SOIL R2

Overall these authors have presented a wide-ranging dataset on Uruguayan soils as they relate to both soil type and land-use type. I commend the authors for this large-scale effort and attempt to present this large and complex dataset. They have drawn some interesting conclusions and comparisons such as the fact that authors posit the movement of surface soils from surrounding grasslands into riverine soils. There is, however, a general lack of clarity. As a reader it is not clearly presented what is being compared, and what are results of native differences to soils due to soil forming factors and ecology, and what is due to anthropogenic influence. For example, forests are discussed, but are any of the forests managed intensively? I think the authors could refocus the writing as well as the data presented on the most relevant comparisons in their opinions. I do believe this is worthy of publication in SOIL, but there are significant issues that need to be addressed, see below.

Reply: Thank you for your time dedicated to review our manuscript. Based on your helpful suggestions we revised the manuscript and hope we presented in the revised version in a better way to enhance clarity what is being compared, what is related to soil forming factors and ecology, and what is due to anthropogenic influence. Timber plantations are managed intensively. Native forests are protected by law in Uruguay. In fact, we would prefer to use the term "forests" mainly for the native forests, which are mostly riverine or gallery forests or to a lesser extent hill and park forests. The later are a transition between the riverine forests and the open savannas. In contrast the Eucalyptus plantations with rotation cycles of 7 to 10 years cannot be compared to planted timber forests in the north that have life cycles over decades and establish as forest like ecosystems. Moreover, our study is limited to the topsoils, whereas soil classification focuses on the whole soil profiles. In regard to soil formation factors, we also checked for spatial autocorrelation (Table S2) and we include the analysis of the different soil classes in Uruguay (e.g. 2.3 and at the beginning of the result section and in the section 3.2). We added the following in the abstract: "The 'soils of the anthropocene' are predominately agricultural. To understand them, we analysed agri- and silvicultural intensification of Uruguayan grasslands in a country wide survey on fertility proxies, pH and trace metals in topsoils originating from different land uses across the whole country. Thus, our results reflect interactions of both the natural diversity of the Uruguayan soil formation and impacts of land use change." The introduction starts with: "Human activities alter the bio- and pedosphere, leaving a footprint of such a magnitude that it can be verified stratigraphically (Waters et al., 2016). This unprecedented transformational force is intimately related to the expansion of societies and its productive frontiers, causing a loss of biodiversity, habitat and soil degradation and, consequently, to ecosystem modification (Foley et al., 2005, Borrelli et al., 2017). In this context, soil sciences have transitioned from studies on natural soil formation to the science of 'anthropedogenesis' (Richter, 2020), focussing on the 'soils of the anthropocene' that are predominately agricultural (51 Million km2) or urban (1.5 Million km2; FAO, 2019)." In addition, we added in the last paragraph of the introduction: "In detail we address the following question: how do fertility proxies such as soil organic carbon and content of nutrients, acidification (pH) and trace metals accumulation in topsoils vary across different land uses (i.e. comparing grassland, timber plantation, native forest, and agricultural land)?"".

Some of the major differences between treatments that authors point out are between forests and grasslands, but the wording of the article makes it seem like the results observed come from human-induced land use changes. Are there not native grasslands in Uruguay that have inherently different characteristics than the forests? It has been observed in many ecosystems that forest soils are the most "healthy" CHECK THIS, so highlighting differences between two natural landscapes (grasslands and forests) doesn't seem necessary here or at least should not be a focus, it should be the difference between soils under heavy anthropogenic influence that should be the

focus (timber plantations, agricultural crops).

Reply: Thank you for this comment, actually the grasslands in Uruguay have been always used and impacted by humans and purely natural grasslands are very scarce. As an example, today within the fenced timber plantations we have grassland plots that are currently without grazing, but have a grazing history in the past. We explain the situation in the description of the study site chapter 2.1 as follows: "Land use change from 1986 to 2017 follows basically three different trajectories: i) the expansion of timber plantations over grassland leading to a disaggregation of grassland by timber plantations; ii) cropland expansion where crop cover maintains the open landscape character of former grasslands, grassland conservation where large and regularly interconnected riverine forests in a landscape dominated by grasslands (Ramírez and Säumel 2021) and grassland intensification changing from natural grassland to so called 'improved' or artificial grasslands (Modernel et al. 2016; Jaurena et al. 2021)."

Abstract:
L17-20 " As an example, the cation exchange capacity was 160 percent higher in
18 native forests compared to grasslands and lowest in timber plantations, reaching only half of
19 the CEC in grasslands acidification of topsoils continues as three fourth of all samples are
20 'extremely acidic' and 'very strongly acidic' and lowest in timber plantations. "

Not clear what you mean by "lowest in timber plantations" do you mean the lowest pH which is more acidic or do you mean the lowest "level of acidity"

Reply: Thank you for this comment, there was a mistake possibly due to a copy paste error in the final document. We are very sorry for this. In order to enhance clarity, we changed this as follows: "As an example, the cation exchange capacity was 160 percent higher in native forests compared to grasslands and lowest in timber plantations, reaching only half of the CEC in grasslands. Acidification of topsoils continues as three fourth of all samples are 'extremely acidic' and 'very strongly acidic'."

