A close look at the quality of REDD+ carbon credits

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The team of authors have different monetary, non-monetary and institutional roles with respect to the evaluated standards. Charlotte Streck sits on the Board of Verra, the organization that administers the Verified Carbon Standard (VCS). Donna Lee and Till Neeff have served on the Technical Standards Committee of the Architecture for REDD+ Transactions' The REDD+ Environmental Excellence Standard (ART/TREES) standard. They have both been contracted to support the Forest Carbon Partnership Facility (FCPF) Carbon Fund, and Verra, on standard development. Climate Focus, the employer of Charlotte Streck, Thiago Chagas, and Hilda Galt, has held and holds contracts with the FCPF Facility Management Team on program development in various tropical forest countries, and on benefit-sharing and verification options for the FCPF. Till Neeff and Donna Lee have served on Technical Advisory Panels for the FCPF Carbon Fund. Climate Focus has coordinated input in the development of the original VCS Jurisdictional and Nested REDD+ (JNR) and REDD+ methodological modules. The authors are advising several private buyers on the acquisition of carbon offsets. The authors also routinely provide technical and strategic advice to developing countries on developing REDD+ programmes.

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1. Introduction

a. Objective

Companies are increasingly relying on carbon credits to offset greenhouse gas (GHG) emissions or support climate goals. Many companies are looking to buy environmentally credible carbon credits that represent a measured ton of reduced or sequestered GHG. However, the absence of clear guidance on the quality of credits makes it difficult to take investment decisions. This is particularly true for forest carbon credits that operate within socially and environmentally complex contexts and are less straightforward in their evaluation than credits generated by projects in the energy or industrial sectors. While investors will conduct their own due diligence, this paper seeks to provide some initial guidance on the technical features and advantages and risks of different carbon standards.

Carbon standards take different approaches to measuring GHG reductions and removals. When using carbon credits to offset emissions, it is critical that the measurement of the "ton" of reduced or sequestered GHG is robust, representing an emission reduction or removal beyond business as usual. Historically, forest carbon credits (in particular from avoided deforestation projects) have been kept out of many important carbon markets due to a lack of confidence in the ability to quantify GHGs from forests, concerns about the potential reversal of credited climate mitigation (e.g. the subsequent loss of trees) and the potential displacement of activities that may occur (e.g. a rise of emissions outside of the project due to activities within the project). However, much has been learned over the past decade about forest carbon crediting through experiences in the voluntary market. And, a new class of forest credits is also emerging: jurisdictional forest credits (see Box 1 for terminology used in this report).

This report assesses several carbon standards, focusing on criteria that influence the integrity of carbon credits: additionality, baseline setting, quantification of emission reductions (in particular uncertainty), permanence, and leakage. We do not assess other social and environmental (e.g. biodiversity, soil, water) features commonly associated with forest carbon projects. The report builds upon the analysis carried out in an earlier publication, which explored whether forest carbon credits should be eligible under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).[1] We have tailored our discussion in this report to be applicable beyond CORSIA, and included analysis of the recently released REDD+ Environmental Excellence Standard of the Architecture for REDD+ Transactions.

Most attention is paid to avoided deforestation projects and programs, which produce the overwhelming majority of forest carbon credits traded on voluntary markets to date. Because of the attractiveness of supporting "nature" and the availability of large inventory, such credits are currently the preferred choice of voluntary offset buyers, surpassing wind energy credits that attracted much demand otherwise.[2] The report distinguishes credits generated at the project level from larger jurisdictional programs. It also includes consideration of "nested" REDD projects, i.e. projects embedded in jurisdictional monitoring and accounting schemes, as nesting may address some project specific risks (see Box 1 on terminology).

Box 1 Terminology

Throughout the document, a "**carbon standard**" denotes a set of rules that determines the creation and issuance of carbon credits, either for projects or for larger-scale programs. A "**project**" uses methodologies that have been specifically created at the scale of activities, usually implemented by non-state entities (private project developers and investors, often in cooperation with NGOs, communities or local (forest) authorities). By contrast a "**program**" or "**jurisdictional program**" denotes a mitigation activity at the sectoral level, such as large-scale REDD+ programs at national, subnational or jurisdictional scale. Such programs are qualitatively different from projects as they look at performance over very large areas.[3] Throughout this report, "**nesting**" refers to the integration of projects into jurisdictional programs through harmonized GHG accounting rules. "**Carbon credits**" are used to describe GHG emission reductions representing carbon dioxide equivalent (CO_2e) not emitted or removed and stored in biomass.

b. Evaluated carbon standards

Two types of carbon standards were selected for analysis: (1) standards that issue carbon credits at the project level and make up a large portion of current voluntary carbon markets, with a focus on VCS and the emerging "nesting guidance" for forest projects; and (2) standards that are designed to generate jurisdictional REDD+ credits (i.e. VCS JNR, the FCPF Carbon Fund, and ART).[4] A detailed discussion is not included of those carbon standards that have prominence in carbon markets but exclude REDD+ activities (i.e., the CDM[5]). The standards are described briefly below:

<u>Project standards</u>

The Verified Carbon Standard (VCS) was developed in 2005 and is the most widely used voluntary carbon standards with over 1500 certified VCS projects covering all relevant mitigation sectors (energy, transport, waste, forestry, among others). Currently, there are 14 approved methodologies for forestry and REDD+, with CDM methodologies also being accepted. At the time of writing in early 2020, there are 167 forestry projects included in the VCS project database that have issued close to 180 million carbon credits as Verified Carbon Units (VCUs). Many of these are REDD+ projects. Since the CDM and Gold Standard exclude avoided deforestation projects, the VCS is the standard of choice for the overwhelming majority of forest credits generated for the voluntary carbon and almost all REDD+ projects.

VCS Nested Projects are a potential new class of forest carbon credit that would be integrated within national or subnational REDD+ accounting schemes. As of the time of this report, Verra, the standard organization that administers the VCS, is actively advancing the development of new requirements and guidance[6] for such REDD+ project nesting, which will eventually be included in the VCS Program.

<u>Jurisdictional standards</u>

The VCS Jurisdictional and Nested REDD+ (VCS JNR) is the first standard focused on crediting national and subnational jurisdictional REDD+ programs (and nested projects). The requirements for the VCS JNR were first released in 2012. There are currently no approved jurisdictional programs under VCS JNR although several are in the process of seeking accreditation. As of the time of this report, Verra is in the process of updating several aspects of the JNR requirements.[7]

The Forest Carbon Partnership Facility's (FCPF) Carbon Fund is a World Bank administered multi-participant trust fund that aims to generate carbon credits through large-scale REDD+ programs. The FCPF has developed a Methodological Framework (MF) that defines the technical requirements for Carbon Fund purchases (largely comprised of donor government funds). The FCPF manages a readiness and capacity building program that supports countries in achieving REDD+ and Carbon Fund readiness. The Carbon Fund signs Emission Reduction Payment Agreements to purchase a share of the credits from programs supported by the FCPF, but also allows countries to sell remaining credits or future vintages. The FCPF has a sunset clause, ostensibly ending the Fund's operation by 2026. By early 2020 the FCPF had signed four Emission Reduction Purchase Agreements (ERPAs). It is not clear how many of these ERPAs have already entered into effect.

The Architecture for REDD+ Transactions (ART) is the newest REDD+ jurisdictional scheme. It is promoting a set of requirements for jurisdictional REDD+ programs known as the REDD+ Environmental Excellence Standard (TREES). The ART/TREES aims to issue tradable credits in both voluntary and compliance markets. Under ART/TREES rules, REDD+ credits will be generated at the national level, with subnational programs allowed only initially. There are currently no countries (or subnational jurisdictions) applying the ART/TREES standard, as it was only released in February 2020.

c. Overview of quality criteria for carbon credits

The quality of carbon credits hinges on whether a convincing case can be made that a project or program has indeed reduced the GHG emissions or sequestered the carbon dioxide (CO_2) it claims. Below are the criteria most often used to assess whether such claims are credible.

Baselines represent a benchmark level of emissions that a project or program needs to outperform in order to issue carbon credits. Establishing baselines is complex because it involves developing a counterfactual trajectory of emissions in the absence of the project or program. This is often understood to represent the business-as-usual (BAU) scenario, i.e. how would emissions have increased (or decreased) had the project or program not been implemented. Credible baselines need to be conservative and err towards a reference scenario that assumes rather less than more future emissions.

