially based on expert judgment of national authorities.

54 See North and Macal (2007) and Gilbert and Troitzsch (2005).

In the case of spatial modeling, several stand-alone solutions as well as modules embedded in common GIS software exist to simulate future allocation of land-use change. Clark Labs' IDRISI Package (http://www.clarklabs.org) includes several LUC modeling functions (GEOMOD, Markov chains, Land Change Modeler (LCM)), of which LCM is the most advanced. Dinamica EGO (http://www.csr.ufmg.br/dinamica/) is a freely-available visual spatiotemporal simulation environment that provides great flexibility in developing LUC models. Numerous other spatial modeling environments complement the picture (Verburg and Veldkamp 2005; Pontius et al. 2008).

8.4 Main Steps in Developing a Baseline Model

Whether or not spatiotemporal models are combined with numerical modeling, certain steps have to be followed to develop a useful baseline model:

1. Before even starting to think about choosing a certain modeling technique, a **conceptual model** should be established, verbally describing the modeling purpose, agents, their behavior and relationships, assumptions, parameters, fundamental equations, and restrictions. This may, indeed, be a daunting task. First, settling on a concise and conclusive description of a system's behavior takes time and is cumbersome, while programming seems to get us directly to results. Unfortunately, experience suggests that programmers tend to get lost in details without a good roadmap. Second, keeping a model simple while keeping the complexity of real world interactions in mind is challenging. It is easier to extend a simple model than to reduce the complexity of a fully programmed one. Despite these challenges, however, the conceptual model is key to achieving the modeling purpose.
2. Next, programmers can **implement the conceptual model** using lower or higher object-oriented programming languages, numerical or spatiotemporal programming environments, or readily available models and tools. No matter what modeling technique has been chosen, it is important to use independent data sets for model calibration and validation.
3. It is good practice to conduct a systematic **sensitivity analysis** to identify those system parameters which have the highest impact on overall performance, to quantify the uncertainties of those key parameters, and to estimate the likelihood of certain development pathways (IPCC 2003). Usually, Monte Carlo simulation (MCS) is used--several statistical software packages (e.g., Excel) and modeling environments (IDRISI, Repast) include MCS modules. Validators/Verifiers usually request information about parameter sensitivity. Under VCS all plausible sources of model uncertainty have to be assessed, and conservative factors have to be applied to discount for model uncertainty.
4. At the end, **verification and validation** (V&V) mark the difference between a useful model and a toy. *Model verification* determines whether a model performs as intended, whether it has been programmed correctly, whether the algorithms have been implemented properly, and whether the model is free of errors, oversights, and bugs. *Model validation* checks whether a model represents and correctly reproduces the behaviors of the real world system (see Figure 1).[55] Some approved methodologies establish specific requirements (e.g., performance benchmarks) for validating spatial models. Validating and verifying non-spatial models projecting the deforestation or degradation rate is far more challenging, as there are no ready-to-use software tools available. Instead, an own V&V approach would have to be developed following standard procedures (Oberkampf and Trucano 2002; North and Macal 2007).

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[55] Those, who are familiar with certification procedures might observe, that the consistency check with real world phenomena under UNFCCC is labeled verification, while validation refers to scientific integrity of all models applied. The reverse use introduced here is common in industry and programming and backed by ISO standards (North and Macal 2007, Gilbert and Troitzsch 2005).

5. Finally, the model must be comprehensively documented. **Model documentation** shall cover all underlying assumptions. This is also critical to ensuring smooth validation/verification under VCS. It is good practice to formalize the modeling approach in general algebraic notation and to reference the introduced parameters and variables unmistakably in comprehensively documented and commented programming code.

Box 12. Recommendations and Key Resources for Establishing the Baseline

- Start with simple statistical approaches. They are robust, transparent, and reduce the risk that the baseline could be rejected because not all its components are supported by peer-reviewed publications.
- Developing an own baseline model by going beyond approved baseline approaches implies the development of a new methodology and, as such would have to undergo the VCS double approval process. As such, this should be considered a last resort.
- The same model used to create the baseline has to capture the with-project case, too. Make sure that your project interventions can be captured with the underlying modelling approach.
- Do not choose the modelling approach before achieving clarity on project's conceptual model. Test the software environment afterwards. Most of the tools mentioned are either available for free or as trial versions.
- Whatever model you choose, aim for simplicity - it will grow and will become more complex during calibration. But do not try to capture every detail of the system on the first step.
- Even if it is not requested by the methodology, spatial modelling has a strong potential to guide the implementation of policy options.

Key Resources

Sohngen, B., and S. Brown. "Measuring leakage from carbon projects in open economies: a stop timber harvesting project as a case study." *Canadian Journal of Forest Research*, 2004: 34: 829-839.

> *This article reports on a partial equilibrium model developed for the Bolivian timber sector. The approach is paradigmatic of IFM, as it showcases how a project-based activity (stopping timber harvesting in concessions) could be nested into a national sector baseline modelled using non-spatial activity data (annual timber yields).*

Gilbert, Nigel, and Klaus G. Troitzsch. *Simulation for the Social Scientist: Second Edition.* Berkshire, England: Open University Press, 2005. Available at: http://cress.soc.surrey.ac.uk/s4ss/S4SS-sample-chapter.pdf.

> *Introduces the main non-spatial modelling techniques and references available software packages. This excellent book applies all techniques to the same example. Part of the book is available at Google books.*

Bisschop, Johannes. *AIMMS: Optimization Modeling.* AIMMS 3, Haarlem, The Netherlands: Paragon Decision Technology, 2011. Available at: http://www.aimms.com/downloads/manuals/optimization-modeling.

> *A good example of a concise and conclusive conceptual model for another partial equilibrium model (farm) can be found in Chapter 11 of this guide.*

Dinamica Environment and Geoprocessing Objects. Available at: http://www.csr.ufmg.br/dinamica/

> *Dinamica EGO is freeware and comes with a comprehensive tutorial with several chapters focusing on spatial modelling in the context of REDD.*

9. Leakage Assessment and Management

9.1 Requirements for Leakage in VCS AFOLU Projects

Discussions on including avoided deforestation under the Kyoto Protocol and in subnational approaches to implementing UNFCCC REDD+ programs have stumbled over how to deal with leakage, or the project's impacts on areas outside of the specified area of a program or project (particularly, displaced GHG emissions). Likewise, leakage represents a key methodological challenge for projects and is a cross-cutting issue in project design and development.

Under the Kyoto Protocol, the UNFCCC defines leakage as "the increase in GHG emissions by sources which occurs outside the boundary of an A/R CDM project activity which is measurable and attributable to the A/R CDM project activity" (UNFCCC, 5/CMP.1, 2005, 1e). To maintain the distinction between the two negotiation tracks, parties discussing a post-Kyoto REDD+ architecture avoid using CDM terminology and instead call REDD+ leakage "emissions displacement."[56]

The VCS follows the spirit of the CDM definition, specifically characterizing leakage as as "any increase in GHG emissions that occurs outside the project boundary (but within the same country), and is measurable and attributable to the project activities" (VCS *AFOLU Requirements*, 4.6.1). The VCS acknowledges that leakage might occur outside the host country but stipulates that such leakage does not need to be quantified. The VCS *AFOLU Requirements* requires developers to address leakage in establishing the project boundary, quantifying GHG emissions and removals, developing the monitoring plan, and outlining the leakage sources and management in the Project Description.

