Uncertainty

Summary →

- Accounting for uncertainty is critical to developing robust carbon credits.
- Many methodologies only account for some sources of uncertainty in baseline and project scenarios, and use constant deductions that do not incentivize better precision.
- NCX uses a comprehensive continuous function that values lower uncertainty at all levels.
- This represents a more rigorous approach to uncertainty accounting, which gives greater precision on the benefits of each project and incentivizes improvements in forest carbon measurements.

Quality carbon credits need robust uncertainty accounting

Uncertainty refers to how confident we are in the number of carbon credits a project will produce. Uncertainty is measured through a set of statistical approaches that assess the precision in measurements and estimates. It can be represented as a range of possible values, reflecting factors we can control (the quality of our methods) and factors we cannot control (random events such as wildfires). High quality carbon programs must balance science, speed, and scale, requiring a robust and trustworthy metric that can be used to define uncertainty for individual projects. There are four key principles for rigorously quantifying the uncertainty of the climate benefits of carbon removals and avoided emissions[1]:

- Completeness: accounting for all sources of uncertainty
- Consistency: methods are reliable over many projects
- Transparency: methods are reproducible by other analysts
- Conservativeness: methods presume more, rather than less, uncertainty

Ignoring major sources of uncertainty in measurements and models prevents us from quantifying the true climate impact of carbon projects[1,2]. Most IFM methodologies account for some sources of uncertainty, such as error from forest inventory data; but uncertainty from future forecasts of baseline and project scenarios is typically not accounted for. Excluding this large source of error will lead to underestimates of full project uncertainty. NCX's approach integrates uncertainty in forest inventory estimates as well as uncertainty in the baseline and project scenarios. This results in a robust and comprehensive uncertainty estimate that rewards improvement and values precision.

1 "Specification with guidance at the project level for quantification, monitoring and reporting of GHG emission reductions or removal enhancements", here

2 Yanai, Ruth D., Craig Wayson, Donna Lee, A. B. Espejo, John Law Campbell, Mark B. Green, Jenna M. Zukswert et al. "Improving uncertainty in forest carbon accounting for REDD+ mitigation efforts." *Environmental Research Letters* 15, no. 12 (2020): 124002.

A Technical Look at the NCX Continuous Uncertainty Accounting Approach

In the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, an increased focus on the purpose and methods for quantifying inventory uncertainty nevertheless concluded that "Ultimately, the measure of uncertainty will be a 95 percent confidence interval around a point estimate for the value." Most carbon accounting then relies on deductions taken when project uncertainty defined by that interval exceeds some threshold. For example, the CDM Methodology Panel (32nd Meeting, 2008) allowed that "if the random uncertainty of overall emission reductions of the project activity does not exceed 15% (at a 95% confidence level), no further action to deal with random uncertainty is required." Similarly, Verra recently adopted a comparable guideline for methodology developers, requiring estimation of the half-width of the two-sided 90 percent confidence interval and deducting where that exceeds 10% of the mean[3]; other major certification bodies have a comparable approach.

These fixed deductions incentivize project developers to meet only the minimum threshold for uncertainty, but don't place a premium on improving precision beyond that threshold. Instead, NCX has developed an approach that always rewards increased precision, so that as we improve our measurements and models, the uncertainty around our delivered climate impact goes down and we can offer even more rigorous credits. This is particularly true for projects, like ours, that operate at the scale and speed necessary to deliver significant and urgent climate impact.

In our carbon accounting for projects, NCX applies a continuous function that: (1) explicitly values precision at all levels; and (2) accounts for uncertainty of both field measurements and statistical models across time. This function allows us to more directly incorporate uncertainty of leakage and harvested wood products into final estimates. At this time, we apply this approach to the estimation of project impact, inclusive of the beginning and ending estimates of standing carbon in the project and baseline scenarios.

We have started from a recommended series of deductions for a project, based on overall uncertainty:

Table 1. Acceptable uncertainty limits for random uncertainty (reproduced from CDM Meth Panel report, Table 4, which was adapted from 2006 IPCC Guidelines, Volume 2, Chapter 2, Tables 2.2 to 2.6.)

