CarbonPlus

Methodology for GHG and Co-Benefits in Grazing Systems v1.0

(peer reviewed)

-Upgrades from version 0.92-

October 2023

Main Edits, Upgrades, and Additions in Version 1.0 of the CarbonPlus Methodology for Grazing Systems

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The Carbon*Plus* Methodology for Grazing Systems 1.0 is a measurement-based approach coupled with remote sensing data analysis that can be used to monitor the changes in SOC stocks and co-benefits over time, to generate Carbon Credits.

This methodology was developed in-house by the Regen Science Team, addressing challenges and experiences from several stakeholders, including land stewards, methodology developers, soil scientists, project developers and other experts in the space of VCMs.

Version 1.0 of the Methodology has gone through an exhaustive formal peer review done by three experts in the fields of soil sciences, geostatistics, and GHG accounting. We welcome constructive comments and debates for continued improvements!

Below, we briefly explain some of the most relevant upgrades from the previous version.

Approaches to Estimate SOC stocks

One major change of this upgrade is that the traditional "sampling & extrapolation approach" is no longer an option. Machine Learning and Interpolation have been added as new alternatives.

In summary, there are three possible approaches you could follow:

(1) **satellite calibration based on SOC%** values from the sampling points, using **multiple correlations or Machine Learning**

(2) **satellite calibration based on SOC stocks** values from the sampling points, using **multiple correlations or Machine Learning**

(3) **spatial interpolation** of the SOC stocks values from the sampling points, using GIS.

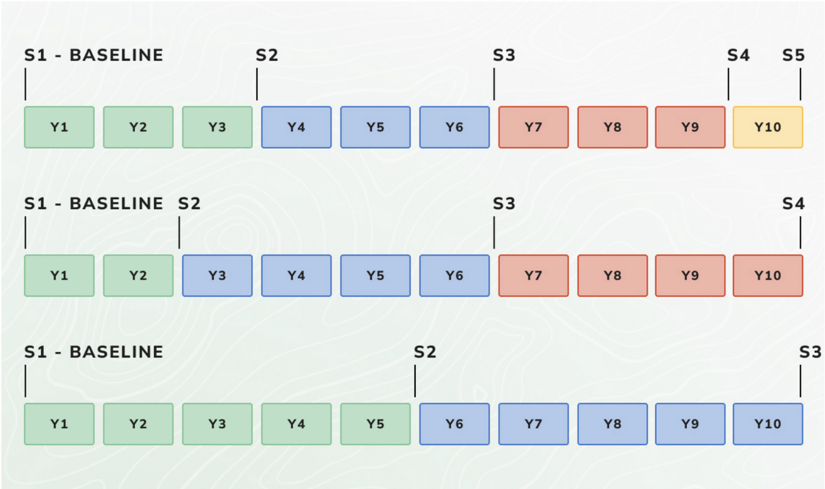
Eventually you can run the three and use the one that provides the best accuracy.

A great addition to this version is the automated version for satellite imagery processing and full analysis! You can follow the User Guide with links to Jupyter Notebook on Github.

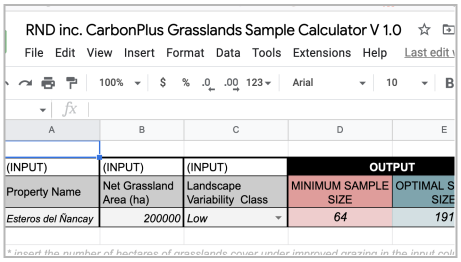
Temporal Boundaries

We are now upgrading this requirement per the recommendations from the reviewers to **every 5 years max** (formerly 4). So, this means at least one sampling at the beginning (baseline), another one in year 5 and a final one in year 10 are required. Project developers might opt to do more frequent sampling (maximum every 1 year), in particular when there are high sequestration rates, to increase the frequency of credit issuances. But the total **minimum** amount of sampling rounds required is **now 3 for the whole crediting period of 10 years**, instead of 4.

Examples of acceptable sampling timelines



Sample Size Calculator


RND inc. CarbonPlus Grasslands Sample Calculator V 1.0

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A	B	C	D	E
(INPUT)	(INPUT)	(INPUT)	OUTPUT	
Property Name	Net Grassland Area (ha)	Landscape Variability Class	MINIMUM SAMPLE SIZE	OPTIMAL S SIZE
Esteros del Ñancay	200000	Low	64	191

We created the [Carbon*Plus* Grasslands Sample Size Calculator]() which estimates the **minimum** and **optimal** number of samples to achieve the minimum accuracy of 50% and to avoid uncertainty discounts.

The inputs for the calculation are fairly simple: just the **net area of grazed areas in the property (in ha)**, and the **Landscape Variability class** of the property, which can be deducted from a survey table that is provided.

Another major change is that achieving the minimum number of samples provided by the calculator is now a requisite.

The [Conceptual bases of the RND inc. CarbonPlus Grasslands Sample Size Calculator V 1.0. Document]() provides more insights into this Sample Calculator.

Sampling Procedures

Sampling Depth

It is a **requisite** from now on to have a **minimum depth of 30cm** (formerly 10cm). We consider this as one of the most relevant upgrades in this version, as formerly it was allowed to sample only the first 10cm of the soil layer to generate credits. Soil scientists have been increasingly recommending a minimum sampling depth of 30cm to the VCMs during the past few years, as the carbon in the first 10 cm has proven to be too labile and subject to higher fluctuations due to climate.