Project proponents are responsible for managing, mitigating, and accounting for leakage. Developers have to identify leakage management zones as part of the overall project design, where land-use activities shifting from the project area might occur. Once these areas have been identified, developers are requested to mitigate leakage by providing economic alternatives or promoting improved land-use practices reducing deforestation and/or degradation within the leakage management zone. Developers have to choose these management options carefully, as any significant increase in GHG emissions associated with them must be accounted for, while positive leakage (i.e., decreased GHG emissions or increased removals outside the project boundary) has to be excluded from project accounting.

The *AFOLU Requirements* (Section 4.6.1) distinguish three types of leakage which have to be accounted for:

- **Market leakage** occurs when projects significantly reduce the production of a commodity causing a change in the supply and market demand equilibrium that results in a shift of production elsewhere to make up for the lost supply.
- **Activity shifting leakage** occurs when the actual agent of deforestation and/or degradation moves to an area outside of the project boundary and continues their deforesting activities elsewhere.
- **Ecological leakage** occurs in PRC projects where a project activity causes changes in GHG emissions or fluxes of GHG emissions from ecosystems that are hydrologically connected to the project area. [57]

[56] The Cancun Agreements (UNFCCC, 1/CP.16, 2010) request that parties monitor and report emissions displacement at the national level and report on how displacement of emissions is being addressed (paragraph 71c), though this is of course in the absence of clear overall rules for REDD+ under the UNFCCC.

[57] Ecological leakage only becomes an issue for REDD if it is part of Peatland Rewetting and Conservation (PRC) activity.

If the omitted decrease in carbon stocks or increase in GHG emissions attributed to leakage amounts to less than five percent of total GHG benefits generated by the project, it can be considered *de minimis*, or insignificant, and can be neglected. VCS encourages the use of the *Tool for testing significance of GHG emissions in A/R CDM project activities* (see Box 13). Leakage can be determined either directly using monitoring tools,[58] or, as in the case of market leakage, indirectly using the IFM discount factors provided in Table 3 of the *AFOLU Requirements* (2011, 40).

The *AFOLU Requirements* provide specific rules for each of the AFOLU categories. In the case of avoided planned deforestation (APD), leakage accounting is focused on the deforestation agent(s), who might own, manage, or use forest lands outside the project boundary. These lands have to be identified and monitored to prove that land use has not materially changed as a result of the project activity. If the agent(s) cannot be identified, the most likely class of deforestation agent within the region can be used as a surrogate. AUDD activities, on the other hand, are required to identify, describe, and monitor potential sources of leakage based on socioeconomic drivers. Both types of activities have to quantify domestic market leakage using the IFM discount factors referenced above if illegal logging activities are included in the baseline.

Although the VCS leakage requirements already appear to be quite comprehensive, they have not been fully consolidated yet. The VCS Association is particularly concerned about the consistency and accuracy of market leakage assessments, and agriculture-driven market leakage does not yet have the comprehensive guidance necessary to achieve these qualities. Activity shifting due to avoided migration into project area is another unsettled issue. The VCS Association is reviewing AFOLU guidance for leakage and is expected to come up with clarifications during 2011. Importantly, any adjustments will not be retroactive.

9.2 Leakage Assessment in Approved REDD Methodologies

As a review of VCS-approved REDD methodologies indicates (see Table 2), the methodologies differ substantially in how leakage is addressed. Some include market leakage (VM0007 and VM0004) while others do not (VM0006 and VM0007), and those that do include it vary in their approach (for example, VM0004 includes the alternative of developing a country-wide market leakage assessment). All approved methodologies require the assessment of activity-shifting leakage, and the delimitation of a “leakage belt” (or “leakage zone”) where these activities might move and increase deforestation or degradation emissions. This leakage area will need to be monitored to capture and account for leakage, though methodologies vary in their approach to determining the spatial domain of this area.

As all of these methodologies were developed before the revised VCS Version 3.0 had been approved, they may not be 100% compatible with the new AFOLU leakage requirements under development. VCS policy indicates that new program requirements are not retroactive for projects already registered and that these projects can continue to use previously-approved methodologies until the crediting period expires. However, if a methodology is deemed to materially conflict with new VCS program requirements, it may be withdrawn or put on hold. Projects have a grace period to use methodologies after they are put on hold. Developers are advised to follow up on the decisions of the VCS Association and relevant policy updates published on the VCS website to monitor changes to guidance or tools that may affect already approved methodologies.

[58] Here, the conceptual difference between monitoring and modeling becomes blurred. The *AFOLU Requirements* (2011, 39-40) references several models suitable for direct accounting of IFM market leakage, including Sohngen and Brown (2004).

Table 2. The Scope of Leakage in Approved VCS Methodologies

Methodology	Activity	Market Leakage	Activity Shifting
VM0007	Avoided (un)Planned Deforestation and/or Degradation[a]	Mandatory if existing deforestation involves timber harvesting for markets or if degradation due to fuelwood collection and charcoal production is anticipated in the baseline (Module VMD0008). A variable leakage factor is defined based on the relation between merchantable timber volumes in the project and displacement area. A collateral damage factor and transport emissions are included. The leakage factor for charcoal and fuelwood is fixed (Module VMD0011).	Activities subject to potential displacement are: conversion of forest lands to grazing lands, crop lands, or other land uses. Agents are categorized as either locals or immigrants, and the proportional contribution of each to baseline deforestation must be estimated. A leakage belt is required. For immigrant agents, leakage is assumed to affect the leakage belt and the entire available national forest area (in effect resulting in very high leakage discounts – potentially nearly 100% - for deforestation caused by immigrant agents). Applicable Module: VMD0010.
VM0004	Avoided Planned Conversion of Peat Swamp Forest[b]	Market leakage must be considered if the project area would be harvested for commercial timber before clearing the site for a new land use. Developers may assess leakage either by applying default market leakage discounts (identical to VMD0011) or conducting a country-wide market leakage assessment to be developed by the project.	This methodology's applicability criteria require that there are no human settlements inside project. Only pre-project planned activities could shift outside the project area. If it can be demonstrated that these will shift to degraded non-forest land, leakage is assumed to be zero. Leakage areas defined as parcels of land under the control of deforestation agents must be monitored to demonstrate that management plans and practices on these have not materially changed as a result of the project, or to quantify the emissions impact of any management changes.
VM0006	Avoided Unplanned Deforestation and/or Degradation[c]	Negligible due to applicability criteria of the methodology (i.e., timber cannot be sold or transferred beyond participating communities).	Drivers of activity shifting are categorized as either: Geographically-*constrained* drivers (i.e., fuelwood collection, charcoal production, conversion forest to cropland by local communities, conversion to settlements, timber logging for local and domestic use, forest fires). In these cases, a leakage belt is to be determined using a cost-transportation based GIS approach, and deforestation from geographically constrained drivers must be estimated and monitored for this area. Geographically-*unconstrained* drivers (commercial logging, conversion forest to cropland by migrants). In these cases, leakage due to logging to be discounted using VCS default values; leakage due to cropland clearing from migrants moving beyond the leakage belt is set to 100% by default. Emissions from leakage management and prevention are estimated.

