Additional Background Information on Tonne-Year Accounting

1 April 2022

1 INTRODUCTION

Carbon gains from many Agriculture, Forestry and Other Land Use (AFOLU) projects can be lost. For example, if a forest fire occurs in a previously reforested area, the carbon stored in the trees is re-emitted back into the atmosphere. Most greenhouse gas crediting programs, including the Verified Carbon Standard (VCS), manage this risk by withholding a portion of the emission reductions and removals generated in a pooled buffer account that can be used to compensate for any future reversals. A less well-known but alternative approach for managing non-permanence risk is tonne-year accounting. Tonne-year accounting quantifies the benefit of sequestering a tonne of carbon dioxide (CO_2) on an annualized basis. This document provides a brief overview of tonne-year accounting and further details on the 100 to one conversion rate at which Verra has proposed to include tonne-year accounting in the VCS. If Verra introduces tonne-year accounting, it would not replace the buffer but instead be offered as an alternative that projects could choose to apply and forgo buffer contributions.

2 BACKGROUND

One tonne-year is a metric tonne (MT) of CO_2 stored for one year. The advantage of tonne-year accounting is it enables sequestration projects to quantify the benefits of carbon storage on an annual or short-term basis. In conventional carbon credit accounting, the atmospheric benefit of emission reductions and removals (ERRs) is quantified using 100-year global warming potentials (GWPs). Therefore, removals must remain stored for 100 years to achieve the calculated benefit. For this reason, sequestration projects using conventional carbon credit accounting have a permanence liability of 100 years after the carbon is removed from the atmosphere, which is managed through the buffer.

This same permanence liability does not exist with tonne-year accounting because the sequestration activity is credited based on the number of years the carbon is held out of the atmosphere using an annual factor derived from the radiative forcing effect of CO_2. In other words, tonne-year accounting credits temporary carbon storage based on the duration of storage. For example, if a tonne of CO_2 is sequestered for one year, it generates one tonne-year, while a tonne of CO_2 sequestered for five years creates five tonne-years.

3 TONNE-YEAR CONVERSION RATE

The most challenging aspect of using tonne-year accounting for carbon credit quantification is determining how to convert tonne-years into permanent tonnes. The two most commonly referenced approaches are the Moura-Costa and Lashof methods. Both approaches are based on 100-year Global Warming Potentials (GWPs) and are mentioned in Section 2.3.6.3 of the IPCC Special Report on Land Use, Land-Use Change and Forestry. However, they differ in how they calculate the benefit of temporary carbon storage, which affects the tonne-year to ERR tonne equivalency ratio.

Both the Moura-Costa and Lashof methods look at the area under the 100-year decay curve of CO_2 in the atmosphere to determine equivalence; however, the Lashof method considers the impact of CO_2 re-emission at the end of the storage period, while the Moura-Costa method does not. More specifically, the Lashof approach views carbon storage for a given number of years as equivalent to delaying a CO_2 emission beyond the end of the storage period (or 100-years when 100-year GWPs are used). In contrast, the Moura-Costa approach only looks at the area under the curve. Due to these distinctions, the two approaches produce different equivalence ratios. Using the Moura-Costa method, shown in Figure 1, approximately 48[1] tonne-years is equivalent to one tonne (Lavasseur et al., 2012; Moura-Costa & Wilson,1999), whereas under the Lashof method, shown in Figure 2, 100 tonne-years is equivalent to one tonne (Fearnside et al., 2000).

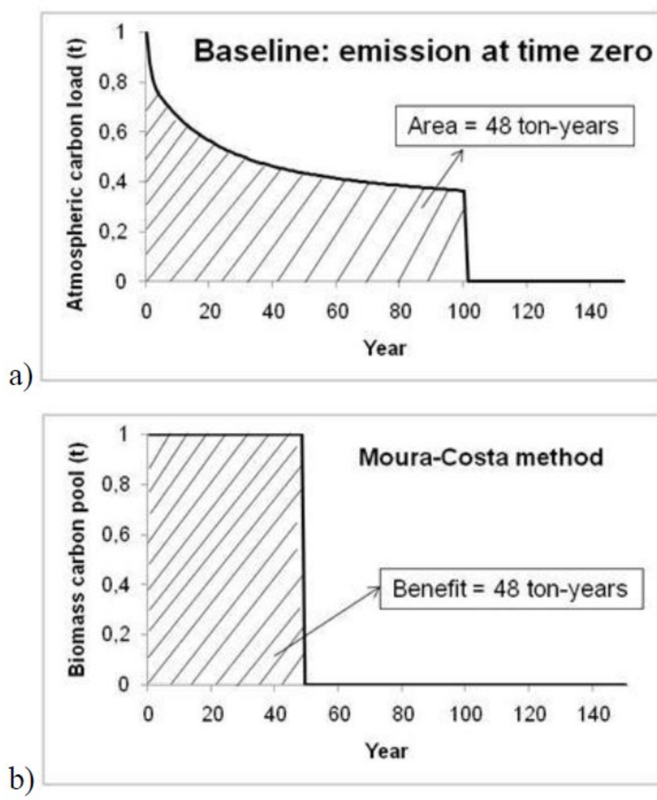

Figure 1: Moura-Costa method for determining tonne-year to tonne equivalency (Source: Lavasseur et al., 2012)

[1] Note: This value differs between publications and ranges from 46 to 55.

