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Dear Dr Merino-Martín, dear Editor,

Herewith I resubmit the revised version of my manuscript entitled 'Benchmarking soil multifunctionality' for further consideration. I am happy with the positive reviewer comments made and the suggestions for improvement.

In response to the reviewer comments I have added section on working with the method in the Global South and added guidelines for the sampling of homogeneous sets of soil cores. I have added reference to current relevant projects and expanded to references in the outlook to support the questions raised there. I went through the entire manuscript to shorten the text where possible and remove digressions present. I also clarified the language where needed.

For further details please see below my detailed responses to the comments raised.

I hope this constitutes a meaningful revision of the manuscript and we look forward to your decision.

Sincerely,

E.R. Jasper Wubs

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Reviewer: 1

Dear author,

I've read with great interest your Ms which offers stimulating thoughts on how to assess soil multifunctionality and soil health. The topic is definitely timely and worth being considered for publication in SOIL. In particular, I've found interesting the concept approach of using LV.

I've however some major recommendations to improve it.

1. I would recommend to give an example of application of this approach with LV. So far, only one example is given for soil fertility, but the different soils functions mentioned in the Ms should be illustrated similarly

Response: That is indeed something I am planning to do, however, the idea of this paper was to get the concept out and then to leverage the wisdom of the soil science crowd before I/we start measuring for real. So it should be read more as a perspective paper than a research article.

2. The practicability of the approach will definitely be a challenge especially in the global South. I would recommend to discuss this point more in depth

Response: Thanks for pointing this out. Having worked in the global south this is on my mind a lot and indeed it can be more prominent in the paper. I have added a section to the effect in the ms (L526-530).

3. In the description of the soil sampling strategy, I've questioned myself on how practically speaking homogeneous soil monoliths will be selected. Which criteria should be taken into account to define homogeneous area : for instance soil type x land-use x climate ?

Response: In general I would recommend to sample as small a space as possible so it is most likely to be homogeneous, and then to take replicate observations through the field and landscape of interest. For sure soil type, land use and climate need to be the same, but I think a finer level of detail is necessary to make the method worthwhile. I added the guidance on this to the ms (L516-517).

4. More references would be necessary in the outlook section where many questions are formulated but the scientific rationale behind each of them should be more justified

Response: I have added additional references to the section.

5. A review of the existing approaches to benchmark soil multifunctionality would be necessary especially because there are several Soil Mission projects on this topic : Soil Health Benchmarks project (<https://soilhealthbenchmarks.eu/>), SOLO project (<https://soils4europe.eu/>) just to give 2 examples

Response: thank you for pointing this out. I was part of SOLO and its mission is not to benchmark soil multifunctionality, rather it tries to set roadmaps for future soil research

needs. The soil health benchmarks project is a good approach building on Creamer et al 2022. I now added this information to the text

6. Finally, I would recommend to shorten the Ms and avoid some digressions

Response: Thanks, I have gone through the ms to shorten it.

I hope these comments will be helpful to revised the Ms.

Yours sincerely,

Julien Demenois

**Citation:** <https://doi.org/10.5194/egusphere-2024-2851-RC1>

Referee 2

This is an interesting paper that proposes using structural equation modelling to help define soil health. It makes a strong argument for the approach and introduces the reader to the methodology with clearly worked through illustrations of how the method might work. However, this where I had a problem with the paper, as it never went on to apply the proposed method and illustrate its application with some results and then discuss them. For this reason I cannot recommend the paper for publication in SOIL and suggest that it is rejected.

- Response: Thanks for your viewpoint and comments. Indeed, I wrote the paper as a perspectives paper outlining the idea for the method. I did this because I think a good method to measure and quantify soil health is too complicated and too important to do in one go. Rather I aim to leverage the wisdom of the soil science crowd to improve the method before I/we start measuring in earnest.

I have specific comments which are included to help the author improve the paper:

L39 I don't follow the reasoning behind this statement 'Furthermore, soil biodiversity importantly contributes to climate change adaptation, by storing precipitation in soils (Lal, 2020).

- Response: Soil biodiversity helps stabilize SOM which importantly contributes to maintaining water in soils. This link was indeed not explicit and I remedied that in the current version.

L64. What are we looking for in Creamer et al 2022 and Vogel et al 2018?

- Response: Both references come up with conceptual models for modelling the multiple functions of soils.

L129 I don't think SOIL has boxes. Also I am not sure the photograph of Sewall Wright adds very much.

- Response: thanks for pointing this out, I have removed the photograph.

L178 I get the irony, but not really appropriate in a scientific paper

- Response: thanks, I removed it.

L244 I don't agree. Combining methods does not always lead to more accurate results. Combining a poor method with a good one leads to less accurate results.

- Response: I did not mean it in a general sense, but as in the example. Nevertheless, thanks for pointing this out. I included your reasoning in the ms.

L247 A reference is needed for the IQ test for soils.

- Response: the IQ test for soils is the method that is outlined here for the first time in this paper, so there is no independent reference possible. It is introduced, however, in several places before this point in the text.

L254 . I would avoid literary references that not everybody will get.

- Response: okay, I removed it.

L258 figure 2 needs a significantly fuller caption explaining the different shapes and colours

- Response: I clarified the shapes and colours better, but other than that I am not sure what the reviewer is referring to. Is it clear right that the caption extends beyond the first bold face line (L255-263)?

L265 What does the \* refer to - presumably the figure caption. Incorporate into the caption rather than adding notes like this.

- Response: this was removed and explained in the caption line.