Methodology for GHG and Co-Benefits in Grazing Systems V1.0

Response to Reviewer 2- Miguel Taboada

Reviewer's Information

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Authors response to reviewer

Please find below a detailed response to each comment. We indicate where in the text and how each comment was addressed.

Section	Reviewer's Comment	Authors Response	Reviewer´s Decision (PASSED/ REQUIRES FURTHER REVIEW with comment)	Author´s final comments
1.1. scope	According to Allen et al. "Major soil health indicators discussed in the context of climate change are: aggregate stability, water infiltration, and bulk density, soil organic matter content, carbon and nitrogen cycling, microbial biomass and activity, and microbial diversity". Therefore, I think that pH, Macronutrients, CEC and so-called Minor nutrients cannot be solely considered as SOIL HEALTH. It seems that other key biological indicators (soil enzymatic activity) are lacking. Perhaps, rather than SOIL HEALTH this set of parameters should be called SOIL FERTILITY. Besides, Calcium, Magnesium, Potassium, Sodium, Aluminum are not Minor Nutrients. Calcium, Magnesium, and Potassium are also Macronutrients. Sodium is not a nutrient, but a	According to the reviewer's suggestion, we have renamed the Indicator as "Soil Fertility" throughout the document, in replacement to "soil health". We have also renamed the indicators as soil cations, in replacement to micro nutrients.	agree	*-not required-*

	problematic cation in soil when in excess. Aluminun is not a nutrient either, but a constituent of soil that may cause soil acidity. References Allen, D.E., Singh, B.P., Dalal, R.C. (2011). Soil Health Indicators Under Climate Change: A Review of Current Knowledge. In: Singh, B., Cowie, A., Chan, K. (eds) Soil Health and Climate Change. Soil Biology, vol 29. Springer, Berlin, Heidelberg. **https://doi.org/10.1007/978-3-642-20256-8_2**			
1.1.Scope	Bare soil is an indicator of land degradation and not of Ecosystem Health. Ground cover by vegetation and the composition of this vegetation may be indicators of ECOSYSTEM HEALTH. For example, in some ecosystems bare soil does not decrease but grasses disappear and	We agree with the reviewer in that, conceptually, it is the vegetation cover increase which indicates health, rather than the bare soil reduction. Nonetheless, bare soil (i.e. [1 - vegetation cover]) has been identified as a good indicator of ecosystems resilience[1] and grasslands health[2], through the negative relationship. Given the indicator that´s	I agree. However, please take into account that Ecosystem Health requires a set of	We acknowledge that this is not a complete indicator / the best indicator for overall ecosystem health. But, nonetheless it ´s a very relevant one. It's

[1] Li et al. 2013. Three-Dimensional Framework of Vigor, Organization, and Resilience (VOR) for Assessing Rangeland Health

[2] Ludwig et al. 2000. Monitoring Australian Rangeland Sites Using Landscape Function Indicators and Ground- and Remote-Based Techniques

	shrubs increase by encroaching.	measured more directly through satellite imagery here is the bare soil, we prefer to keep the indicator as bare soil for simplicity. The reviewer might be suggesting a more comprehensive analysis of vegetation cover species replacement which would fall beyond the scope of this qualitative assessment of co benefits.	indicators in addition to solely Bare soil.	also very easy to track and non expensive. We are open to improving it if there are better, more comprehensive options that can keep it simple, easy and cheap to track, as this is a co-benefit.
1.3.1.	Suggested change to SOIL FERTILITY	Changed accordingly	agree	*-not required-*
2.1.1.	Woody vegetation, water bodies, riverine areas are not man-made objects.	We corrected the text accordingly.	agree	*-not required-*
2.2. Temporal Boundaries	*"It is recommended (not mandatory) that two (2) soil sample rounds occur consecutively during the last two years."* Why? Perhaps it has more sense that SOC be checked at 5 years	The original reasoning behind this is that by having two consecutive samplings at the end, there would be a more robust final estimation of the SOC stocks at the end of the crediting period to be compared with the baseline. And this would support more robustly the total net issuance of credits during the project lifetime, in particular when there have been extraordinary sequestration rates and there´s consistency between these two	I'm not sure to understand your response. However, I have no doubt that you might compare SOC stocks every 4 or 5 years, with a robust soil sampling	Thanks for the advice! (no further comments required by reviewer, as we already fixed this section according to his comments)