The Methodology allows for deeper carbon than just 30cm, which should be more stable soil carbon, although the chances to correlate to satellite imagery are reduced when going deeper.

This means that, for the deeper layers, interpolation might be the only approach that hits the accuracy or error[1] requirement of 50%.

Compositing

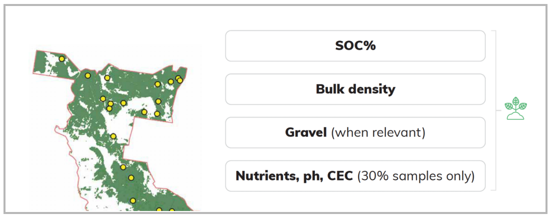
We now explicitly recommend taking composite samples within each sampling point, for SOC and for the soil fertility indicators, when it corresponds (only 30% of total samples). This holds for the upper topsoil layer (0-30cm), while for deeper carbon, only one sample per sampling point is required. We based this decision on recommendations and requests from soil scientists taking samples in some of the projects. Sampling deeper carbon might be too laborious and/or cost prohibitive, in particular for Bulk density, and it is also a more stable soil layer for nutrients and for bulk density.

Sample Analysis (Lab.)

What to analyze?

It is now stated very clearly that **all the soil samples** must be analyzed for:

- % SOC
- Bulk density
- Gravel content, only when relevant (i.e. when soil has more than 10 % gravel or the stones are >2 cm



Only 30% of the samples must be analyzed for all the macro and minor nutrients, for the **Soil Fertility** co-benefit. This is a major update that allows to get more samples while **reducing the total laboratory costs** for analysis, when compared to the previous version in which all the samples were analyzed for all the parameters.

Also, we now deleted the requirement to include CEC as one of the mandatory parameters to track.

Stronger sampling recommendations and requirements

[1] See section below to learn more about the distinction between error and accuracy

We added recommendations throughout the document to help Project Developers to carry out a successful sampling, such as core sampler diameter, and that the same analytical procedures and service laboratory shall be used across all sampling events, to reduce additional errors from calibration bias or changes in the analytical techniques.

Sampling permanent plots is now a requirement.

GIS analysis

Extracting spectral values from the sampled points

The idea behind this is that correlations should be linked in time with the sampling period. We have now updated this section to allow for a whole year (+/- 6 months around the sampling date). Although the changes in soc stocks might not be too large within the year, we have some examples of pretty high SOC sequestration rates, above 4 ton CO2eq/ha/y in which cases the changes in one year could be pretty substantial.

Satellite calibration: context for this innovative approach

Given the innovative nature of the GIS analysis based on samples and satellite data, in section 3.3.1. “CALCULATING SOIL ORGANIC CARBON STOCKS USING A SATELLITE CALIBRATION APPROACH” we have now added some explanatory text with relevant scientific literature references. We hope to expand this section as we expand on use cases and scientific literature keeps evolving.

Skills required to run this method

We now added the full skill set required to run this Methodology to the beginning of the Methodology document, which felt important to help users evaluate the adoption of this Methodology in the first place, and then to set up the right team of professionals to run a project.

Calculating the Greenhouse Gas Emissions

We added subsections to better guide the estimation of GHG from other sources than cattle:

- Fertilizers

- Fuel and electricity use
- Additional Agrochemicals

We also now request that for Methane and for Fertilizer emissions **at least a Tier 2** approach (IPCC) must be followed, and a Tier 3 when information is available. Formerly, the previous version of the Methodology only required to use default emission factors based on the Tier 1.

Accuracy Metrics: Uncertainty versus Error

We now make a clear distinction between Uncertainty and Error, and require that the Monitor adopts one or the other and uses the corresponding metrics and terminology consistently throughout the project lifetime. Reporting uncertainty metrics is preferred, but skilled experts would be required to quantify it using GIS, so reporting Error is allowed as an option as long as it's clearly reported as such. Uncertainty and Error terms can not be used interchangeably. Another change is that the Error that was formerly estimated using a train-test approach is now calculated through the normalized root mean square error (nRMSE) from performing **leave-one-out cross validations (LOOCV)**. Using Loocv means that the extra 30% of samples for estimating the error (test pool) is no longer needed, so this change helped us to **reduce the sampling size**.

Co-Benefits: Ecosystems Health

VIGOR

The **EVI index** was included as a proxy to NPP, alternative to NDVI.

Values must be compared between the project and a **control area**, which could be one of the following three options now:

- Business as usual belt (this is same as the former versions)
- Business as usual target properties (min area 200ha)
- A “Best case scenario” (a reserve, or protected area or natural ecosystem for example)

Note that the scoring procedure will be different depending on the control type.

ORGANIZATION

WOODY VEGETATION LANDSCAPE METRICS

We now recommend the landscape metrics **heterogeneity** and **patch connectivity** for this co-benefit.

A minor correction: Water courses / wetlands terms have been replaced by the term “water bodies”. Ephemeral water bodies have been included.

RESILIENCE

Same as with the Vigor upgrades, the relative area covered by **bare soil** must be compared between the project and a control area, which could be one of the following three options now:

- Business as usual belt (this is same as the former version)
- Business as usual target properties (min area 200ha)
- A “Best case scenario” (a reserve, or protected area or natural ecosystem for example)

Co-Benefits: Soil “fertility”

This co-benefit was formerly named “soil health”. We acknowledged based on one of the reviewers comments that soil health would require a wider set of indicators than nutrients and pH. We agreed on renaming it “soil fertility” to better reflect what's being measured.