Additionality refers to the requirement that emission reductions or removals would not have happened without the incentive of carbon credits. Over the last decades approaches to demonstrating additionality have grown increasingly restrictive.[8] For projects, additionality is typically assessed by applying "tests" that confirm the project would not have been realized in the absence of carbon finance. Additionality is closely linked to baseline setting—jurisdictional programs rely mainly on conservative baseline setting to capture non-additional emission reductions and removals.

Permanence reflects the need for an emission reduction to represent a long-term mitigation benefit. This is particularly relevant when credits are issued for storing carbon – whether in trees or in geological formations – since there is a risk that the credited carbon removal is reversed, i.e. is emitted back into the atmosphere.[9] Such events can be natural or driven by human activities. For example, a forest restoration project can be reversed if the land owner decides it is more profitable to grow crops.

Leakage is the increase of GHG emissions outside of the boundaries of a project or program that can nonetheless be attributed to the project or program itself.[10] Leakage can be positive or negative. Positive leakage, i.e. additional emission reductions outside of the accounting area, is generally discounted. Negative leakage occurs when a reduction in emissions within the project or program boundary leads to higher emissions elsewhere. How leakage is managed, quantified and accounted for depends on the type of activity and the carbon standard under which the activity is registered.

Quantification of GHG emissions and removals refers to the accurate and precise measurements of GHG reductions and removals. Quantification may require, for example, estimating the carbon stock in forests and the area of deforestation. Quantification relies on the collection, analysis and archiving of data for measuring GHG emissions and removals. Carbon standards mostly require that quantification of emission reductions be undertaken in a conservative manner to avoid overestimation of emission reductions. The analysis of uncertainties is essential to ensure conservativeness.

2. Assessment of carbon standards against the quality criteria

This section considers the application of the quality criteria to different project types and scales of intervention. We then consider how evaluated carbon standards apply each quality criterion and whether these standards are able to produce carbon credits that fully meet the quality feature in question.
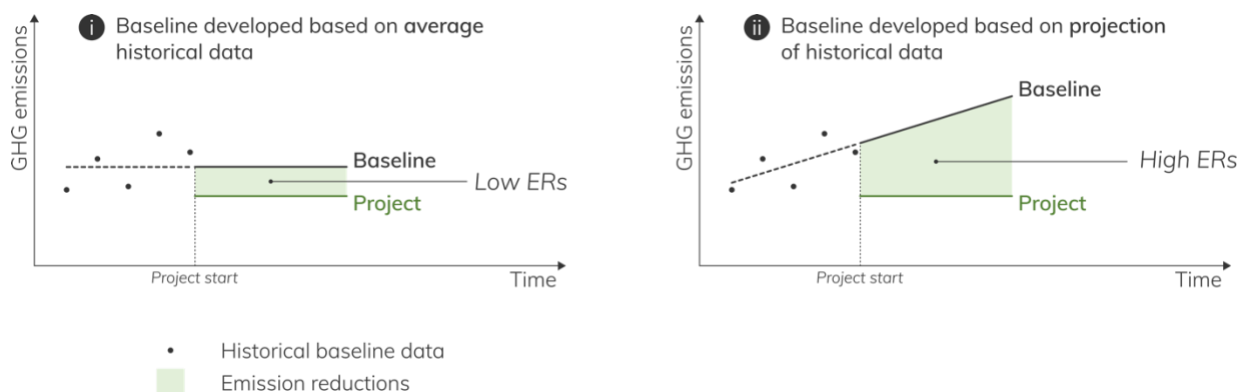
a. Baselines

For many types of projects and programs, setting reliable baselines is the most important factor in generating robust carbon credits. Baselines are developed using a variety of approaches, including activity-specific emissions trajectories, historical average emissions, and sectoral performance standards.

Activity-specific baselines forecast emissions in the project area based on the evaluation and assumptions of expected future drivers of emissions and consideration of plausible options of what might happen in the absence of a project or program. Common methodologies for activity-specific baselines are scenario analysis or emissions modelling. Scenario analysis in REDD+ or, more specifically, "avoided deforestation" projects is often determined by assessing a reference area with similar drivers and applying the historical deforestation rates seen there to the project area. The baseline scenario can also assume the implementation of infrastructure projects (such as roads) or agricultural policies that lead to increased deforestation, in which case more complex modelling may be needed.[11] The use of complex modeling approaches, however, makes it very difficult for auditors to assess the modelling assumptions used that create the baseline. This creates a risk for baselines that may be overly generous in assuming future reference emissions.

Jurisdictional REDD+ baselines are typically set using **historical data**. One common option is to simply use the *average historical value* of emissions over a reference period (Figure 1 (i)). This approach is sometimes considered a proxy for obtaining a business-as-usual scenario in REDD+ jurisdictional programs. Another option is to develop historical *trends* from historical data (e.g. a linear projection) to determine the baseline (Figure 1 (ii)). In other cases, "adjustments" to historical average data are permitted, such as for planned deforestation from infrastructure and land concessions.[12] Data show that for most developing countries a historical average reference level tends to be conservative, as in many cases deforestation is increasing; however, where deforestation is slowing the opposite is true.[13]

The approach to establishing the baseline is critical for the robustness of REDD+ emission reductions. The example below illustrates this point (Figure 1). Should historical emission patterns simply continue, then a historical average baseline will yield very low (if any) emission reductions; but an upward sloping baseline would lead to higher emission reductions.

Figure 1: Example to illustrate how critical baseline setting is for robust carbon credits

Nested baselines are now being considered for avoided deforestation projects. Historically, the choice of a benchmark reference area for developing an activity-specific baselines has resulted in gerrymandered selection of high-deforestation zones. Nesting would require that, in aggregate, project-level baseline emissions do not exceed (and take only a reasonable share of) the value of a well-constructed BAU jurisdictional reference level.[14] This reduces the ability to inflate baseline emissions. The latest thinking on nesting involves allocating a jurisdictional baseline down to projects, apportioning emissions according to deforestation pressure. This allocation approach to determine project baselines is being considered by the VCS and updates on nesting requirements are expected to come online during 2020.[15]

Management of baselines by evaluated carbon standards

Carbon standards prescribe a number of methodological principles and rules to avoid artificially inflated baselines, such as:

Conservativeness. Project or programs claim a lower amount of emission reductions than are likely to have occurred in reality. For example, setting a jurisdictional baseline as the average historical level of emissions is conservative if deforestation is rising in the region.

Periodic updates. Limiting the period over which a baseline is valid ensures that crediting of emission reductions occurs against an up-to-date baseline scenario, i.e. one that reflects the changing social, economic and technological conditions of the project or program area.

Prescriptive rules to reduce incentives to inflate baselines. Under all program rules, there is considerable scope for cherry-picking data to maximize baseline emissions. For example, reference levels are sensitive to the choice of the reference period[16] and should be chosen to be conservative and adequately justified.[17]

Table 1: Examples of how carbon standards approach baseline setting

Carbon Standard	Approaches for baseline setting	Strategies for achieving conservative baselines	Baseline revision	Reference period for baseline
VCS (avoided deforestation projects)	Comparison to a reference region or modelling	Current methodologies sometimes do not lead to conservative baselines. But avoided deforestation projects are expected to "nest" into jurisdictional programs, which should result in more conservative baselines.	Currently 10 years, but considering shortening to 5-7 years.	Historical periods for parametrizing baseline models depend on the methodologies.
VCS JNR	Average historical baseline or historical trend	The use of a historical average baseline will be conservative where deforestation is rising. The use of historical trends may not be conservative.	Currently 5 to 10 years, but considering shortening to 4-6 years.	Must be 8 to 12 years or, if using a trend, it must be based on historical data of at least 10 years prior to the crediting period.
FCPF Carbon Fund	Historical average for all programs, except for High Forest Low Deforestation (HFLD) regions	The use of 10-year historical average baselines will be conservative where deforestation is rising. Countries with high forest cover and historically low deforestation rates can assume an increase of emissions above the historical average by up to 0.1% of carbon stocks in the forest, which may not be conservative.	No guidance provided since the FCPF Carbon Fund has a limited period of operations to 2026.	Must be "about 10 years" that can only be extended with "convincing justification."[18]
ART / TREES	Historical average for all programs	The use of a historical average baseline will be conservative where deforestation is rising.	5 years	5 years with demonstration of no bias in data selection.