		final measurements to back it up. We required SOC measurements every 4 years max. Note we are changing this requirement to every 5 years max now (section 2.2), but anyways an intermediate check is still required. The recommendation to have 2 consecutive samplings at the end was now deleted, as we haven´t figure out yet how to make a final assessment of the whole period for risk mitigation that would justify it.	scheme at the start and a t the end of the project. It makes no sense to compare SOC stocks and/or contents in consecutive years.	
2.2. Temporal Boundaries	*"The maximum time between monitoring rounds is four (4) years."* unclear for me. What means? after 4 years a second project?	This means that the frequency for sampling is maximum every 4 years, within the 10 years timelife of the project. In other words, sampling rounds must be carried out every 4 years or more frequently, starting with the first one at year zero, which is the baseline. We are now upgrading this requirement per the recommendations from the reviewers to every 5 years max. 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.	agree	*-not required-*
3.1.1.1. SAMPLE SIZE ESTIMATION	I'm afraid that a high heterogeneity will be included if we do not distinguish main land	We have added some clarifications in the text so it is more clear now when reading this section that the sample size estimation will depend on the assessment of the	agree. Stratification is firstly required to distinguish different	*-not required-*

FOR SATELLITE CALIBRATION AND SPATIAL INTERPOLATION	nits or envronments before sampling. For example, in some ecosystems fine-textured and coarse textured soils coexist. The Esteros is a good example where the highlands have sandy sediemnts and the lowlands have clayey sediments. They behave very differently in terms of SOC sequestration. No doubt, when we use a samplling calculator the work is easier but I´m affraid that we cannot find SOC sequestration because of the high variability. I suggest to include SoilMapping as a previous stage to separe different soil unitis. This doest not require field work and can be done using satellite images with adequate expertise and/or using local soil maps (INTA in Argentina).	landscape variability, too. And then we added this note with the recommendation to stratify for the location of those samples, once the number is determined: *"Note: The RND Science team highly encourages stratification to achieve better accuracies from the amount of samples estimated by the RND online calculator. Please refer to section 3.1.2 for more information about the stratification process."*	main land units and/or environments.	

3.1.1.1. SAMPLE SIZE ESTIMATION …	**Table 1.** good! but why not to use this Table as an approach to separe different land units in terms of soil sampling?	As the reviewer noted later when reviewing the section 3.1.2. stratification is a strong recommendation and we provide guidelines to do it properly. We have now added this note to make it clear from this upper section: *Note: The RND Science team highly encourages stratification to achieve better accuracies from the amount of samples estimated by the RND online calculator. Please refer to section 3.1.2 for more information about the stratification process.*	agree	*-not required-*
	"These subsamples could be composited or analyzed separately." Should be	We replaced could by should in the text, as indicated by the reviewer.	I understand and agree. However, "should" is not mandatory. I'd prefer to replace "could" by "shall".	We replaced "should" by the word "shall" as suggested.
3.1.1.2. ANCILLARY SOIL SAMPLE DATA	*"The sample dates for the project area and the sample dates for the farm providing the ancillary data must fall within one month of each other."* I don't think this is important. More important is the soil management would be similar between farms.	We deleted this section, as it was confusing and the requisites hard to match for data to be useful for the GIS analysis. We still allow for grouping projects , in which case it makes more sense that there´s a coordination between to close farms to reduce the sampling costs. The grouping of farms is allowed at the credit class level.	agree	*-not required-*