VM0009	Avoided Unplanned Deforestation[d]	Not addressed.	Activity shifting of deforestation and degradation (fuelwood, charcoal, large trees logging) must be accounted for, with degradation considered a precursor of deforestation. Developers are required to determine a leakage area, not necessarily adjacent to the project area, using GIS analysis. A leakage model is developed for this area and is a type of baseline model for the leakage area. Any observed deforestation or degradation greater than that predicted by the model (i.e., greater than what was expected without the project) is considered leakage and is deducted from project crediting.

a. Modules developed by Avoided Deforestation Partners
b. Methodology developed by Infinite Earth
c. Methodology developed by Terra Global Capital
d. Methodology developed by Wildlife Works Carbon

Box 13. Recommendations and Key Resources for Assessing Leakage

- Considering the uncertainties regarding the evolving VCS leakage framework, project developers should first consider the approved methodologies while noting that the leakage accounting elements of approved methodologies might have to be adjusted and harmonized in the long run. If the methodology conflicts with new leakage requirement it still can be used as long as its validation will occur before the end of the grace period. Otherwise, the new leakage requirements will apply.
- While activity shifting can be tracked using spatial models, market leakage is difficult to model and can be very complicated (see Sohngen and Brown 2004). Accepting default discount factors is a good way to avoid high model development costs and risk due to model uncertainties.

Key Resources

CDM A/R Methodological Tool: Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity (Version 01). Available at: http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-15-v1.pdf.

CDM *Tool for testing significance of GHG emissions in A/R CDM project activities* (Version 1). Available at: http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-04-v1.pdf.

10. Permanence and Risk Assessment

Since the early days of the Kyoto Protocol, the question of the permanence of forest carbon related emission reductions and GHG removals has been one of the most controversial LULUCF issues (Trines 2008). Forest carbon is considered particularly risk-prone, as emission reductions and removals could be reversed, either by natural events (droughts, floods, storms, fires) or anthropogenic impacts due to failure of a project or policy to control the drivers, underlying causes, and agents of deforestation. Even worse, climate change itself threatens the permanence of forest carbon sinks (Lewis et al. 2011).[59] The discussion of permanence of forest carbon emission reductions and removals has led to a situation in which GHG removals due to AR activities under the CDM can only generate temporary credits or are excluded from compliance markets altogether (as in the case of the European Union Emissions Trading System). However, voluntary carbon markets accept REDD+ and AR credits generated within a comprehensive risk accounting framework.

The VCS uses risk assessment as the basis for setting aside a proportion of project emissions in an AFOLU pooled buffer account. These emissions reductions are not VCUs and cannot be traded. They serve as a reserve in the case of reversals after VCUs have been issued. An overview of the management of reductions in this buffer account is described in the Step by Step Overview and in the VCS *Registration and Issuance Process* (2011).

[59] According to recent climate modelling, the Amazon droughts of 2005 and 2010 demonstrate a mechanism by which remaining intact tropical forests of South America can shift from buffering the increase in atmospheric carbon dioxide to accelerating it. Repeated droughts may have important decadal-scale impacts on the global carbon cycle.

10.1 The VCS Approach to Assess AFOLU Risks

Risk assessments have a long history in public and corporate finance, auditing, insurance, environmental impact assessment, and project management—with each of these sectors having developed its own approach for framing different risks. VCS has consolidated an AFOLU *Non-Permanence Risk Tool* (2011) providing the procedures for conducting a non-permanence risk analysis to determine the appropriate risk rating and the number of buffer credits to be deposited in the AFOLU pool buffer account. The primary user of the AFOLU *Non-Permanence Risk Tool* is the project proponent. He or she is requested to assess the project's risks analyzing based on defined criteria, guided by the Tool and following the VCS *Non-Permanence Risk Report Template* (2011).

For AFOLU projects, VCS distinguishes between three categories to classify the *risk factors*: internal risks (project management, financial viability, additionality of the project activity, and project longevity), external risks (land tenure, community engagement, political risks) and natural risks (fire, pest and diseases outbreak, extreme weather, geological risks, other natural risks). Each of these risk factors has been, in turn, broken down into 2 to 10 subcategories to be assessed independently. The subcategories describe specific risk aspects--their wording and focus cannot be adjusted. The *Non-Permanence Risk Tool* is very clear in describing step-wise the process and explanatory guidance for assigning numerical scores to each risk factor.

Note that the assessment of certain risks factors (opportunity costs, financial viability, and community engagement) is closely linked to other procedural steps in project design (additionality test, socioeconomic impact assessment) and could be conducted in parallel. For example, the opportunity cost and financial viability assessment may build on related requirements for the additionality proof and can only be conducted if the proponent has already conducted the corresponding scenario analysis.[60] While some risk factors (e.g. political risk) can be easily assessed, others, e.g. natural risks or financial viability, require considerable analytical work.

For risk factors, the sum across all subcategories has to be calculated. For each of the three risk categories the tool establishes threshold values: if, for example, the sum of the risk ratings across all corresponding risk factors and subcategories in internal risks is greater than 35, a project has to be assessed as *Fail*, implying that the risk is deemed unacceptably high and the project shall not be eligible for crediting. Moreover, if the overall risk rating - established as the sum of the internal, external, and natural risk ratings - is greater than 60, the project fails the entire risk analysis.

Once the overall risk rating value has been determined as the sum of internal, external, and natural risks, its total value has to be converted to a percentage. This value is then applied as a multiplier to the net changes in project carbon stocks (i.e., gross emissions reductions) to determine the number of buffer credits to be deposited in the AFOLU pooled buffer account.

The risk report is assessed and the buffer credits deposited at the time of verification. Buffer credits are not issued with a verified carbon unit (VCU) serial number.[61] Every 5 years, the project is requested to update the risk buffer based on the risk assessment of the current verification event. At this time, a "time release discount" (TRD) is applied (calculated independently of the risk rating), and a portion of buffer credits can be released and converted to VCUs.

[60] The additionality tools for the CDM, and those included in VCS methodologies, do not necessarily require an investment analysis, allowing project proponents to choose either an investment analysis or a barriers analysis. The VCS *Non-Permanence Risk Tool*, however, requires both a financial and opportunity cost assessment for projects with baseline activities, which are not subsistence-driven. Project anticipating non-subsistence baseline activities are advised to choose the investment analysis option to prepare the inputs for the risk assessment.

[61] Buffer credits are also not subject to the VCS issuance levy.

The TRD recognizes that risks decline with successfully demonstrated project performance and encourages projects to be periodically verified.

If upon a subsequent verification, the risk rating remains the same as during the previous verification event, buffer credits have to be deposited applying the same risk rating multiplier. Then, a 15% time release applies to the total number of buffer credits owed by the project--i.e., the number of buffer credits deposited in the previous period(s) plus the new buffer for the current verification period. Table 3 illustrates this case for a project with a constant non-permanence risk rating of 30%, generating net emission reductions of 100 tCO_2e every 5 years. It shows that the buffer withholding percentage is constantly decreasing over time.