Key baseline considerations for generating robust carbon credits

Setting baselines for avoided deforestation projects is challenging. Forecasting emissions trajectories into the future is difficult and hugely uncertain. Deforestation is the result of complex socio-economic dynamics. The drivers of deforestation are hard to predict. Therefore, developing a counterfactual baseline scenario for forest programs tends to be more challenging if compared with projects in other sectors. Under the VCS, the use of reference areas by avoided deforestation projects to model what would occur in a project area has, in some cases, resulted in the cherry picking of proxy areas, leading to (unrealistic) volumes of carbon credits. By contrast, relying on historical data in jurisdictional programs tends to be conservative, particularly where it is clear that deforestation is rising.

The nesting of avoided deforestation projects into a jurisdictional baseline can mitigate the risks of baseline inflation. This is particularly the case if project baselines in aggregate are a reasonable share of a jurisdictional or national reference level. Although nesting is still in early stages in most countries, VCS – the Carbon Standard used for the large majority of voluntary avoided deforestation projects – is currently developing new nesting requirements that are expected to make project baselines more conservative. In particular, the allocation of a conservative jurisdictional reference level among discrete projects reduces the risk of unrealistically high baselines at the project level, limiting instances in which reference areas with higher rates of deforestation are cherry-picked as a proxy for setting project baselines.

The stringency of carbon standards varies. The FCPF Carbon Fund's methodological framework requires using historical averages of at least ten years even in countries with clearly rising deforestation. However, it allows countries with high forest cover and low deforestation (HFLD) rates to increase the baseline by up to 0.1% of carbon stock, which may not be conservative. By contrast, the crediting level for ART's TREES uses a historical average over five years, which is conservative where deforestation is rising (which is the case for most tropical forest countries), but less so where it is falling. The ART/TREES does not allow for "adjustments", which is generally considered conservative.

Table 2: Summary evaluation of baseline provisions for specific standards

Forest projects		Jurisdictional programs		
VCS stand-alone	VCS nested	VCS JNR	FCPF Carbon Fund	ART / TREES
There is evidence of baseline inflation in some avoided deforestation projects.	Although not tested yet, nesting can be expected to reduce the risk of baseline inflation. This is particularly true for avoided deforestation where nested projects are provided a risk-adjusted share of the jurisdictional reference level.	No experience yet with JNR standard, but the use of a historical average baseline will be conservative where deforestation is rising	Includes rigid rules avoid gaming baselines. Average historical reference emissions are likely conservative where deforestation is rising.	Not tested yet, but includes rigid rules to avoid gaming baselines. The short historical period likely better reflects BAU than the longer period currently used by the FCPF Carbon Fund and JNR. No adjustments allowed.
For other types of projects, such as reforestation, baseline setting is more straightforward because the counterfactual case is clearer.		Where a trend baseline is used, it may not always be conservative.	HFLD countries may set a baseline well above historical average emissions that may not always be conservative.	

b. Additionality

Demonstrating project-level additionality requires demonstrating that the activity faces barriers that would prevent it from otherwise going ahead—for example, that the project activity is not already required by law or is not financially viable without income from the carbon credits.

A project is non-additional if it is **common practice.** For example, certain commercial forestry projects may be common practice in the context of a strong forestry sector. The additionality argument can be corroborated by **prior consideration,** i.e. evidence that the decision to pursue carbon certification occurred before the start of the project.

The **investment analysis**, in turn, requires projects to demonstrate that the proposed project activity is economically less attractive than the existing alternatives. Demonstrating additionality via investment analysis can be problematic for project types - such as commercial timber plantations - that generate revenues from sources other than selling carbon credits.[19]

Finally, the **barrier analysis** requires projects to demonstrate that certain barriers prevent the project from being implemented. In the energy and industry sectors, increasingly individual project testing is being replaced with standardized classifications (i.e. **positive or negative lists**) determined by the carbon standard.[20]

For **jurisdictional programs additionality assessment is simplified**. When generating carbon credits at the jurisdictional level, it would not make sense to propose project-style additionality testing since such programs often include a multitude of specific actions ranging from public policy interventions, to private sector engagement, to community-scale interventions. Hence, jurisdictional programs are sometimes considered additional simply if they outperform the baseline.[21] We also note that, if the jurisdictional reference level is stringent, the risk of non-additionality is lessened for nested[22] projects or programs.[23]

Management of additionality by evaluated carbon standards

All carbon standards that approve projects essentially follow or build on the step-wise additionality tool used by the CDM.[24] The CDM was the first carbon standard to employ positive lists in an effort to reduce transaction costs and obstacles to participation for certain groups of countries and types of projects. Positive lists have since also been published by the VCS and Gold Standard.[25] The CDM, VCS and Gold Standard also define ineligible project types.[26]

Jurisdictional programs do not require additionality tests similar to those used by projects. A barrier analysis in the style of the CDM additionality tool would not be helpful to understand public policy choices. However, a couple of carbon standards require providing further assurances that there is additionality. Notably, the FCPF Carbon Fund requires forest programs to demonstrate "new or enhanced" measures have taken place. VCS JNR requires that crediting can only start after new laws, policies, or concrete implementation of mitigation activities have taken place. Table 3 below summarizes the additionality approach adopted by evaluated carbon standards.

Table 3 Examples of how carbon standards address additionality

Carbon Standard	Additionality tests
VCS (avoided deforestation projects)	Requires additionality tests combining: (i) prior consideration; (ii) investment analysis; (iii) common practice analysis; (iv) barrier analysis.
VCS JNR	Additionality is mostly assumed through baseline setting. However, JNR also requires that the program start date be justified based on relevant GHG laws, policies or regulations that target GHG mitigation, and/or concrete implementation of mitigation activities
FCPF Carbon Fund	Additionality is mostly assumed through baseline setting. However, emission reduction programs must also provide information on measures that address a significant portion of emissions, and demonstrate that the program is ambitious, takes a programmatic approach, and reflects a variety of interventions from the national REDD+ strategy in a coordinated manner.
ART / TREES	Additionality is assumed through (presumed conservative) baseline setting.

Key additionality considerations for generating robust carbon credits

Most project carbon standards provide reasonable assurances of additionality. Carbon standards like the CDM, the VCS, and the Gold Standard tend to require projects, including forest carbon projects, to apply a multiple-step approach to establish their additionality. The core of additionality testing is the investment analysis that establishes that the project would not have happened without carbon finance.

Additionality testing delivers clearer results where projects have little or no financial incentive other than the revenues from carbon credits. For avoided deforestation projects there is generally a clear case for arguing that the project or program would not have been developed (and maintained) if not for the incentive created through carbon credits. This is because forest protection in many tropical countries is weak, budgets for forest protection are largely absent, and economic incentives for deforestation abound. This is not the case, for instance, for certain renewable energy projects, such as large solar and wind power plants in emerging economies, where plummeting capital costs over the years made these investments largely attractive on their own.

For jurisdictional programs, additionality is strengthened if the carbon standard requires evidence of new policies or actions. Jurisdictional programs often rely on baseline setting to capture additionality. But jurisdictional programs present greater risks that carbon credits generated merely reflect larger economic trends or political dynamics rather than specific efforts to reduce deforestation. To mitigate this risk, the Carbon Fund and JNR require jurisdictional programs to demonstrate that dedicated action has been taken to reduce emissions (e.g. through new or enhanced policies and actions that tackle the key drivers of emissions). The ART/TREES does not require such additional evidence.

Table 4: Summary evaluation of additionality provisions for specific standards

Forest projects		Jurisdictional programs		
VCS stand-alone	VCS nested	VCS JNR	FCPF Carbon Fund	ART / TREES
For avoided deforestation projects additionality is straightforward to demonstrate. Additionality is harder to demonstrate for financially attractive activities (e.g. commercial reforestation).	The additionality test for nested projects is not different than for regular VCS projects.	Assumed to be reflected in a conservative baseline. Additionally, there is the requirement to implement new policies or actions.	Assumed to be reflected in a conservative baseline; there is also a requirement to implement new (or enhanced) policies or actions.	Assumed to be reflected in a conservative baseline, without other requirements.

c. Permanence

Carbon stored in planted forests can be **released due to natural disturbances** (i.e. fire, floods, pests and diseases, landslides and even climate change). The risk of reversals is most relevant in land-based mitigation projects.[27] The risk of non-permanence may increase in regions affected by climate change, for example, where regions become hotter and drier, forests may become more vulnerable to disturbance and change.