Estimated uncertainty range at 95% confidence level of overall emission reductions	**Conservativeness factor**
$> \pm 15\%, \leqslant \pm 30\%$	0.943
$> \pm 30\%, \leqslant \pm 50\%$	0.893
$> \pm 50\%, \leqslant \pm 100\%$	0.836
$> \pm 100\%$	to be addressed in the methodology

3 https://verra.org/wp-content/uploads/2022/06/VCS-Methodology-Requirements-v4.2.pd

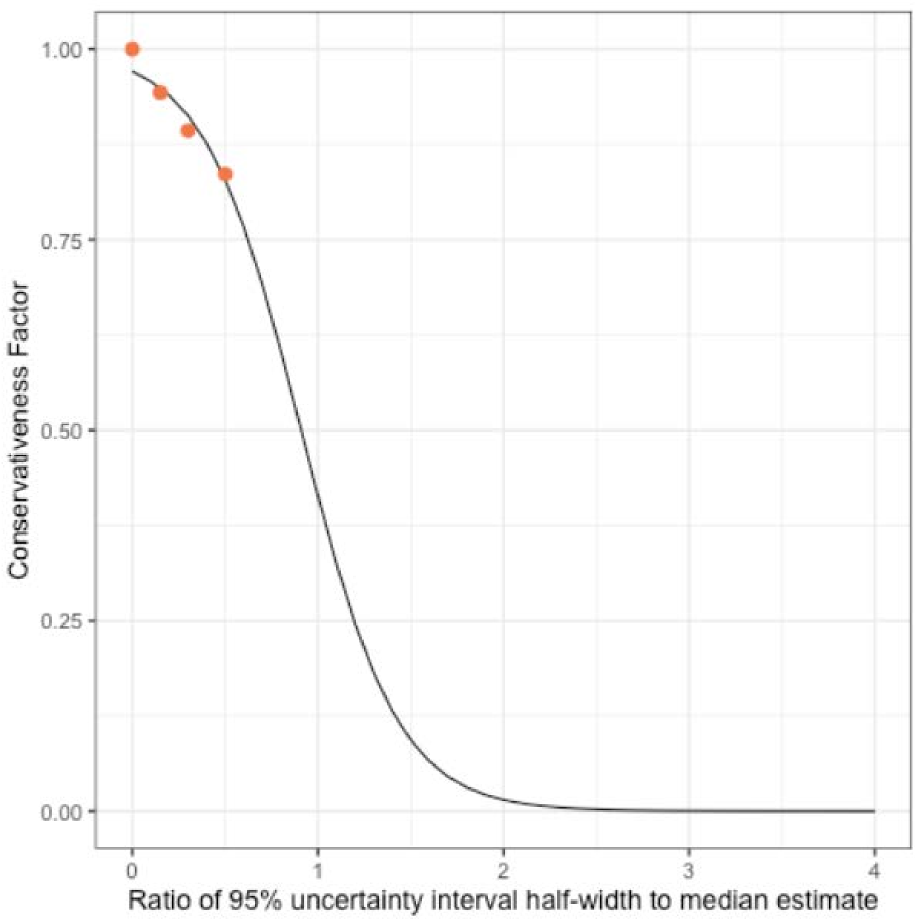
Using these as a starting point, we fit a continuous function to calculate a 'conservativeness' factor for any uncertainty range. The function we used (graphically presented in Figure 1) is:

$$u = 1 / (1 + e^{-3.502478 + 3.851745 * x})$$

Where *u* is the conservativeness factor and *x* is the ratio of the halfwidth of the 95% uncertainty interval to the median value of the metric of interest.