If the project manages to reduce its non-permanence risks over time, it will be rewarded by having the new, reduced risk rating retroactively applied to all deposited buffer credits. Additionally, the 15% time release discount applies to the newly-balanced buffer. Table 5 illustrates this case for the same project, with constant annual net emission reductions but decreasing risk ratings at every verification event. As expected, the proportion of the total risk buffer to the total (accumulated) credits generated by the project decreases at an increasing rate over the project lifetime, with 4.4% of the total accumulated project credits withheld after 30 years (i.e., 25 years after the first verification event), compared to 13.3% of the total accumulated project credits in the case of a constant 30% risk rating. Thus, reducing the total risk to the minimum risk rating of 10% over 30 years could yield an additional 8.9% of the total amount of VCUs. If the new risk rating is higher than the rating reported at the last verification event, no release of buffer credits shall occur and new buffer credits have to be deposited applying the new risk value as a percentage to the net emission reductions of the previous period(s).

In this way, project proponents are materially rewarded for ensuring that their projects effectively engage local land users, work closely to build support and capacity with relevant institutions and political leaders, and continually re-assess potential risks to the project's success.

Table 3. Buffer Calculated with Consistent Risk Rating

Assumes that verification has taken place every 5 years. Overall risk rating is assumed to be constant at 30.

Years Since First Verification	Project's Total Carbon Stock [tCO_2e]	Net Change in Project Carbon Stock [tCO_2e]	Buffer Withholding Percentage (=Overall Risk Rating)	Buffer Credits Owed for Current Period *without TRD* [tCO_2e]	TRD Factor (15% Reduction Compounded Every 5 Years)	Buffer Credits for Current Period *with TRD* [tCO_2e]	Previously Accumulated Buffer Credits *without TRD* [tCO_2e]	Previously Accumulated Buffer Credits *with Current TRD* [tCO_2e]	Buffer Size: Time-Released Credits Accumulated (Owed) by Project to Date [tCO_2e]	Buffer Size as % of Total Project Credits	Previously Deposited Buffer Credits [tCO_2e]	Net Buffer Credits to be Deposited [tCO_2e]
0	100	100	30%	30.00	100%	30.00	0.00	0.00	30.00	30%	0.00	**30.00**
5	200	100	30%	30.00	85%	25.50	30.00	25.50	51.00	26%	30.00	**21.00**
10	300	100	30%	30.00	72%	21.68	60.00	43.35	65.03	22%	51.00	**14.03**
15	400	100	30%	30.00	61%	18.42	90.00	55.27	73.70	18%	65.03	**8.67**
20	500	100	30%	30.00	52%	15.66	120.00	62.64	78.30	16%	73.70	**4.61**
25	600	100	30%	30.00	44%	13.31	150.00	66.56	79.87	13%	78.30	**1.57**

Table 4. Buffer Calculated with Declining Risk Rating

Assumes that verification has taken place every 5 years. Overall risk rating is assumed to decline non-linearly over time.

Years Since First Verification	Project's Total Carbon Stock [tCO_2e]	Net Change in Project Carbon Stock [tCO_2e]	Buffer Withholding Percentage (=Overall Risk Rating)	Buffer Credits Owed for Current Period *without TRD* [tCO_2e]	Previously Accumulated Buffer Credits *without TRD* [tCO_2e]	Adjustment to Previously Accumulated Buffer Credits Based on New Risk Rating [tCO_2e]	Buffer Credits Owed by Project to Date *with Current Risk Rating Retroactively Applied & Without TRD* [tCO_2e]	TRD Factor (15% Reduction Compounded Every 5 Years)	Buffer size: Time-Released Credits Accumulated (owed) by Project to Date [tCO_2e]	Buffer Size as % of Total Project Credits	Previously Deposited Buffer Credits [tCO_2e]	Net Buffer Credits to be Deposited (Released) [tCO_2e]
0	100	100	30%	30.00	0.00	0.00	30.00	100%	30.00	30%	0.00	**30.00**
5	200	100	25%	25.00	30.00	-5.00	50.00	85%	42.50	21%	30.00	**12.50**
10	300	100	20%	20.00	55.00	-15.00	60.00	72%	43.35	14%	42.50	**0.85**
15	400	100	15%	15.00	75.00	-30.00	60.00	61%	36.85	9%	43.35	**(6.50)**
20	500	100	12%	12.00	90.00	-42.00	60.00	52%	31.32	6%	36.85	**(5.53)**
25	600	100	10%	10.00	102.00	-52.00	60.00	44%	26.62	4%	31.32	**(4.70)**

10.2 Other Procedural Issues

Under certain conditions a project might not only fail in achieving its mitigation targets, but cause an increase in emissions or decrease in removals. The VCS registration and issuance process establishes rules as to conditions and extent to which AFOLU buffer credits would have to be canceled in case of such a *reversal*[62]. In the case of *catastrophic reversals* over which the project proponent has no control, additional rules for adjusting the baseline and the risk buffer apply, forcing the project to compensate the risks and losses caused by *force majeure*[63].

Finally, project developers and proponents should bear in mind that the verifier will re-assesses the non-permanence risk at every verification event. Nevertheless, the burden to provide for a conservative realistic risk assessment is on the side of the proponent.

11. The Way Ahead

11.1 Nesting Project-Based Activities

The REDD(+) policy environment is changing constantly. Though the UNFCCC negotiations continue, most of the technical issues (reference emission levels, MRV, degree of IPCC compliance of national REDD+ schemes) have so far not been discussed in depth or resolved. Simultaneously, several voluntary initiatives focusing on the subnational and project level activities have emerged, each developing their own protocols and methodologies.

In several sections, this document has emphasized the importance of coordinating the design of project-based activities with emerging (sub)national efforts. While uncertainties about the future of REDD+ and how to link project-based, subnational, and national accounting frameworks will remain for quite some time, there is a growing need to integrate projects into higher level approaches (jurisdictions, sector-based approaches, national REDD+ schemes). Thus, project-based accounting will have to anticipate higher-level methodological elements to achieve consistency across the different implementation levels without compromising the integrity of the project-based methodologies.[64] Some of the currently audited and approved methodologies provide flexible options regarding the baseline approach and the measurement system consistent with national REDD+ compliance schemes. Project developers are advised to explore the potential for synergies and consistency across different implementation levels before deciding in favor or against the use of a certain methodology.

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[62] A reversal is a situation where the net GHG benefit is negative, taking into account project emissions, removals and leakage, in any monitoring period (*VCS Program Definitions*, 2011)).

[63] Note that in case of catastrophic reversal VCS goes beyond what is currently being negotiated in the AWG-KP regarding force majeure affecting LULUCF activities eligible under Kyoto-track. In the past, parties considered these risks to be factored-out from anthropogenic emissions. However, in the era of climate change the distinction of natural and anthropogenic becomes fuzzier as changes in extreme weather event patterns are seen as a direct consequence of anthropogenic GHG emissions.