The scale of activities matters for permanence risks. Jurisdictional programs are more difficult to control and predict given the size of territories, political and budgetary shifts, and changes in agricultural commodity prices. They are also exposed to policy changes that lead to an increase of deforestation. On the other hand, where jurisdictional programs cover many types of forest activities located in different areas, reversals from some activities might be compensated by the success of others.

Management of non-permanence risks by evaluated carbon standards

Nearly all evaluated carbon standards deal with non-permanence risks by making use of buffer accounts. Projects and programs contribute a share of their carbon credits to a buffer pool and, should reversals occur, an equivalent number of credits are cancelled to secure the permanence of issued carbon credits.

But variations of the buffer approach exist. The VCS requires forest projects or programs to deposit a certain quantity of credits into a pooled buffer account to be used to offset any reversal. The number of units required to be placed in reserve is based on an analysis of the likelihood of a reversal of each project or program (the "non-permanence risk rating"). Projects or programs with risk-rating percentages deemed unacceptably high (i.e. above 60%) are not eligible for crediting.[28] For land use-related projects, risk assessment considers a period of 100 years.[29]

The ART/TREES and the FCPF Carbon Fund also require non-permanence risks to be assessed and reversal mitigation measures included during the program design. Both also use the buffer approach with the amount of emission reductions set aside defined in accordance with the level of risk of the program.

In all cases, the long-term guarantee that reversals will be compensated is critical because projects and programs could end and simply walk away from the carbon standards without undergoing further verifications that could reveal reversals. In the case of the ART/TREES, while countries are responsible for compensation, including replenishment of the buffer if the reserve is insufficiently stocked—including claims on future emission reductions—a country may also simply walk away from the ART/TREES. Similarly, the FCPF Carbon Fund requires program developers to establish a domestic reversal management system (either a buffer or an insurance mechanism) to address reversals beyond the term of the ERPA, but it is hard to see how this requirement could be enforced after the termination of the ERPA.[30]

While there is very little experience yet on the effectiveness of buffers for guaranteeing permanence of emission reductions from jurisdictional REDD+ programs, for VCS avoided deforestation projects, experience is positive and buffer set-asides have so far been effective in covering for reversals. It is not a given that the positive experience of project buffers translates one-to-one to buffers for jurisdictional REDD+ programs. Since only a moderate number of programs can be expected to contribute to buffers, more stringency would be needed. It is important to note that so far, no jurisdictional credits have been issued and buffer accounts are therefore not yet in place.

The Table below provides information on how various carbon standards address the criteria for permanence: reversal assessment, monitoring, mitigation and compensation.

Table 5: Examples of how carbon standards address non-permanence risks

Carbon Standard	Definition	Risk assessment	Reversal monitoring	Other reversal mitigation	Reversal compensation
VCS (avoided deforestation projects)	Emissions of "loss events" that emit more than five percent of previously verified emission reductions.[31]	Tool for projects defines a risk of 10-60% as a basis for a pooled buffer. Projects with longevity[32] lower than 30 years fail the risk analysis.[33]	Loss events trigger a dedicated monitoring and assessment process.	Risk assessment includes mitigation factors that provide incentive for reversal mitigation; covers a period of 100 years.	Through retiring buffer credits up to a maximum of total issued credits – no liability for projects; compensation during crediting period (ranging between 20 and 100 years).
VCS JNR	Emissions of "loss events" that emit more than five percent of previously verified emission reductions.	Tool for jurisdictions defines a risk of 10-60% as a basis for a pooled buffer.[34]	Loss events trigger a dedicated monitoring and assessment process.	Risk assessment includes mitigation factors that provide incentive for reversal mitigation; aims to address capacity to protect the carbon stocks in the long term.	Through retiring buffer credits up to a maximum total o issued credits – no liability for programs; compensation during crediting period, of up to 30 years.
FCPF Carbon Fund	Emissions of "reversal events" that lead to a decrease in emission reductions between reporting periods.	Simple tool to assess risk and assign buffer contribution between 10 to 40%.	Ongoing monitoring to detect decrease in ERs – and additional monitoring for reversal events.	Program must implement strategies to reduce reversals, account for reversals during contract term, and put in place a management mechanism for reversals post-ERPA period.	Through retiring buffer credits up to a maximum of total buffer amount – no liability for programs.
ART / TREES	When annual emissions are higher than the Crediting Level (i.e. the ART/TREES reference level).	Simple tool to assess risk and assign buffer contribution between 5 to 25%.	Ongoing monitoring (e.g. mandatory in years 1, 3 and 5 of crediting period).	Country is encouraged to address reversals through program design and report on measure undertaken.	Through retiring buffer credits; in the case of a deficit – participant is responsible to replenish.

Key permanence considerations for generating robust carbon credits

Overall, forest carbon credits carry a higher potential risk of non-permanence than energy-related carbon credits, which has triggered the development of risk mitigation approaches. Non-permanence risks are particularly important for projects that are credited for storing carbon – whether in underground geological layers (as happens in CCS projects) or when planting trees – that can be released back into the atmosphere. These types of credits require a dedicated system capable of guaranteeing permanence in the long-term.

Over the last decade carbon standards have converged on the use of buffer systems to manage non-permanence risks. Although the same basic approach is used, there are differences regarding the magnitude of risks and, consequently, the number of units that endow the buffer, as well as the way in

which carbon standards deal with reversals once the crediting period has lapsed. Risk analysis may also draw on different types of criteria, giving greater or less prominence to risk mitigation strategies.

Buffers to manage the reversal risk of forest carbon projects have so far been successful. Forest carbon crediting has resulted in buffers that are oversubscribed. With the exception of recent Amazon fires (for which the VCS has publicly stated that existing buffer systems have been resilient enough for local projects affected[35]), there have been few reversals and therefore there is a glut of reserve units in buffer pools. There is no experience yet, on the other hand, on the effectiveness of buffer reserves for jurisdictional programs.

Table 6: Summary evaluation of permanence provisions for specific standards:

Forest projects		Jurisdictional programs		
VCS stand-alone	VCS nested	VCS JNR	FCPF Carbon Fund	ART / TREES
Prescribes the allocation of a risk-adjusted percentage of carbon credits to go into a buffer account, which is currently oversubscribed with credits.	Based on experience for stand-alone VCS projects, the allocation of carbon credits to the buffer is expected to be successfully managed.	Too early to tell. No track-record. Since only a moderate number of programs can be expected in the buffer, more stringency than for projects is needed. Also, a short crediting period (maximum of 30 years) may entail greater risk of reversals post-crediting period.	Too early to tell. No track-record. No assurance that reversals will be compensated once the ERPA period has lapsed.	Too early to tell. No track-record. Compensation is required by the standard, but a country also has the option to simply leave the standard before fully compensating reversals.

d. Leakage

Leakage emissions need to be accounted for in order to capture the true emissions reductions resulting from a project or program. For avoided deforestation projects and jurisdictional programs, the most common types of leakage are *activity-shifting* leakage and *market leakage*.

Activity-shifting leakage occurs when activities that cause emissions are relocated to an area not monitored by the project or program. Activity-shifting leakage has been documented in several carbon project types in the energy sector, where production shifted to regions or countries where the sector is not regulated under a carbon pricing system.[36] Activity-shifting leakage has been extensively discussed in forest carbon projects and programs. Where deforestation agents are highly mobile, such as multinational agribusinesses, there is a likelihood that they move their activities to other areas or countries when access to farmlands is restricted. Leakage would also occur if a plantation was established on high-productivity cropland or grazing land, leading farmers to move their operations to an adjacent forest.