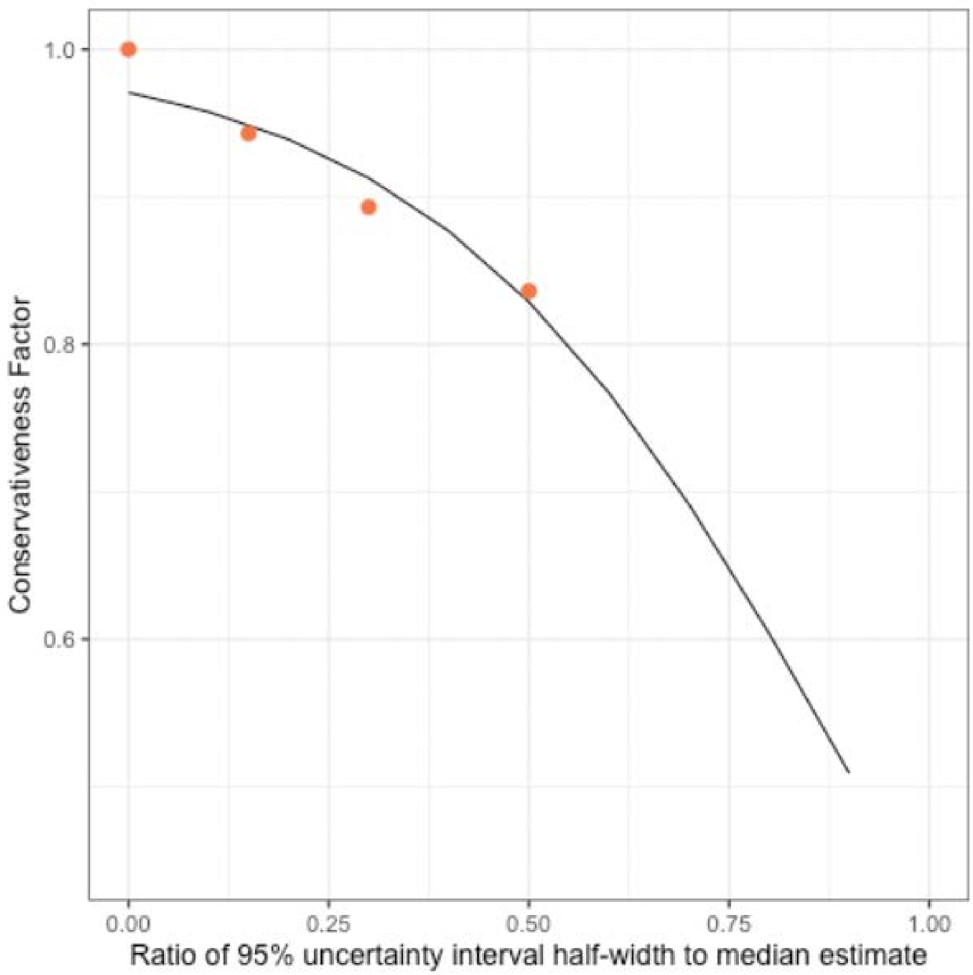
In our harvest deferral methodology, this is applied to our estimate of forest carbon credits generated due to deferring harvest for one year. To account for uncertainty, the raw number of credits is multiplied by the conservativeness factor, an explicit reduction in the number of credits produced by each cycle based on the uncertainty in the estimate of the impact of the cycle.

Figure 1. Logistic regression function fit to IPCC-derived stepwise guidelines.



Note that this curve moderately penalizes uncertainty up to about 25 percent, with increasing impact as precision decreases. This is consistent with the goal of incentivizing improvement. Projects can yield many more credits via actions that greatly improve uncertainty estimates, such as adopting more robust data or models. Even as uncertainty approaches zero this curve results in a small deduction (Figure 2). This is consistent with the conservativeness principle, and is an acknowledgement that no model captures all sources of uncertainty.

Figure 2. Logistic regression function fit to IPCC-derived stepwise points for a narrower range of uncertainty interval half-widths



Ongoing Work

While this approach is more rigorous than uncertainty deductions typical in other forest carbon programs, it is sensitive to some particular implementation details. Most critically, this approach relies on the original Conservativeness Factors cited - our team is interested in collaborating with other developers and scientists to build a more robust dataset of recommended or realized conservativeness factors to define the utility function. Additionally, the approach remains sensitive to the number of Monte Carlo simulations used to generate an uncertainty distribution, as well as the population for which that value of interest is being calculated. We acknowledge that balancing science and scale to appropriately represent uncertainty requires robust documentation of the defined population(s) of interest. We plan to release more details and context on this approach as we roll out our full methodology and project documentation.