[64] Actually, two approaches are evolving (Chagas, et al. 2011). In disaggregated or bottom-up baseline development project baselines are emerging in parallel building up a patchwork or mosaic of baselines, which shall be nested into (sub)national frameworks by approval through (sub)national authorities. Consolidated or Top-Down Approaches provide (sub)national baselines or standardized methodological elements, which projects are requested or may be required to use.

Beyond UNFCCC REDD+ compliance schemes, it makes sense to analyze methodological options emerging under different carbon market standards or subnational cooperation. The Governors' Climate and Forest Task Force (GCF), a coalition of 16 jurisdictional entities in Brazil, Mexico, Indonesia, Nigeria, and the US, is developing design recommendations for subnational frameworks.[65] Another opportunity may lie with the Climate Action Reserve's (CAR) Forest Project Protocols for the US. [66] CAR is currently developing standards for project accounting for possible REDD programs in Mexico. The technical proposals of both initiatives are worth considering in discussing technical aspects of nesting options with (sub)national authorities.

Furthermore, the VCS Association recently established the Jurisdictional and Nested REDD Initiative, which will develop guidance and criteria for the integrated, jurisdiction-wide crediting of REDD projects, policies, and programs and will provide a pathway for project activities to be integrated into larger (sub)national frameworks. [67] The initiative will also develop guidance for setting regional baselines, helping ensure consistency and environmental integrity while streamlining processes and lowering transaction costs for projects.

11.2 From Idea to Implementation - The Technical Development Path

Table 5 indicates which technical products are required for each step of the REDD project development process (see the Step-by-Step Overview for an in-depth discussion of each of these steps). As the suggested sequence emphasizes, it is critical to start with the deforestation and degradation analysis, as this analysis is of paramount importance to the definition of the spatiotemporal boundaries, the analysis of the drivers, agents, and underlying causes of deforestation, and—ultimately—the technical and financial feasibility of the project.

Table 5. Technical Outputs of the REDD Development Chain

Step	Technical Outputs
Project Idea and Preliminary Assessment	Deforestation and degradation analysis (patterns & rates) Feasibility Assessment Project Idea Note
Project Design and Planning	Analysis of agents and drivers Preliminary definition of project boundaries Socioeconomic impact assessment Biodiversity impact assessment Program planning (logical framework) Non-permanence risk analysis
Development of Project Design Document (Carbon Accounting)	New methodology design (if applicable) VCS Project Description (= Project Design Document) Design monitoring plan (deforestation and degradation rates & patterns, emissions & removals, drivers, socioeconomic & environmental impacts) Harmonization with emerging governmental requirements and guidance
Development of Project Implementation Strategy	Reassess feasibility in light of technical outputs Development of with-project scenario and ex-ante estimates of emissions reductions
Financing and Investment Arrangements	Long-term financial plan

65 The draft designs developed by Boyd (2010) and De Gryze and Durschinger (2010) have not yet been approved.

66 See http://www.climateactionreserve.org/how/protocols/adopted/forest/current/.

67 See http://v-c-s.org/program-documents/program-development for further information.

Approvals, Validation and Registration	Possible insertion into national accounting frameworks
Implementation and Monitoring	Monitoring Report (deforestation and degradation rates & patterns, emissions & removals, drivers, socioeconomic & environmental impacts) Loss Event Report (if necessary)
Verification and Issuance	Non-Permanence Risk Report Addressing Information Request (IRs) and Corrective Action Requests (CARs)

11.3 Human Resources: Outsourcing Versus In-House Capacity Building

Designing, measuring, and reporting emissions reductions and removals require (to varying degrees and lengths of time) several specialized skills sets. These skills have to be available at several milestones (e.g., during PDD validation, verification of project impacts, leakage and non-permanence risk assessments, or in the case of a loss event). Experience shows that the implementing institution needs to guarantee that the technical knowledge stays with this institution over a long period of time (10 years, until the first baseline review), independent of changes in staff or consultants. This requirement creates a major responsibility and institutional commitment for the project proponent and their implementing partners, which goes beyond the typical timeframe of a consultancy contract.

Long-term institutional alliances of partners with complementary capabilities and skills for project development, implementation, and MRV may be necessary to meet these needs. Commercial project developers may also bring technical and transactional expertise to complement project proponent's assets, and where they also have an investment at stake should be committed to the long-term success of the project.

There is no iron rule as to which technical skills are needed to apply a methodology and to implement the monitoring plan. At minimum, the following professional skills are required to design, implement, and document the carbon accounting framework for the products outlined in Table 5:

- A forester with good skills in forest mensuration and statistics for the initial biomass inventory, periodic monitoring, and reporting.
- A GIS engineer for geo-data processing and database maintenance, and eventually land-use change modeling.
- A remote sensing specialist to process the change detection analysis and annual forest monitoring. Alternatively, this task could be outsourced or official national REDD datasets could be used, if available.
- A specialist in land-based carbon accounting to design the monitoring framework consistent with the selected methodology and national MRV system and to assemble the analytic parts. This task could be assumed by a qualified team forester, or outsourced at an early stage but should be assumed by the project proponent (or a qualified long-term implementation partner) before the first verification event.

It is worth noting that GIS and remote sensing are key technologies in the fields of conservation and natural resources management. Their importance goes far beyond REDD+ and might be strategic for the development of institutions involved.

In cases where some or all of these skills have to be outsourced beyond the project proponent and long-term partners, it is essential that long-term capacity building mechanisms and financial resources are available to enable the proponent or implementing partners to fully manage the applied methodology elements before the first verification event.

Box 14. Recommendations and Key Resources for Integrating Technical Project Design

- Think beyond the project-based approach. Ask how the project could fit into the future (sub)national compliance framework. Identify potential challenges and barriers which might complicate the future integration of project-level and (sub)national accounting frameworks. Consider adjusting the temporal and spatial project boundaries in a way that facilitates integrated accounting.
- Carefully estimate the costs of developing a new methodology, anticipating at least one year between first submission and approval (less time need be allowed for methodology revisions). Pursue the simplest option. Increasing complexity at the accounting or implementation level could become a burden, if not a barrier for successful implementation.
- Again, carefully plan the project activities using the planning and management tools referenced in Box 9.

Key Resources

Chagas, Thiago, Jacob Olander, Charlotte Streck, Robert O'Sullivan and Joerg Seifert-Granzin. *Nested Approaches to REDD+: An Overview of Issues and Options.* Washington, DC: Forest Trends and Climate Focus, 2011.Available at: http://forest-trends.org/publication_details.php?publicationID=2762.

Discusses the technical, legal, and policy aspects of different nesting approaches and includes an overview on relevant REDD compliance schemes beyond UNFCCC.

Laffoley, D.d'A. and G. Grimsditch (eds.). *The management of natural coastal carbon sinks.* Gland, Switzerland: IUCN, 2009. Available at: http://data.iucn.org/dbtw-wpd/edocs/2009-038.pdf.

VCS. *VCS Project Description Template.* VCS Version 3, Washington, DC: Verified Carbon Standard, 2011. Available at: http://www.v-c-s.org/VCSv3_templates.html.