In the consultation, Verra proposes a tonne-year to ERR tonne equivalency ratio of 100 to one based on a simplified version of the more conservative Lashof method. Using the traditional Lashof method the tonne-years created by a project change from year to year depending on the duration of the removal. In the early years, the tonne-years generated are less than one and in later years they exceed one. The reason for this (as noted previously), is the Lashof method quantifies the benefit of temporary carbon storage by looking at the area under the decay curve of carbon dioxide in the atmosphere that is pushed beyond year 100 because of the delay. Since the decay rate of CO_2 is not constant, but instead has a decreasing concave up curve, this rate fluctuates over time. For example, if an emission is delayed by 46 years, the benefit would be approximately 37% of the benefit of a 100-year delay (Figure 2). Table 1 shows the percent of a full credit that would be generated at 10-year intervals using the Lashof method.

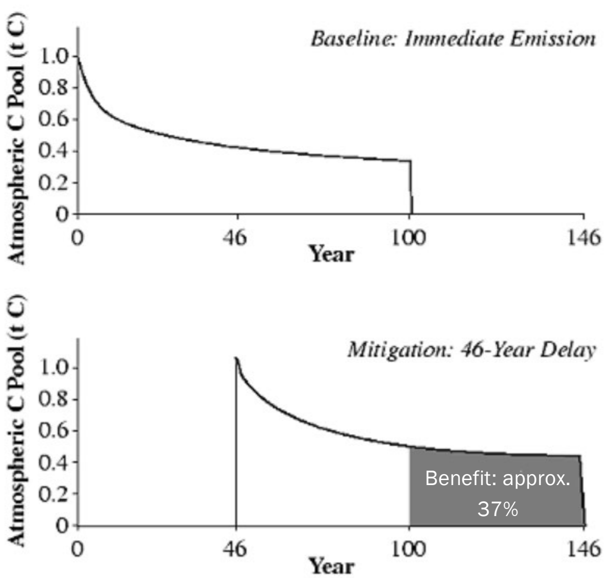

Figure 2: Lashof method for determining tonne-year to tonne equivalency (adapted from IPCC, 2000)

Table 1: Credits issued as a function of duration using the Lashof method (Source: IPCC, 2000)

Project Duration (years)	Percentage of a Full Credit
0	0
10	7.4
20	15
30	22.9
40	31.2
50	39.9
60	49.3
70	59.4
80	70.6
90	83.3
100	100

For simplicity, Verra proposes a modified version of the Lashof approach where each single year delay is treated as equivalent to 1% of a full credit. Therefore, 100 single-year delays equal 100% of a full credit. This was a policy rather than a scientific decision. The primary difference between this approach and the traditional Lashof method is the rate at which a full credit is generated (see Table 2 for comparison); however, in both cases, 100 tonne-years or 100 single-year delays are equivalent to one tonne or full credit.

Table 2: Credits issued as a function of duration using the simplified Lashof method

Project Duration (years)	Percentage of Full Credit
0	0
10	10
20	20
30	30
40	40
50	50
60	60
70	70
80	80
90	90
100	100

4 CONCLUSION

The simplified Lashof method proposed by Verra has previously been adopted by the Climate Action Reserve (CAR) in their forestry and agriculture protocols. Tonne-year accounting is also employed in some Western Climate Initiative protocols in Quebec. Nonetheless, to date, adoption has been limited by feasibility. Specifically, the small volume of tonnes that can be credited at a 100 to 1 conversion rate makes the economics of using this approach challenging. As demand for carbon credits increases and the need for all removal opportunities to be maximized (including short-term storage) grows, the economics of using tonne-year accounting may change.

In advance of proposing this revision, Verra consulted several scientific experts on tonne-year accounting and heard broad support for the benefits of temporary storage; however, some diversity in opinions on how to credit the benefit. At this time, we have chosen to propose an approach that is relatively conservative, consistent with other carbon crediting programs and easy to understand and implement.

APPENDIX: TONNE-YEAR QUANTIFICATION EXAMPLES

Example 1 *-* If a project generates 30,000 VCUs in year one and chooses to use tonne-year accounting instead of making buffer contributions, they would be able to create and sell 300 VCUs (i.e., 1/100th of the tonnes or 30,000 tonne-years) in year 1. Then, in year 2, they could sell another 300 VCUs and so on, up until year 100. Therefore, in year 100, they will have generated and sold a total of 30,000 VCUs.

Example 2 *-* Alternatively, if this same project chooses to use a buffer approach to permanence, and its VCS *AFOLU Non-Permanence Risk Tool* analysis shows a risk rating of 20%, it would create 24,000 VCUs for sale in year one, contribute 6,000 VCUs to the pooled buffer account and have a long-term permanence liability.

Example 3 - Similarly, if a project uses a methodology that quantifies emission reductions and removals in tonne-years and it generates 30,000 tonne-years in year one, it could create and sell 300 VCUs (i.e., 1 VCU for every 100 tonne-years) in year one. If, in year two, the same project generated another 30,000 tonne-years, it would be able to create and sell 300 additional VCUs. Then, if the project stopped in year three, it would not be able to generate any further credits, but it also would not have to report a loss.

Table 3 below summarizes these examples. The main difference between conventional sequestration projects that use the buffer and projects using tonne-year accounting is projects using tonne-year accounting will be issued credits at a much slower pace. However, they do not need to make buffer contributions because the carbon is not sold until after the permanence period associated with the credited removal is achieved.

Table 3: Summary of tonne-year quantification examples

Example	Description	ERRs (tonnes)	ERRs (tonne-years)	Buffer contribution (tonnes)	VCUs credited in year 1	Permanence liability
1	Project using conventional accounting that chooses to use a tonne-year accounting permanence approach	30,000		N/A	300	None
2	Project using conventional accounting and a buffer permanence approach with a risk score of 20%	30,000		6,000	24,000	100-years
3	Project using a methodology that quantifies emission reductions and removals in tonne-years		30,000	N/A	300	None