Market leakage occurs when a project or a program changes the supply or demand of an emissions-intensive product, creating an upsurge in emissions elsewhere. Here, the agents causing the leakage are not the baseline agents. For example, reduced supply of timber or agricultural commodities can generate price effects that change emission trends.[37] This may occur, for example, in projects that avoid conversion of forests to agricultural production.[38]

The scale of projects or programs impacts the relevance of such leakage types. Where an incentive program covers an entire country, as in some jurisdictional programs, it becomes harder for baseline agents to shift their activities outside program boundaries. Leakage has often been considered easier to capture for jurisdictional programs that cover larger areas, as emissions that would otherwise be considered as leakage are accounted for within the larger program boundary.[39] However, even jurisdictional programs can carry significant risk of activity shifting and market leakage, especially where policies apply to commodities with rapid markets (e.g. soy, timber, cacao, palm oil or beef). The Amazon Soy Moratorium, for example, led to some displacement of activities to other areas of Brazil and Paraguay.[40]

Projects and programs can be designed to mitigate leakage risk. For example, well-designed activities to address deforestation from encroachment of smallholders would not only prevent such encroachment (through activities such as patrolling forest areas), but also offer alternative livelihood options to replace (rather than simply ban) activities that cause baseline emissions.[41]

Management of leakage by evaluated carbon standards

Ideally, the approach to managing leakage would include identifying and mitigating leakage; monitoring and quantifying leakage during the project lifetime; and deducting this leakage from estimated emissions reductions.

At project scale, carbon standards typically focus on monitoring leakage and deducting it from claimed emission reductions. The CDM publishes a number of tools on accounting for leakage from particular project types, which are also referred to by other carbon standards. For forest projects, the VCS applies a *leakage module[42]* to quantify a market leakage value. Market leakage associated with the production of agricultural, livestock and forest commodities linked to markets are assessed by the module. Some project methodologies include monitoring and accounting for leakage in a prescribed area around the project accounting area, i.e. the most probable place where activity-shifting leakage may occur.

Carbon standards approving jurisdictional programs differ on whether or not they require quantification and deductions from emission reduction calculations. The VCS/JNR follows a similar approach to stand-alone VCS projects, applying a set of complex tools for quantifying and deducting activity shifting and market leakage. The ART/TREES assumes leakage is a function of the program boundaries and simply makes deductions of the estimated emission reductions based on the percentage of national forest area included in the accounting. The FCPF Carbon Fund requires programmes to mitigate potential displacement through careful programme design, but does not require any discounts from emission reductions calculations.

Following a precedent established with the Kyoto Protocol, international leakage is mostly ignored. Projects registered under the CDM or the VCS do not require treatment of international activity-shifting leakage or international market leakage, whether in forestry or other sectors. For the same reason, most jurisdictional programs, including the VCS JNR and the ART/TREES do not consider any international leakage. Only the FCPF Carbon Fund requires jurisdictional programs to assess the risk of international leakage and design programs in a way that mitigates it, essentially by aiming to produce the same amount of goods and services as in absence of the jurisdictional program.

Table 7 below provides a summary of the scale of accounting as well as requirements by carbon standards to ensure management of leakage risks.

Table 7: Examples of how carbon standards address leakage risks

Carbon Standard	Leakage prevention	Leakage monitoring	Leakage compensation
VCS (avoided deforestation projects)	Leakage mitigation measures reduce leakage discounts.	Required in some methodologies, others use periodic risk assessments.	Required.
VCS JNR	Risk mitigation options, e.g., through new laws or policy, which reduce discounts.	Periodic risk assessment, leakage monitoring and deduction for subnational programs.	Required (based on risk assessment tool) through discount factors.
FCPF Carbon Fund	Require mitigation strategy, assessed by verifiers.	Not required.[43]	Not required.
ART / TREES	Country is encouraged to address leakage through program design and report on measure undertaken.	Not required.	Based on % of national forest included in the accounting area; deduction from 0 to 20% of estimated emission reductions.

Key leakage considerations for generating robust carbon credits

Leakage is an inherent risk of carbon projects and programs. The level of leakage risk depends on what drives baseline emissions and on the design of the project or program, i.e. how well it mitigates the risks. Remaining unmitigated risks should be compensated through deductions for such risks. All reviewed carbon standards have leakage monitoring and management systems in place. However, methodologies take different approaches to account for leakage, with some requiring monitoring and compensation for leakage and others not.[44]

Forest project activities have variable risks of leakage. Some projects have inherently low leakage risk—for example, some reforestation projects, reduced impact logging projects, or projects that change

energy usage by communities away from fuel wood collection. Community projects that improve forest management rather than eliminate forest harvest altogether also are far less vulnerable to activity-shifting leakage. By contrast, avoided deforestation projects that have highly mobile agents causing forest loss can have high risks of leakage and therefore, in such project types, leakage should be quantified and deductions taken (i.e. compensated) in the final credits issued. Where the leakage risk is high and not manageable (e.g. with projects or programs covering industrial agriculture), projects are unlikely to achieve registration under the VCS.

Increasing the accounting area to a national or jurisdictional scale does not eliminate leakage. Jurisdictional programs capture activity-shifting leakage within the larger program area. However, larger-scale programs sometimes carry significant risk of market and international leakage, which is inherently hard to manage. In the forest sector, there may be financially strong deforestation agents, for example, intensified agriculture (e.g. soy operations) or large-scale forestry activities that compete with crop and pasture land and are also highly mobile—in some cases, they may easily cross national borders. Such situations are prone to leakage risks.

For jurisdictional programs, only the VCS JNR and the ART/TREES require quantifying and deducting for leakage. The FCPF focuses on assessing and reducing leakage risks but does not quantify (or takes deductions for) leakage risks. Excluding leakage risks with a reference to the national scale of accounting in large-scale jurisdictional programs implies a willingness to ignore internationally occurring leakage (following what is being done in the context of the CDM).

Table 8: Summary evaluation of leakage provisions for specific carbon standards:

| Forest projects		Jurisdictional programs		
VCS stand-alone	VCS nested	VCS JNR	FCPF Carbon Fund	ART / TREES
Leakage risks can be high for certain forest project types (such as avoided deforestation); projects must monitor, quantify and deduct for multiple types of leakage.	Similar to VCS stand-alone projects but provides added confidence in leakage management since performance at the higher scale is measured and reported.	Requires the assessment of multiple types of leakage risk, plus quantification and deductions for leakage.	Requires the assessment of leakage risk, and addressing risk in program design, but no quantification or deductions for leakage.	Assumes leakage is largely a function of area coverage (and makes deductions accordingly).

e. Quantification and uncertainty

The ability to **accurately measure emissions (or removals) is important** for ensuring integrity of emission reductions. Forest carbon credits suffer from a relative complexity of estimating GHGs from forests—from analyzing satellite data to multiple (and repeated) field measurements across a broad landscape—which can lead to substantial measurement errors.

Improving the accuracy of forest-related GHG emissions may be achieved through improvements in measurement, such as increasing the number of samples or using higher-quality satellite data. In general, making such improvements and, thus, **lowering the uncertainty of GHG estimates is easier for projects** where the underlying variability of ecosystems is typically smaller than that of large-scale jurisdictions.

For estimating **emission *reductions*, understanding the 'signal-to-noise ratio' is important**, i.e. the uncertainty of the baseline in relation to the magnitude of the emission reduction (Figure 2). For example, if a project's baseline emissions range between 50 and 150 ktCO$_2$e (with a mean value of 100 ktCO$_2$e), and monitoring detects emission reductions of only 30 ktCO$_2$e, i.e., smaller than the uncertainty in estimating baseline emissions, then there is a risk that the results do not actually indicate emission reductions that truly occurred. In other words, the 'signal' (i.e. the emission reduction) may be buried in 'noise' (the potential error in the baseline and crediting period), as illustrated below.