3.1.1.2. ANCILLARY SOIL SAMPLE DATA	In some circumstances ancillary data may be used for the baseline if they represent a general baseline or business as usual situation for the area. The farm providing ancillary data may represent the original situation of an area in which several farms initiated sustainable management projects, regardless if this occurred in the last 3 years or not.	Regarding the use of data from other farms for baselines, that would be in order to generate dynamic baselines , which is one of the possibilities allowed at the Credit Class level. We realized that this possibility was not included in the Methodology piece, so we added this now in section 3.6.1.: "An exception to this type of baseline adoption would be when there´s access to sample control sites which represent the same conditions (soil, topography, climate) than the project area but are managed under business as usual, and so a dynamic baseline or also called "contrasting managed baseline" can be optionally used. In this case, the continuity of access to the control sites throughout the project time life should be ensured, and evidence proving the suitability of the control sites should be provided, following the requirements of ANNEX C from the Ruuts protocol."	I understand the meaning of "ancillary data", but I do not understand the meaning of "generate dynamic baselines". Please, could you clarify this?	A dynamic baseline in this context would be one that is continuously updated based on sampling in a business as usual managed area. These baselines are less feasible because it is hard to find the right paired areas that really represent business as usual under the same conditions as the project area and ensure accessibility throughout the project lifetime. But, if found, there are less accountability errors of the additional carbon sequestered in the project, due the changes caused by climatic variability are also captured.
3.1.2. STRATIFICATION	*How to stratify?...* good! That's what I was referring to when I talked about separating land units.	Great. So, in this section of the document we say: *Note: The RND Science team highly encourages stratification to achieve better accuracies from the amount of samples estimated by the RND online calculator in section 3.1.1.1.* We now included a similar note in section 3.1.1.1 which is above in the text to make that clear from the beginning.	agree	*-not required-*

3.1.4. EXTRACTING SAMPLES	*"the recommended sampling depth is 30cm."* At least	Given consensus from the 3 reviewers that 30cm min depth should be mandated, we now upgraded the Methodology in section 3.1.4., point 2) "*The minimum sampling depth is 30 cm. Justification must be provided if sample depth is shallower than 30 cm."*	agree. However, I suggest taking samples at 30 cm depth (at least). Samples could be deeper, typically 40 cm if possible.	Agreed. We added this sentence in the same paragraph *: It might be recommended to go deeper than just 30cm in the soil profile, please consult soil experts in your area for recommendations* .
3.1.4. EXTRACTING SAMPLES	*"8) Samples must be taken at least 10 meters away from any tree, shrub, structure, or body of water."* as well as animal paths (dung accumulation)	Added to the text , according to the suggestion	agree	*-not required-*
3.2. Sample Analysis	*3.2.1. WHAT TO MEASURE? (...) Bulk density* (only required) when different soil units and/or management histories	We are taking a conservative approach, to account for the spatial heterogeneity of bulk density, although we agree with the reviewer in that this could lead to unnecessary measurements in homogeneous landscapes. We could not find literature supporting that´s strong enough for us to skip requesting this metric for all samples at the moment, but maybe the reviewer can point us to a source we could use to back this decision up. On contrary, for instance the FAO guidelines[3] recommend: *The*	agree. Explain ESM approach	We left some useful references in section 3.2.1. explaining the ESM approach, but we are open to add some more per suggestions. The ESM approach is complex and we felt it was better to point out good references rather than replicate within the

[3] FAO. 2019. Measuring and modeling soil carbon stocks and stock changes in livestock production systems: Guidelines for assessment (Version 1). Livestock Environmental Assessment and Performance (LEAP) Partnership. Rome, FAO. 170 pp. License: CC BY-NC-SA 3.0 IGO.