Box 15. Common Pitfalls in Designing REDD Activities

There are some common pitfalls in developing REDD activities which should be avoided from the early steps of scoping potential sites and ideas.

Starting too small: The first estimates of the emission reduction potential of REDD activities tend to overestimate the mitigation potential. Either the true deforestation rate on the site has not been detected at the required accuracy, non-permanence and leakage risks have not been rigorously assessed, or the mitigation potential of with-project activities has been estimated too optimistically. This certainly becomes a problem if the overall mitigation potential of an activity is relatively small. In the worst case, risks or accuracy discounts could reduce emissions reductions and make projects unviable. The site should be chosen such that the realistic mitigation potential provides sufficient buffer for potential discounts, which will certainly occur.

Getting too large: If the project site gets too large, the transaction costs of involving all relevant stakeholders might push the project beyond financial viability. Bear in mind, also, that the proponent has to prove that it is in control of the project site.

Getting too complex: In the majority of tropical countries, degradation and deforestation appear to be a continuum, which indicates the potential for combining several IFM and REDD activities within one site. However, the feasibility of this option has to be assessed carefully, as it implies combining different baselines which have to be spatially consolidated, balanced, and sometimes interconnected.

Getting too expensive: Focusing on low-hanging fruits in the realms of improved forest governance and opportunity costs of forest of forest conservation can help proponents to avoid financial unviability. A thorough cost-benefit analysis will often help to get the necessary perspective on project finances (readers will find tools for assessing project costs and benefits in the Business Guidance).

Getting too optimistic: Timing matters a lot for technical and financial viability. Be prepared for delays in implementing project activities as well as in the validation and verification (V/V) of project outcomes and impacts. Anticipating these delays requires additional finance and human resources in carbon accounting to be available even beyond agreed contractual periods. Make sure that (sub)contracts with technical service providers (if any) foresee up to two months for necessary adjustments of relevant documents during V/V.

12. Conclusion

This document has aimed to guide REDD project developers through the revised VCS Version 3.0, bearing in mind the challenges they may face in the adjustment period – particularly when it comes to working with methodologies that were approved, audited, or developed under a previous version of the standard. It guides the user in choosing eligible activities, VCS compliant methodologies, technologies, and tools to implement the REDD accounting framework. However, this document is not meant to, nor can it, replace the use of the VCS documents, templates, or approved methodologies. These documents have to be constantly consulted during the preliminary assessment and project design, as well as during validation and verification.

Moreover, this technical guidance has emphasized that the REDD(+) environment is constantly changing due to the ongoing UNFCCC negotiations on one side and emerging voluntary and jurisdictional initiatives on the other. Project developers are advised to closely follow developments in both arenas to maximize project consistency and synergies with different levels of REDD policy and implementation, and to position the project's activities to be able to nest into higher level carbon accounting frameworks. Additionally, project proponents and developers need to be aware of the methodological crossroads that require strategic decisions (e.g., choices of spatiotemporal boundaries, stratification, activity data, drivers, and baseline approach). The technical options for nesting within jurisdictional frameworks will need to be developed further based on the upcoming VCS guidance expected for the second half of 2011. There is also some uncharted methodological territory in the AFOLU landscape to be covered by future methodologies or complementary sections at the level of the standards. Agroforestry, tree crops, tidal forests, and unplanned logging are some of the emerging challenges in REDD+. Further guidance is needed as to how these activities can be cost-effectively grouped into landscape-based or jurisdictional approaches.

The choice of appropriate activity data and remote sensing product to capture deforestation trends and patterns becomes a particular challenge in the transition between the current phase-out or failure of widely-used, medium-resolution sensor technologies (Landsat, CBERS, ALOS) and the availability of new workhorses in terrestrial earth observation only available from 2014 onwards. Cooperation between projects and different implementation levels could facilitate data access and burden-sharing in establishing IPCC compliant terrestrial carbon accounting frameworks.

Achieving long-term credibility as well as efficiencies in development and MRV will increasingly require that projects move beyond stand-alone approaches to accounting schemes that are harmonized and formally linked to broader efforts.

References

Archard, F., A.S. Belward, H.D. Eva, S. Federici, D. Mollicone, and F. Raes. *Accounting for avoided conversion of intact and non-intact forests.* Brussels, Belgium: Joint Research Centre of the European Commission, 2005.

Array Systems Computing In.c. *Next ESA SAR Toolbox (NEST).* European Space Agency.

Asner, G.P., D.E. Knapp, E. Broadbent, P. Oliviera, M. Keller, and J. Silva. "Selective logging in the Brazilian Amazon." *Science*, 2005: Vol. 310: 480-482.

BioCarbon Fund. *Methodology for Estimating Reductions of GHG Emissions from Mosaic Deforestation.* RED-NM-001/ Version 01, Washington, DC: The World Bank, 2008.

Bisschop, Johannes. *AIMMS: Optimization Modeling.* AIMMS 3, Haarlem, The Netherlands: Paragon Decision Technology, 2011.

Boyd, William. *Regulatory Design Options for Subnational REDD Mechanisms.* Options Paper, GCF Task Force, 2010.

Brown, S., M. Hall, K. Andrasko, F. Ruiz, W. Marzoli, and G. Guerrero. "Baselines for land-use change in the tropics: Application to avoided deforestation projects." *Mitigation and Adaptation Strategies for Global Change*, 2007: 12(6): 1001-1026.

Canada Centre for Remote Sensing. *Tutorial: Radar Remote Sensing.* Natural Resources Canada, 2008.

CAR. *Forest Project Protocol.* Version 3.2, Los Angeles, CA: Climate Action Reserve, 2010.

CCBA. *Climate, Community & Biodiversity Project Design Standards Second Edition.* Arlington, VA: CCBA, 2008.

Chagas, Thiago, Jacob Olander, Charlotte Streck, Robert O'Sullivan, and Joerg Seifert-Granzin. *Nested Approaches to REDD+: An Overview of Issues and Options.* Washington, DC: Forest Trends and Climate Focus, 2011.

Chomitz, Kenneth M., Piet Buys, Giacomo De Luca, Timothy S. Thomas, and Sheila Wertz-Kanounnikoff. *At Loggerheads: Agricultural Expansion, Poverty Reduction, and Environment in the Tropical Forests.* Washington, DC: The World Bank, 2007.

De Gryze, Steven, and Leslie Durschinger. *An Integrated REDD Offset Program (IREDD) for Nested Projects under Jurisdictional Accounting.* San Francisco, CA: Terra Global Capital, 2010.

Ebeling, Johannes. "Risks and Criticicsms of Forestry-Based Climate Change Mitigation and Carbon Trading." In *Climate Change and Forests: Emerging Policy and Market Opportunities*, by Charlotte Streck, Robert O'Sullivan, Toby Janson-Smith and Richard Tarasofsky, 43-58. London: Royal Institute of International Affairs, 2008.

Ecosystem Marketplace. *State of the Forest Carbon Markets 2011.* Washington, DC: Forest Trends, 2011, forthcoming.