Figure 2. Illustration of the signal-to-noise ratio in estimating emission reductions[45]
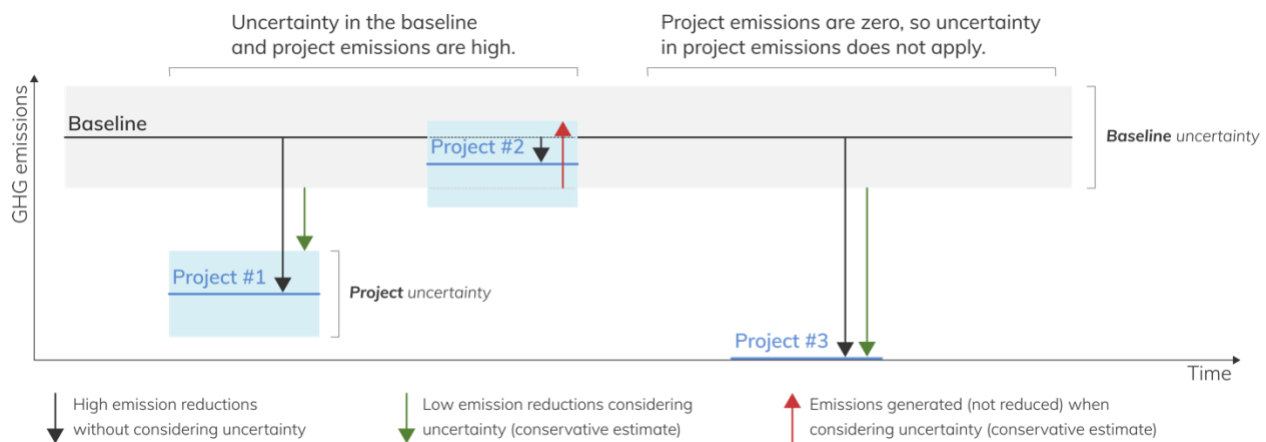
Uncertainty management by various GHG Standards

Carbon standards manage uncertainty by defining the level of uncertainty that is acceptable per monitored parameter and in aggregate for the overall emission reductions. For example, the VCS requires estimating parameters that are no more than 20 to 30% uncertain at a 90 to 95% confidence level and discounting otherwise.[46] To avoid high uncertainties in the overall emission reductions, the CDM and VCS require that methodologies use conservative estimation approaches.[47] Methodologies that are not able to sufficiently demonstrate how they mitigate the risk of overestimation in key parameters are not approved under these carbon standards. Since a detailed assessment of expected uncertainties is undertaken at the time of assessing the methodology, it is assumed that uncertainties no longer need to be assessed when individual projects apply the methodology to estimate emission reductions.

Clearly, building conservativeness into methodologies is only effective if the methodology approval process is sound. However, fully understanding expected uncertainties is extremely complex and requires detailed technical knowledge in a range of fields. Shortcomings occur, for example, when some VCS forest project methodologies require reporting the sampling error of carbon stock measurements but neglect

the potentially significant uncertainties involved in estimating deforestation area. In the case of forest carbon projects, there is also variability in the stringency and/or depth of the validations or verifications, in part due to the complexity of GHG estimation and baseline setting.

Jurisdictional carbon standards take different approaches compared to project standards. VCS JNR, for example, appears more flexible in its allowances for uncertainty. It currently only states that a program should estimate the accuracy of the "forest versus non-forest classification" with a 75% accuracy but does not appear to include estimates on the land use *change* (i.e. area changed from forest to non-forest), which is most critical for the emissions estimate in the case of avoided deforestation. The current guidance does not clearly require programs to estimate the aggregate uncertainty of the GHGs for the baseline, or for the claimed emission reduction.[48]

Neither does ART/TREES require estimating aggregate uncertainty of the emission reduction. Rather, it prescribes discounts if the uncertainty of the baseline emissions or the emissions during the crediting period are greater than 15%. This approach will reduce the risk of overestimating emission reductions in some (but not all) cases. However, it can also result in very high uncertainties of credited emission reductions, particularly where the 'signal' (i.e. emission reduction) is small. For example, if both emissions of the baseline and of the crediting period had uncertainties just under 10%, but emission reductions amounted to only about 20% of baseline emissions, then these emission reductions would be approximately 100% uncertain (but no uncertainty discounts would be applied).

By contrast, the FCPF Carbon Fund's Methodological Framework requires the uncertainty of the emission reduction to be quantified. The FCPF Carbon Fund also requires all uncertainty estimates to be quantified following a specific statistical approach to ensure quality (i.e. Monte Carlo methods[49]). While guidance on calculating uncertainties of the aggregate emission reductions is the most detailed (of any of the GHG Standards we assessed) under the FCPF Carbon Fund, it takes a more lenient approach with regard to allowing high statistical uncertainty, i.e. if uncertainty is higher than 100% at 90% confidence level, the emission reductions are only discounted by a 15% conservativeness factor.

Table 1 Examples of how GHG Standards ensure accurate and precise measurements and quantification methods

GHG Standard	Conservativeness	Uncertainties of Emission Reductions
VCS (avoided deforestation projects)	Conservative estimation methods throughout and use of discounts where uncertainties of individual parameters are large.[50]	Aggregate uncertainties of emission reductions not usually estimated. Rather, it requires methodologies to use discounts where aggregate uncertainties in emission reductions >15% are expected (according to CDM Meth Panel guidance), but consistent application is not obvious. *Note: As of the time of publication, VCS was revisiting its uncertainty provisions, which may be revised.*
VCS JNR	Conservative estimation methods throughout and use of discounts where uncertainties of individual parameters are large (>30 - 50% at 95% confidence).	No clear requirement to estimate aggregate uncertainty in emission reductions. *Note: As of the time of publication, VCS was revisiting its uncertainty provisions, which may be revised.*
FCPF Carbon Fund	Conservative estimation methods and discounts where uncertainty of emission reductions >15% (at 90% confidence)	Clear requirement to estimate aggregate uncertainties of emission reduction estimates, but flexible allowance for high uncertainty (e.g. 15% discount for uncertainty >100%).
ART / TREES	Conservative adjustments to baseline and emissions during the period when uncertainty is >15%.	No requirement to estimate aggregate uncertainty of emission reductions.

Key uncertainty considerations for generating robust carbon credits

Most carbon standards set limits to uncertainty but vary in how such rules are applied. Carbon standards typically set allowable uncertainties after which conservativeness deductions are applied. Only the FCPF Carbon Fund requires an analysis of *aggregate uncertainties in estimated emission reductions.* By contrast, the CDM and VCS require that methodologies demonstrate and justify the conservativeness of default values. The CDM, Gold Standard and VCS all have additional guidance for limiting uncertainty, notably for sampling. Discounting is required if the uncertainty exceeds the permissible uncertainty level.

Forestry is among those sectors where uncertainty in estimating emission reductions is generally larger and therefore the analysis of uncertainties is crucial. In addition, there are cases where methodologies have technical shortcomings, which could obscure whether the uncertainty boundaries are being met. In addition, the signal-to-noise ratio in estimating emission reductions can be high – especially in jurisdictional programs. For example, a jurisdictional program may reduce emissions by 20%, but its emission measurements may be 30% uncertain. The signal-to-noise ratio tends to be less problematic for projects.

Carbon standards approving jurisdictional programs vary widely in their requirements around quantification and measurement, reporting and verification (MRV). The FCPF Carbon Fund has the strongest requirements around quantification but is lenient on applicable discounts in case of high uncertainty. VCS JNR requires conservativeness in estimating emission reductions but is less stringent than the Carbon Fund on quantification of emission reductions.

Table 7: Summary evaluation of uncertainty provisions for specific standards:

Forest projects		Jurisdictional programs		
VCS stand-alone	VCS nested	VCS JNR	FCPF Carbon Fund	ART / TREES
Some methodologies appear incomplete in their estimation of error combined with expected high uncertainties.	Expected to be similar to stand alone projects, i.e. potentially incomplete unless VCS adds additional requirements.	Current guidance appears incomplete in the estimation of error combined with expected high uncertainties.	Strong for the reporting of aggregate error of the emission reduction, but lenient on allowable uncertainty.	Includes conservative discounts for emissions of the baseline and the crediting periods, but not for aggregate error of emission reductions.

3. Conclusions and outlook

We conclude that forest carbon credits, under certain circumstances, may be considered a reasonable option for corporate offsetting. Provided stringent rules are in place, carbon standards can provide sufficient assurance that forest carbon credits come with the environmental integrity equivalent to carbon credits generated in other sectors.

Forest carbon projects have significant benefits but can also present higher risks in some aspects when compared to other project types. Avoided deforestation projects and jurisdictional programs tend to involve many actors and dispersed agents causing deforestation, which makes setting baselines challenging and increases the risk of leakage. There is also a heightened risk of reversals, which must be countered by the carbon standards. Due to a lack of finance for forest protection, however, forest projects are also often unambiguously additional.

Jurisdictional programs favor systemic change but often come with larger risks. Jurisdictional programs seek to create incentives for the reform of land use policies that can impact actions across a larger landscape. This increases the chance of transformational and long-term change. They also have the advantage of capturing activity-shifting leakage within their much larger accounting area and tend to prescribe conservative reference levels. However, jurisdictional programs may be prone to large-scale reversals, for instance, when new governments shift their conservation priorities, and can more easily lead to market leakage. Larger-scale programs also tend to have higher GHG quantification error.