		soil bulk density used in calculating SOC stocks (and Equivalent Soil Mass, Chapter 3) should be the density of the same core in which SOC concentration is measured. This is because the sampling of soils by coring almost invariably results in some compaction (Ellert et al., 2001). Thus, for example, the true depth of sampling when a 0-30 cm core is extracted almost always exceeds 30 cm and, therefore, the soil density in the core removed exceeds the actual field bulk density. This can lead to serious errors when later calculating soil carbon stock on an equivalent mass basis using bulk density and SOC concentration measured in independently taken samples. Ideally, soil compaction during sampling will be minimized, but information on the soil mass per volume sampled is more crucial than true bulk density (that may be required for detailed characterization of in situ gas and water transmission, but not of SOC stocks). We are also now expanding on the option to carry out a ESM approach as an alternative to using the fixed depth approach, in section 3.2.1		Methodology document.
3.2. Sample Analysis	*CEC is not a fertility parameter and it only depends on clay and SOC contents.* *In change, CEC should be determined before exchangeable*	In the Australian rangelands where we started our first use cases, they were tracking changes in ammonia and nitrates and in CEC as indicators for soil quality/ productivity. We found that	May be, but CEC is strongly related to clay percentage and SOC	We finally decided to delete it from the list of mandatory soil fertility parameters.

	cations (Ca, Mg, K, Na).	some of the soil test protocols[4,5] for rangelands in AU recommend testing the different forms of Nitrogen and the CEC, and provide thresholds for the recommended levels. We also had conversations with the agronomists managing those properties to check on these levels. *e.g. CEC: This is a measure of the ability of the soil to hold the nutrients calcium, magnesium and potassium. Good fertile soils with high clay content and moderate to high organic matter levels usually have a cation exchange capacity of 10 or higher.* We might have been biased then, as this seems to not be scalable or considered useful in other areas, per the reviewer's comment. We would like to discuss better alternatives to incorporate more universal indicators, if possible, with the reviewer. This might be a good topic to also discuss during the public comment period.	content. From both, only SOC is expected to vary because of soil management . Clay % can vary when a soil is eroded, for example. I do not know thresholds or limits for CEC as indicator.	
3.2.1.1. BULK DENSITY	Core volume is not provided by the lab, but depends on the core used.	We deleted the option referring to how to calculate bulk density when the lab provides for the volume of samples, as the reviewer is right in that the volume must be calculated by the Monitor based on sampler dimensions.	agree	*-not required-*

[4] https://www.gbcma.vic.gov.au/downloads/LandHealth/Understanding_Your_Soil_Test.pdf
[5] https://www.dpi.nsw.gov.au/about-us/services/laboratory-services/soil-health/interpret

	It is not recommended to use small cores (less than 5 cm in diameter) because they compress the sample inside them. Soil sampling devices are usually very narrow in diameter and compress the sample. This means that BD values are about 20-30% higher than that in the field.	The recommendation was now added to the Methodology doc. to make this clear according to the reviewer's suggestion (section 3.1.4. EXTRACTING SAMPLES): *"8) It is NOT recommended to use small core samplers or rings (less than 5 cm in diameter) because they might compress the sample within. A diameter of 7.62cm (3-inch) would be ideal."*	agree	*-not required-*
3.3. A	The key question is whether SOC data are correlated with spectral data. Which aspect of spectral data will be considered? How is this correlated to a given SOC stock? This needs further explanation	This methodology was designed after finding strong correlations between several bands of the sentinel 2 satellite and SOC values from geolocated samples. This was consistently found from several sites, ecoregions and for different sampling periods. Nonetheless, in case of lack of correlation the methodology allows for an interpolation, as the number of samples required should suffice to achieve a good result. When looking for correlations, the Monitor will need to iterate through the spectral data at the sampling points from different satellite images, from different dates around the sampling date (a whole time series). There have been some recent publications that support our findings and approach. This approach might look very innovative and unprecedented for SOC, but is very similar in	I have no experience on the use of this methodolog y that seems very promising. Given its innovative character, I suppose or suggest to accompany with specific publications justifying the correlation with SOC variations in the field.	Our expectation is that once we have some more use cases implementing this method we will be able to publish some scientific papers in recognized journals. Meanwhile we left the referenced papers in section 3.1.1. where correlations have been found between SOC and sentinel-2 satellites.

