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Interactive comment on "Assessing biogeochemical and human-induced drivers of soil organic carbon to inform restoration activities in Rwanda" *by* Leigh Ann Winowiecki et al.

Anonymous Referee #1

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The authors of this manuscript compiled an interesting dataset to assess "biogeochemical and human-induced drivers of soil organic carbon" (SOC) which might be used to evaluate soil restoration activities in Rwanda. Two districts of Rwanda were sampled in a stratified approach and about 150 samples were taken from topsoils and subsoils of each of the two districts. Various soil and site properties were determined and created maps of SOC contents and extent of soil erosion could be valuable tools to monitor future changes in soil restoration. Despite of this valuable dataset I have concerns to recommend publication of this manuscript. The most important criticism I have is a mismatch between the title, the introduction and the results / discussion of the manuscript. The authors wanted "to understand the extent of land degradation across two key ac-

tion districts in Rwanda". The introduction of the paper is written to meet this motivation including to introduce the most important threat – soil erosion. However, the authors did not introduce the various indicators of soil health and land degradation including interactions between them. The second specific objective ("Understand the drivers of SOC dynamics") was not introduced at all although the title of the study indicates the potential importance of such drivers. In the section "Results" the authors presented the obtained data determined in the laboratory and in the field in a quite broad and general way which makes it very difficult to relate them to the extent of soil degradation and potential restoration activities. Furthermore, biogeochemical drivers of SOC were only discussed in a very superficial way without going into details of the processes and the existing literature. Therefore, the manuscript needs a complete revision / rewriting including a better focus of the paper, e.g. differences in the extent of soil degradation (including possible reasons for the differences) and potential consequences for restoration measures by using the indicators the authors determined. Data might be exploited to find interesting relationships between the determined indicators and to better understand the processes behind them. The controls of soil organic carbon should be an important focus of this data evaluation and interpretation.

In addition to this major criticism, I have further comments, which might be used to rewrite the paper: Title: Please find a title which really describes the main content / main message of your paper

Abstract: In the abstract you gave some interesting data, however, you did not relate the data to differences in soil degradation and their potential to be used for soil restoration measures. I miss a conclusion related to the main objective / title of the paper, i.e. relationships between drivers of soil C and restoration activities. Please use the appropriate format to report 13C ratios

Introduction: Please use the introduction to prepare the main objectives of your study. If you want to keep the focus as intended by the title, the more general parts of the introduction should be shortened substantially.

Methods: I miss details about the soils in your two districts, e.g. soil types, parent material. More details about soil sampling (auger?) and scoring as well as classification of soil erosion are necessary. Please add details about the instruments (EA, IRMS) and the location of the laboratory. The method to analyse soil texture was not described. It is not clear what kind of "full library" you used for calibration and prediction of MIR data (just from your study or more). The approach for soil mapping has to be described as well. This is a central part of the manuscript. It is not sufficient to give just a reference. Although the authors did some statistics, there is no description of the statistical approach. Statistics needs to be incorporated into the results section as well. It is not clear why the authors used both medians and mean values.

Results Often, median or average values of all land uses were given (please see my earlier comment regarding the use of these two parameters). I would prefer a presentation of the differences between the different land use systems as done in Figs. 1, 6. That would allow a better comparison between the two areas and with data from the literature. What is the reason for the higher tree density in one of the districts (120 vs 68 trees per ha)? I do not understand the database for a similar median of 25 trees per ha in the two districts. I would not describe the SOC contents of your soils as low – particularly SOC contents of your subsoils are quite high. Please distinguish between different land uses. You mentioned a high accuracy of your maps but what is the base of this statement? What does a R2=0.82 indicates? Is that the R2 between prediction of the model and measurements done in the framework of this study? Figure 5: change x and y axes Figure 9: database not clear: How was the prediction done and were the predicted values compared with measured values of the study?

Discussion This is a very weak section of the paper. It is not a discussion of your results related to the objectives as drivers of SOC and how they are related to restoration. You might explain and discuss differences in your measured indicators and what do these differences mean for soil health and restoration. Furthermore, you have to discuss these results based on the international literature. You found differences in topsoil

SOC contents between your districts. Discuss possible reasons for that. You might discuss potential effects of soil texture, pH and exchangeable bases on SOC. I would recommend to differentiate between topsoils and subsoils (also in Fig. 5). On the other hand, I would try to use the data of both districts in one regression. Do the effects of clay / sand on SOC depend on land use or on tree density? I would also add some discussion about reasons and consequences of the hotspots of soil erosion and low and high SOC contents. These are just some examples how the discussion might be rewritten.

In conclusion, I recommend major revisions of this manuscript, which means a complete rewriting.

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