The nesting of projects in jurisdictional programs can help overcome many risks associated with avoided deforestation projects. The main shortcoming of avoided deforestation projects—the forest carbon project type that currently generates the largest volume of emission reductions in the voluntary market— is the setting baselines, where there is evidence that many are inflated. Ensuring that multiple avoided deforestation project baselines located in a jurisdiction, in aggregate, sum up to a reasonable share of the jurisdictional baseline can mitigate the baseline inflation risk. In addition, monitoring and discounting for leakage at the jurisdictional scale can also reduce the risk of over-crediting of projects. At the same time, completing the nesting process demands substantial institutional and technical capacity from governments. It is crucial in this respect that carbon standards approving avoided deforestation projects, in particular the VCS, move such projects to a "nested" system as quickly as possible, revise methodologies to promote greater conservatism, or improve the auditing by validation bodies.

A number of tools are needed in order to move the nesting of projects in jurisdicational programs forward. In particular, practical examples and lessons learned are needed from developing countries that have pioneered this approach. At the time of this report, a number of forest countries are working on building nested systems and, once completed, they will be useful for other governments to build upon when developing their own nesting approaches. In the meantime, establishing a community of practitioners that can share knowledge and help to guide governments in developing nested approaches could promote access to technical information and capacities. Finally, there is a need for a new or revised standard on nesting -- as the current standards provide insufficient guidance on nesting[1].

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[1] At the time of this report (March 2020), Verra was developing its Nesting Guidance, which could fill this gap if completed.

Table 8: Summary table

	Forest projects		Jurisdictional programs		
	VCS stand-alone	VCS nested	VCS JNR	Carbon Fund	ART / TREES
Crediting baselines	There is evidence of baseline inflation in some avoided deforestation projects. For other types of projects, such as reforestation, baseline setting is more straightforward because the counterfactual case is clearer.	Although not tested yet, nesting can be expected to reduce the risk of baseline inflation. This is particularly true for avoided deforestation where nested projects are provided a risk-adjusted share of the jurisdictional reference level.	No experience yet with the JNR standard, but the use of a historical average baseline will be conservative where deforestation is rising. Where a trend baseline is used, it may not always be conservative.	Includes rigid rules and oversight to avoid gaming baselines. HFLD countries may set a baseline well above historical average emissions that may not always be conservative.	Not tested yet but includes rigid rules to avoid gaming baselines. The short historical period likely better reflects BAU than the longer period currently used by the CF and JNR. No adjustments allowed.
Additionality	For avoided deforestation projects additionality is straightforward to demonstrate. Additionality is harder to demonstrate for financially attractive activities (e.g. commercial reforestation).	The additionality test for nested projects is not different than for regular VCS projects.	Assumed to be reflected in a conservative baseline, plus requirement to implement new policies or actions.	Assumed to be reflected in a conservative baseline; there is also a requirement to implement new (or enhanced) policies or actions.	Assumed to be reflected in a conservative baseline, without other requirements.
Permanence	Prescribes the allocation of a risk-adjusted percentage of carbon credits to go into a buffer account, which is currently oversubscribed with credits.	Based on experience for stand-alone VCS projects, the allocation of carbon credits to the buffer is expected to be successfully managed.	Too early to tell. No track-record. Since only a moderate number of programs can be expected in the buffer more stringency than for projects is needed. Also, a short crediting period (maximum of 30 years) may entail greater risk of reversals post-crediting period.	Too early to tell. No track-record. No assurance that reversals will be compensated once the ERPA period has lapsed.	Too early to tell. No track-record. Compensation is required by the standard, but a country also has the option to simply leave the standard before fully compensating reversals.
Leakage	Leakage risks can be high for certain forest project types (such as avoided deforestation); projects must monitor, quantify and deduct for multiple types of leakage.	Similar to VCS stand-alone projects but provides added confidence in leakage management since performance at the higher scale is measured and reported.	Requires the assessment of multiple types of leakage risk, plus quantification and deductions for leakage.	Requires the assessment of leakage risk, and addressing risk in program design, but no quantification or deductions for leakage.	Assumes leakage is largely a function of area coverage (and makes deductions accordingly).
Quantification and uncertainty	Some methodologies appear incomplete in their estimation of error combined with expected high uncertainties.	Expected to be similar to stand alone projects, i.e. potentially incomplete unless VCS adds additional requirements.	Current guidance appears incomplete in the estimation of error combined with expected high uncertainties.	Strong for the reporting of aggregate error of the emission reduction, but lenient on allowable uncertainty.	Includes conservative discounts on the baseline and crediting periods, but not for aggregate error of emission reductions.

[1] Chagas, T.; Galt, H.; Lee, D.; Neeff, T.; Streck, C. (2019) Should forest carbon credits be included in offsetting schemes such as CORSIA? https://www.climatefocus.com/publications/should-forest-carbon-credits-be-included-offsetting-schemes-such-corsia

[2] Forest Trends' Ecosystem Marketplace. Financing Emission Reductions for the Future: State of Voluntary Carbon Markets 2019. Washington DC. Forest Trends, 2019.

[3] For example, Carbon Fund Emission Reduction programs range from 1.6 to 35 million hectares.

[4] We note that the Paris Agreement has defined a framework for future carbon markets in its Article 6. While the emerging guidelines for Art. 6 may influence private and public carbon markets, this report does not yet consider the impact of such guidelines or of Nationally Determined Contributions (NDCs) under the Paris Agreement. This is because Art. 6 rules are still being negotiated and their final shape remains unclear. Also, NDCs today fall well short of the ambitious commitments needed to meet the Paris Agreement's temperature target, with national pledges not always set below conservative business as usual scenarios.

[5] The Clean Development mechanism (CDM) has generated more than 10,000 mitigation activities in over 100 countries; it permits crediting from afforestation and reforestation but does not include avoided deforestation. Forestry projects under the CDM are sparse and only account for a few dozen registered projects.

[6] This report uses the most recently available information from Verra on its emerging nesting guidelines, found at: https://verra.org/project/vcs-program/rules-and-requirements/redd-nesting-public-consultation/

[7] https://verra.org/wp-content/uploads/2019/12/Proposed-Updates-to-the-JNR-Requirements-English.pdf

[8] A. Michaelowa (2009): Interpreting the additionality of CDM projects: Changes in additionality definitions and regulatory practices over time, in: D. Freestone, C. Streck (eds.): Legal aspects of carbon trading, Oxford University Press, Oxford, p. 248-271

[9] C. Galik et al. (2014). Alternative approaches for addressing non-permanence in carbon projects: an application to afforestation and reforestation under the Clean Development Mechanism. Nicholas Institute for Environmental Policy Solutions. Mitig. Adapt. Strateg. Glob. Change. DOI 10.1007/s11027-014-9573-4.

[10] Project boundaries are not only spatially defined, i.e. they are conceptual and define what is measured and monitored.

[11] Other forest project types determine the baseline differently—for example, reforestation projects often consider historical land use and/or assumptions of how much planting would occur in the absence of the project.

[12] Adjustments are also sometimes allowed in the case of 'high forest low deforestation' (HFLD) regions under the assumption that these regions face forest loss even though historically deforestation has been low.

[13] Personal communication with Marieke Sandker, Food and Agriculture Organization.

[14] From authors' analyses conducted on several Latin American and Sub-Saharan African countries, it can be shown that the aggregation of avoided deforestation project baselines within a jurisdiction is unrealistically high when compared to a jurisdictional baseline, suggesting that some projects have likely inflated expected deforestation rates.

[15] See Verra (18 December 2019). Request for Proposals: Consultancy to Develop VCS REDD+ Project Allocation Tool and Rules.

[16] Mertz et al (2018). Uncertainty in establishing forest reference levels and predicting future forest-based carbon stocks for REDD+, Journal of Land Use Science, 13:1-2, 1-15, DOI: 10.1080/1747423X.2017.1410242

[17] JNR Requirements v3.4, paragraph 3.11.12. Paragraph 3.11.13 (1) also allows programs to use a baseline "accepted and approved under the UNFCCC for the purposes of generating GHG emission reductions for market-based mechanisms"; since such baselines have not been agreed in the UNFCCC, we do not cover this instance.