Epstein, Joshua M. *Generative Social Science: Studies in Agent-Based Computational Modeling.* Princeton, NJ: Princeton University Press, 2007.

FAO. *Global Forest Resources Assessment 2010 Main Report.* FAO Forestry Paper 163, Rome: Food and Agriculture Organization of the United Nations, 2010.

Fundación Amigos de la Naturaleza (FAN). "Project Design Document of Noel Kempff Mercado Climate Action Project." Version 02.03, 2006.

Geist, H., and E.F. Lambin. "Proximate causes and underlying driving forces of tropical deforestation." *Bioscience*, 2002: 52(2): 143.

Gilbert, Nigel, and Klaus G. Troitzsch. *Simulation for the Social Scientist: Second Edition.* Berkshire, England: Open University Press, 2005.

GOFC-GOLD. *A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals caused by deforestation, gains and losses of carbon stocks in forests remaining forests, and forestation.* Report version COP16-1, Alberta, Canada: Natural Resources Canada, 2010.

Hamilton, Katherine, Unna Chokkalingam, and Maria Bendana. *State of the Foerst Carbon Markets 2009: Taking Root and Branching Out.* Washington, DC: Ecosystem Marketplace, 2010.

Hartmann, S. "The World as a Process: Simulations in the Natural and Social Sciences." In *Simulation and Modelling in the Social Sciences from the Philosophy of Science Point of View*, by R. Hegelsmann, 77-100. Dordrecht: Kluwer, 1996.

Henderson, Floyd M., and Anthony J. Lewis. *Principles and Applications of Imaging Radar: Manual of Remote Sensing, Volume 2.* New York, New York: John Wiley & Sons, 1998.

IPCC. *2006 IPCC Guidelines for National Greenhouse Gas Inventories.* Hayama, Japan: Intergovernmental Panel on Climate Change, 2006.

IPCC. *Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types.* Hayama, Japan: Intergovernmental Panel on Climate Change, 2003.

IPCC. *Good Practice Guidance for Land Use, Land-Use Change and Forestry.* Hayama, Japan: Intergovernmental Panel on Climate Change, 2003.

Knight, J.F., and R.S. Lunetta. "An experimental assessment of minimum mapping unit size." *IEEE Transactions on Geoscience and Remote Sensing* (U.S. Environmental Protection Agency), 2003: 2132-2134.

Kuntz, S., et al. "A multi-stage inventory scheme for REDD inventories in tropical countries." *9th Seminar on Remote Sensing and GIS Applications in Forest Engineering.* Parana, Brazil, 2010.

Laffoley, D.d'A. and G. Grimsditch (eds.). *The management of natural coastal carbon sinks.* Gland, Switzerland: IUCN, 2009.

Lee, Jong-Sen, and Eric Pottier. *Polarimetric Radar Imaging: From Basics to Applications.* Boca Raton, FL: CRC Press, 2009.

Lewis, S.L. "The 2010 Amazon Drought." *Science*, 2011: Vol. 331 (6017): 554.

Lusch, David. *Introduction to microwave remote sensing.* East Lansing, MI: Basic Science and Remote Sensing Initiative, Michigan State University, 1999.

Maniatis, Danae, and Danilo Mollicone. "Options for sampling and stratification for national forest inventories to implement REDD+ under the UNFCCC." *Carbon Balance Management*, 2010: 5:9.

MapREady. Version 2.3.17, Alaska Satellite Facility, 2010.

Martinuzzi, Sebastian, William A. Gould, and Olga M. Ramos Gonzalez. *Creating cloud-free Landsat ETM+ data sets in tropical landscapes: cloud and cloud-shadow removal.* Gen. Tech. Rep. IITF-32, U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, 2007.

North, M.J., and C.M. Macal. *Managing Business Complexity: Discovering Strategic Solutions with Agent-Based Modeling and Simulation.* Oxford: Oxford University Press, 2007.

Oberkampf, William L., and Timothy G. Trucano. *Verification and Validation in Computational Fluid Dynamics.* SAND2002-0529, Albuquerque, New Mexico: Sandia National Laboratories, 2002.

Orrell, David. *The Future of Everything: The Science of Prediction.* Toronto: First Thunder's Mouth Press, 2007.

Pearson, Timothy, Sarah Walker, and Sandra Brown. *Sourcebook for Land Use, Land-Use Change and Forestry Projects.* Winrock International and World Bank BioCarbon Fund, 2005.

Polsarpro: Polarimetric SAR Data Processing and Educational Tool . Version 4.2, European Space Agency, 2011.

Pontius Jr., Robert Gilmore, et al. "Comparing the input, output, and validation maps for several models of land change." *Annals of Regional Science*, 2008: 42: 11-37.

REDD+ SES. *REDD+ Social and Environmental Standards.* Version 1, CCBA and CARE International, 2010.

Saatchi, S. S., R. A. Houghton, R. C. Dos Santos Alvala, J. V. Soares, and Y. Yu. "Distribution of aboveground live biomass in the Amazon basin." *Global Change Biology*, 2007: 13: 816–837.

Saatchi, Sassan S., et al. *Benchmark map of forest carbon stocks in tropical regions across three continents.* Proceedings of the National Academy of Sciences, 2010.

SAR Training Processor. Version 1.1.10, Alaska Satellite Facility, 2009.

Sohngen, B., and S. Brown. "Measuring leakage from carbon projects in open economies: a stop timber harvesting project as a case study." *Canadian Journal of Forest Research*, 2004: 34: 829-839.

Souza, CM, DA Roberts, and MA Chochrane. "Combining spectral and spatial information to map canopy damage from selective logging and forest fires." *Remote Sensing of Environment*, 2005: 98: 329-343.

Strahler, Alan H., et al. *Global Land Cover Validation: Recommendations for Evaluation and Accuracy Assessment of Global Land Cover Maps.* GOFC-GOLD Report No. 25, Luxemburg: Office for Official Publications of the European Communities, 2006.

Streck, Charlotte, Robert O'Sullivan, Toby Janson-Smith, and Richard Tarasofsky. *Climate Change and Forests: Emerging Policy and Market Opportunities.* London: Royal Institute of International Affairs, 2008.

Trines, Eveline. "History and Context of LULUCF in the Climate Regime." In *Climate Change and Forests: Emerging Policy and Market Opportunities*, by Charlotte Streck, Robert O'Sullivan, Toby Janson-Smith and Richard Tarasofsky, 33-42. London: Royal Institute of International Affairs, 2008.

UNFCCC. *1/CP.16 The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action Under the Convention.* FCCC/CP/2010/7/Add.1, Cancun, Mexico: United Nations Framework Convention on Climate Change, 2010.

UNFCCC. *3/CMP.1 Annex: Modalities and procedures for a clean development mechanism as defined in Article 12 of the Kyoto Protocol.* FCCC/KP/CMP/2005/8/Add.1, Montreal: United Nations Framework Convention on Climate Change, 2005.

UNFCCC. *4/CP.15 Methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.* FCCC/CP/2009/11/Add.1, Copenhagen, Denmark: United Nations Framework Convention on Climate Change, 2009.

UNFCCC. *5/CMP.1 Modalities and procedures for afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol.* Montreal: UNFCCC, 2005.