		essence to any other digital mapping approach. Furthermore, there´s another methodology being approved in our registry that has received a lot of attention EU and early investment due to its high accuracy of results, which is based on the same approach, except that they use a particular machine learning algorithm and expand to cropland. We now added some context and relevant references that you will find in a new paragraph at the beginning of this section 3.3.1. Gholizadeh et al . **2018** Izurieta et al. 2022 Castaldi et al 2019 Angelopoulou 2019		
3.3.1.1. EXTRACTING SPECTRAL VALUES AT SAMPLING POINTS **Table 3**	Understood! However, some of these spectral data (NDVI, BSI, clay and silt, total vegetation, and so forth) are related to SOC but determination indexes are usually not higher than 0.6. That means that a great proportion of variability is not explained by the variable (spectral data). The only and valid solution is to provide local validation to the selected parameters.	We agree with this but might be worthwhile to set up a meeting to explain further how this approach works. These proxies (NDVI, BSI, clay and silt, total vegetation) are tested through machine learning and /or multiple regression along with the sentinel bands spectral data extracted at the sampling points, which is specific to that sampling area and time period. And only used as ancillary explanatory variables if they improve the model prediction power when calibrating the satellite imagery with the samples.	agree. Please, reconcile my response with the previous one to point 3.3.A.	*-not required-*

3.5.1. EMISSIONS FROM LIVESTOCK **about eq. 8**	This is a Tier 1 approach from IPCC GL 2006, refined 2019. It could be fine, but ~~in my opinion~~ it greatly limits the possibility of changing EF in improvement projects, which for example improve forage digestibility. It deposits much of the livestock emissions in the methane emission from enteric fermentation. If we can only "play" with one EF per livestock head, we have little chance of highlighting a handling improvement.	We are open to changing this section to a more detailed version, but at the same time we are trying to balance complexity with feasibility and trying to simplify the protocol to the extent possible to avoid errors from implementation and calculations. With that in mind we would like to open the possibility for a more detailed assessment , optional, in case the Monitor is well trained and has the appropriate data. We kindly request the reviewer if he can provide any link or point us to the extended approach that he is suggesting here.	To my knowledge, and unlike the case of Direct and Indirect N2O emissions for fertilizers, there are not other options to estimate CH4 emissions by changing EFs. THe only possibility is to adopt a proper DE as percentage as explained in Table 10.2 (updated) p. 10.21. IPCC/Refinement%20to%20the%202006%20IPCC%20Guidelines/19R_V4_Ch10_Livestock.pdf	We now request that a Tier 2 approach must be followed at minimum, or Tier 3 when more refined information is available (like for Argentina)
3.5.2. EMISSIONS FROM FERTILIZER, eq.9	Idem CH4, this is also a Tier 1 approach. In farms applying N fertilizers, it is important to distinguish between different N sources, such as urea ammonium nitrate.	Idem previous.	In this case, the 2006 IPCC Gl refined 2019 give or allow a more detailed approach to	Thanks for pointing us to this, we now updated this section requesting a Tier 2 approach, citing the IPCC -2019 refinement

			take into account the different N sources. It refers to Table 11.1 (updated p. 11.12 for Direct N2O emissions, and Table 11.3 updated, p. 11.26 for Indirect N2O emissions). IPCC/Refinement%20to%20the%202006%20IPCC%20Guidelines/19R_V4_Ch11_Soils_N2O_CO2.pdf)	reference you provided.
4. Calculating the Soil Health Indicators	They are not "soil health" indicators, but soil fertility indicators. Some biological or biochemical indicator is required to be considered as soil health indicator.	According to the reviewer's suggestion, we have renamed this as "Soil Fertility" throughout the document, in replacement to "soil health".	agree	*-not required-*
4. Calculating the Soil Health Indicators	not "minor" nutrients	We have renamed the indicators as soil cations, in replacement to minor nutrients.	agree	*-not required-*

4. Calculating the Soil Health Indicators	not nutrients	Idem previous comment.	agree	*-not required-*