[18] FCPF Carbon Fund Methodological Framework, criterion 11.

[19] Carbon projects in sectors that are able to attract private finance are more challenging to demonstrate additionality. There is often a considerable degree of judgment and subjectivity in assessing the financial returns of a project. But where projects generate no revenues other than through selling carbon credits, the investment analysis will generate clear results. This is the case for industrial gas projects where industrial processes need modification, for example in phasing out HFC-23 generation in adipic and nitric acid production. Equally, tree planting for protective purposes and without a strong linkage into timber markets will not usually generate revenues and may therefore often be seen as additional. See M. Purdon & R. Lokina (2014) Ex-post evaluation of the additionality of Clean Development Mechanism Afforestation Projects in Tanzania, Uganda and Moldova. Available at https://www.cccep.ac.uk/wp-content/uploads/2015/10/WP149-Ex-post-evaluation-of-Clean-Development-Mechanism-Afforestation-projects.pdf

[20] Positive and negative lists tend to define not only specific technologies but also their required scale or geographical location to be considered automatically additional.

[21] However, it can also be problematic to simply consider any outperformance of a baseline additional because emissions also respond to market trends, to climate patterns, to demography and other factors that are not linked to deliberate climate policies. Because of this, some Carbon Standards require jurisdictional programs to strengthen confidence that emission reductions are the result of new policies or actions.

[22] In this instance, "nesting" refers to the case where project baselines in aggregate comprise a reasonable share of the jurisdictional reference level.

[23] Conversely, where confidence in jurisdictional baselines is lacking, the additionality of nested projects or programs may also be questionable without applying tests to assess additionality.

[24] The *Tool for the demonstration and assessment of additionality* was first published in 2004 and refined several times over the years. CDM, Tool for the demonstration and assessment of additionality (version 7.0.0) EB 70, Annex 08. It requires that projects demonstrate additionality through a combination of: prior consideration; investment analysis; common practice analysis; and/or barrier analysis.

[25] VCS (no date) *Standardized Methods* [online] Available at https://verra.org/project/vcs-program/methodologies/standardized-methods/; Gold Standard (no date) *CDM Tool 32 – Positive list of technologies for additionality* [online] Available at https://globalgoals.goldstandard.org/cdm-tool-32-positive-list-of-technologies-for-additionality/

[26] The VCS, for example, now excludes all renewable energy projects that are not located in Least Developed Countries in a 'negative list'.

[27] Although carbon stored underground in geological carbon-capture and storage (CSS) activities could also be released, e.g. after an earthquake

[28] VCS (2013) Jurisdictional and Nested REDD+ (JNR) Non-Permanence Risk Tool (version 3). Available at http://verra.org/wp-content/uploads/2018/03/JNR_Non-Permanence_Risk_Tool_v3.0.pdf; VCS (2016) AFOLU Non-Permanence Risk Tool (version 3.3) Available at http://verra.org/wp-content/uploads/2018/03/AFOLU_Non-Permanence_Risk_Tool_v3.3.pdf

[29] VCS's global buffer pool has currently 36.5 million credits from more than 120 projects located in 34 countries. Recently, in light of the increased forest fires taking place in the Brazilian Amazon, the VCS stated publicly that diversification of projects from different countries ensures that the buffer is resilient enough and "is not put at risk even by disastrous events such as the fires in the Brazilian Amazon". See Verra, "Fires in the Brazilian Amazon – A case in point for Forest Carbon Projects" 3 September 2019, available at https://verra.org/fires-in-the-brazilian-amazon-a-case-in-point-for-forest-carbon-projects/.

[30] VCS (2017) Program Definitions. Available at: https://verra.org/wp-content/uploads/2018/03/Program_Definition_v3.7.pdf.

[31] VCS (2017) Program Definitions. Available at: https://verra.org/wp-content/uploads/2018/03/Program_Definition_v3.7.pdf

[32] Longevity refers to the number of years beginning from the project start date that project activities will be maintained. See Verra's VCS AFOLU Non-Permanence Risk Tool. Version 3.3 of 19 October 2016.

[33] See Verra's VCS AFOLU Non-Permanence Risk Tool. Version 3.3 of 19 October 2016.

[34] See Verra's Jurisdictional and Nested REDD+ Non-Permanence Risk Tool. Available at: https://verra.org/wp-content/uploads/2018/03/JNR_Non-Permanence_Risk_Tool_v3.0.pdf

[35] Antonioli, David and Swickard, Naomi (2019). Not the Full Story. https://verra.org/not-the-full-story/

[36] Schneider, L.; Lazarus, M. and Kollmuss, A. (2010) Industrial N20 Projects under the CDM: Adipic Acid – a Case of Carbon Leakage? Stockholm Environment Institute; Erickson, P.; Lazarus, M. and Chandler, Chelsea (2011) The potential for CDM induced leakage in energy intensive sectors. Stockholm Environment Institute, Centre for European Policy Studies and CO_2logic. GTZ and BMU (2007). The CDM in the Transport Sector - Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities. See also P. Zegras, Y. Chen, and J. Grütter (2009). Potentials and Challenges for Using the Clean Development Mechanism for Transport Efficient Development: A Case Study of Nanchang, China; and Asian Development Bank (2013). The Clean Development Mechanism A Field Guide for Transport Projects. Working Paper Series No 1.

[37] There are few studies on carbon leakage through policies and projects. Delacote et al. review the potential leakage effects among two payment-for-ecosystem services programs. Delacote, P., Robinson, E. J. Z. and Roussel, S. (2016) Deforestation, leakage and avoided deforestation policies: a spatial analysis. Resource and Energy Economics, 45. pp.; BC Murray (2008) Leakage from an avoided deforestation compensation policy: Concepts, empirical evidence, and corrective policy options- Nicholas Institute for Environmental Policy.

[38] In already highly mechanized regions, leakage to areas outside of the covered jurisdiction is more likely than with systems or technologies that can spare land through intensification. But intensification is also not without pitfalls, and precaution has to be taken to avoid leakage through 'rebound effects', i.e. increasing the economic attractiveness and hence land appetite through intensification. Examples from Australia show that conservation of natural forests has not resulted in the degree of leakage previously predicted, as timber plantations have led to a substitution away from wood produced from natural forests. See R. Warmann, RA Nelson (2016) Forest conservation, wood production intensification and leakage: An Australian case, Land Use Policy, Volume 52, March 2016, Pages 353-362.

[39] However, while accounting at larger scales may capture smaller-scale leakage, it does not automatically eliminate the risk of over-crediting due to leakage. In particular, international leakage may still occur, especially when internationally operating firms are involved. Energy-intensive industries may also relocate to countries without emission limits, or agribusiness may open up production areas in other countries.

[40] Moffette, F. and H. Gibbs (2018) Agricultural Displacement and Deforestation Leakage in the Brazilian Legal Amazon." Semantic Scholar. https://www.semanticscholar.org/paper/Agricultural-Displacement-and-Deforestation-Leakage-Moffette-Gibbs/d72be96e9cf2e37893f7b10744eab73864256cb7 (accessed 8 March 2020).

[41] Schwarze, R.; Niles, J.O. and Olander, J. (2002) Understanding and managing leakage in forest-based greenhouse-gas mitigation projects. Philos Transact Ser A Meth Phys Eng Sci 360 (1797):1685-703

[42] See AFOLU Project Market Leakage Module, available at https://verra.org/methodology/afolu-project-market-leakage/

[43] Carbon Fund Methodological Framework, Section 3.5, criterion 17

[44] We note that this study has not been able to go through the hundreds of methodologies applicable under the GHG Standards at such a granular level.

[45] The figure is a simplification. A more detailed trend analysis would also consider covariances between emission estimates at varying time points.

[46] VCS (2017) VCS Standard (version 3) Available at https://verra.org/wp-content/uploads/2018/03/VCS_Standard_v3.7.pdf

[47] Guideline: Completing the proposed new baseline and monitoring methodology form (version 02.0)

[48] According to Verra, JNR will be revised to clarify and improve the requirements around uncertainty.

[49] A simulation technique to aggregate uncertainties between different variables and sources of error.

[50] VCS Program Criteria for GHG Projects and Programs (version 3), Chapter 3