UNFCCC. *Report on the expert meeting on methodological issues relating to reference emission levels and reference levels. Note by the secretariat.* FCCC/SBSTA/2009/2, Bonn, Germany: United Nations Framework Convention on Climate Change, 2009.

VCS. *AFOLU Non-Permanence Risk Tool.* VCS Version 3 Procedural Document, Washington, DC: Verified Carbon Standard, 2011.

VCS. *Agriculture, Forestry and Other Land Use (AFOLU) Requirements.* VCS Version 3 Requirements Document, Washington, DC: Verified Carbon Standard, 2011.

VCS. *Methodology Approval Process.* VCS Version 3 Procedural Document, Washington, DC: Verified Carbon Standard, 2011.

VCS. *Program Definitions.* VCS Version 3 Requirements Document, Washington, DC: Verified Carbon Standard, 2011.

VCS. *Registration and Issuance Process.* VCS Version 3 Procedural Document, Washington, DC: Verified Carbon Standard, 2011.

VCS. *VCS Project Description Template.* VCS Version 3, Washington, DC: Verified Carbon Standard, 2011.

VCS. *VCS Standard.* VCS Version 3 Requirements Document, Washington, DC: Verified Carbon Standard, 2011.

Verburg, P. H., and A. Veldkamp. "Editorial: Introduction to the Special Issue on Spatial Modeling to Explore Land Use Dynamics." *International Journal of Geographical Information Science*, 2005, 19:2: 99-102.

White, Douglas, and Peter Minang. *Estimating the Opportunity Costs of REDD+: A Training Manual.* Version 1.3, Washington DC: World Bank Institute, 2011.

Glossary

For CDM projects, readers may wish to refer to the official definitions provided in the CDM Glossary of Terms, available at: http://cdm.unfccc.int/Reference/Guidclarif/glos_CDM.pdf.

VCS also provides standard Program Definitions, which are available at:
http://www.v-c-s.org/sites/v-c-s.org/files/Program%20Definitions%2C%20v3.0.pdf.

Additionality – The principle of carbon additionality is that a carbon project should only be able to earn credits if the GHG benefits would not have occurred without the revenue (or expected revenue) of carbon credits. The same principle of additionality can be applied to social and biodiversity benefits.

Attribution – The isolation and accurate estimation of the particular contribution of an intervention to an outcome, demonstrating that causality runs from the intervention to the outcome. That is, attribution demonstrates that benefits claimed by the project (usually *co-benefits*) have been caused by the project and not another phenomenon.

Baseline – See *reference scenario*.

Biodiversity target – Biodiversity features which the project will target in its efforts to achieve net positive impacts on biodiversity. These will usually comprise High Conservation Values.

Causal model – See *theory of change*.

Co-benefits – Benefits generated by a forest carbon project beyond GHG benefits, especially those relating to social, economic, and biodiversity impacts.

Control – In the context of impact assessment for forest carbon projects, an area that does not experience project interventions but is otherwise similar to the project area. Controls are used to monitor the reference scenario and to demonstrate the attribution of outcomes and impacts to the project.

Counterfactual – The outcome that would have happened had there been no intervention or project – i.e., the final outcome of the reference scenario.

Evaluation –The systematic and objective assessment of an on-going or completed project, program or policy, and its design, implementation, and results.

GHG benefits – Any emissions reductions from reducing carbon losses or emission removals from enhanced carbon sequestration due to the forest carbon project activities.

Impact – The positive and negative, primary and secondary, short- and long-term effects of a forest carbon project. Impacts may be direct or indirect, intended or unintended. Impacts result from a chain of inputs, outputs, and outcomes.

Indicator – A measurable variable that reflects, to some degree, a specific monitoring information need, such as the status of a target, change in a threat, or progress toward an objective.

Inputs – The financial, human, and material resources used for a forest carbon project. Most relevant in discussion of outputs, outcomes, and impacts.

Leakage – The geographical displacement of GHG emissions – or social, economic, or biodiversity impacts – that occurs as a result of a forest carbon project outside of the forest carbon area. Leakage assessments must consider adjacent areas as well as areas outside of the project zone.

Measurement, Reporting, and Verification System – A national, subnational, or project-level set of processes and institutions that ensure reliable assessment of GHG benefits associated with real and measurable emission reductions and enhancement of carbon stocks.

Methodology – An approved set of procedures for describing project activities and estimating and monitoring GHG emissions.

Monitoring – A continuing process that uses systematic collection of data on specified indicators to provide indications of the extent to which objectives are being achieved.

Multiple-benefit projects – Projects that generate sufficient environmental and social co-benefits, in addition to GHG benefits.

Outcomes – The likely or achieved short-term and medium-term effects of an intervention's *outputs*.

Outputs – The products, capital goods, and services that result from a forest carbon project.

Project area – The land within the carbon project boundary and under the control of the project proponent. (The CCB Standards use distinct language for *project area* and *project zone*.)

Project developer – The individual or organization responsible for the technical development of the project, including the development of the PDD, the assessment of social and biodiversity impacts, monitoring and evaluation, etc. Although the term does not necessarily describe a commercial entity, it often refers to an external company that is contracted to do work on the ground.

Project Design Document – A precise project description that serves as the basis of project evaluation by a carbon standard, commonly abbreviated to PDD. (Alternatively, VCS calls this the "project description," or PD)

Project participant – Under the CDM, a Party (national government) or an entity (public and/or private) authorized by a Party to participate in the CDM, with exclusive rights to determine the distribution of CERs – equivalent to *project proponent* under the VCS. In the voluntary market, project participant is used more loosely to describe any individual or organization directly involved in project implementation.

Project proponent – A legal entity under the VCS defined as the "individual or organization that has overall control and responsibility for the project." There may be more than one project proponent for a given project. Carbon aggregators and buyers cannot be project proponents unless they have the right to all credits to be generated from a project.

Project zone – The project area plus adjacent land, within the boundaries of adjacent communities, which may be affected by the project. (The CCB Standards use distinct language for *project area* and *project zone*.)

REDD – A system that creates incentives and allocates emissions reductions from reducing emissions from deforestation and forest degradation.

REDD+ – A system that creates incentives and allocates emissions reductions from the following activities: (a) reducing emissions from deforestation; (b) reducing emissions from forest degradation; (c) conservation of forest carbon stocks; (d) sustainable management of forests; and (e) enhancement of forest carbon stocks.

Reference scenario – An estimated prediction of what will happen in a given area without the project. Reference scenarios may cover land use patterns, forest conditions, social conditions, and/or biodiversity characteristics. Also called the "business-as-usual scenario" and the "baseline."

Starting conditions – The conditions at the beginning of a project intervention. Also called "original conditions" in the CCB Standards and sometimes referred to as the "baseline" in the field of impact assessment. This can, however, lead to confusion, considering that CCB Standards and carbon standards use the same term to describe the "reference scenario" of a forest carbon project.

Theory of change – The hypothesis, as developed by the project design team, of how the project aims to achieve its intended goals and objectives, including social and biodiversity objectives. This is sometimes referred to as the *causal model.*