L38-39 "Mio." what does this mean?
Reply: we do not use the abbreviation to avoid misunderstanding: Changed to Million.

L73 replace "nutrient" with "nutrients"
Reply: changed accordingly, thank you for your careful revision.

L75-78 run-on sentence and not completely clear to reader, please split it up/reword it.
Reply: We suppose that the comment is related to this sentence, which is now splited into two: "Soil classifications are mainly based on subsoils. However, we focus on topsoil as the most relevant and very responsive interface for ecological processes and farmer's management. Understanding the state of the art of topsoils and its processes is crucial for developing recommendations for sustainable land management practices."

L80-83 "We contribute to a
81 better understanding of globally occurring degradation processes in the field of tension between
82 desired soil productivity, yield limits, especially in erosion sensitive soils, and necessary soil
83 conservation."
This sentence does not make sense to me, please explain what you mean by "field of tension"
Reply: Thank you for this comment. We changed this as follows: "We contribute to a better understanding of globally occurring degradation processes among often conflicting goals such as desired soil productivity, yield limits, especially in erosion sensitive soils, and necessary soil conservation."

L88 not clear how trace metal mobility was measured in this study, trace metal presence was clear

from the methods and results, but not their mobility, or do you mean cation exchange capacity in general?

Reply: Thank you for this comment. We changed this as follows: "Specifically, in order to explore the gains and losses of macro and micro-nutrients and soil organic carbon across landscapes and to determine the impact of land use change on acidification and trace metal presence and related trade-offs with soil degradation and conservation."

L89-94 you begin to make a list with the numeral "(i)" but then make the list as a sentence with commas, either put numerals next to each measured parameter, or leave the numerals out and present the sentence as a list of measured parameters

Reply: Thank you for this comment. We changed this as suggested (without numerals).

L89-94 it would also be useful for the reader to restate the major comparisons made in the study (the varying combinations between grassland, forest plantation, forest, and cropland)

Reply: Changed as suggested: "In detail we address the following question: how do fertility proxies such as soil organic carbon and content of nutrients, acidification (pH) and trace metals accumulation in topsoils vary across different land uses (i.e. comparing grassland, timber plantation, native forest, and agricultural land)?"

Methods:

L 102-105 please specify how many plots and samples of each land use type was collected, assuming they are equally distributed 280 samples/4 treatments = 70 samples in each treatment? So n = 70? And how many plots of each treatment? That is not clear from this sentence. Please also specify the numbers of samples collected in each sub-category. Since there are many different land uses and sub categories, I would suggest putting this information into a table that specifies land use, land use sub category, a brief explanation of that land use, number of plots and samples within each category and sub category, and total number of samples for each category and subcategory that are analyzed statistically. There are many different treatments and sub treatments and as they are written it is hard to understand how many of each were sampled and what was analyzed in each one. While this information is present within Table 1 and Tables A1-A4, it is hard to pick out. Would it be possible to say how many samples were collected in each treatment in a simple table?

Reply: Yes, the sample numbers per treatments are provided in the tables of the appendices, we added this information into Table 1. Unfortunately, we have no equal distribution of samples per land use types as a second shipment did not get the allowance for export and importation. The N for subtypes can be find in the supplements… Fig. S3

L121-123 you state here that the edges of plots were sampled, why not sample in the middle of the field? Edges are typically avoided in soil sampling in order to get a representative sample of a plot, how far from the edge of the plot was sampled?

Reply: The rectangular plots are placed in homogeneous areas of each land use to avoid edge effects. Thus, our sampling was at the virtual edges of our plots but without edge effects. We added the sentence: ". The plots are placed in homogenous areas to avoid edge effects."

L126-127 how big were the pieces taken out? Ones that did not pass the 2mm sieve? Removing organic matter from soil can significantly affect the percentage of organic matter and the C/N ratio

Reply: Yes. This is a normal procedure in soil labs. Soil samples were sieved through a 2-mm mesh screen to remove, roots, and debris prior to analysis.

L128-129 which samples were analyzed for soluble cations and micronutrients?

Reply: We also added this information in Table 1. A detail for the samples analyzed for soluble cations and micronutrients is described in APPENDIX A, in Tables A1 and A2.

L133-135 which methods, specifically, were used to determine carbonate and SOC content?

Reply: We added the methods in line 130f. as follows: "We analysed 280 samples regarding macronutrients, pH and trace metals and 80 samples for soluble cations and micronutrients (Table 1; Sadzawka et al. 2006; Zagal & Sadzawka 2007)."

L136-139 include superscript charges for each ion
Reply: done as suggested

L182-186 were any outliers removed, or were they only identified? If any were removed you might add that justification based on experimental conditions in your supplemental material.
Reply: This information can be found in Fig.S2 and added the main text line 190ff. as follows: "We tested for outliers using the 1.5-3 IQR threshold and the function* outlierTest *from the R package* car *(Fox and Weisberg 2019), reviewing the flagged observations case by case in the experimental context. The outliers were removed (Supplementary Material: Fig.S2)."

L195 is there a reference for Benjamini and Hochberg?
Reply: Added.

Results
L214-222 - you rank the highest and lowest values in addition to the mean, but there are not statistical results presented in any of the referred tables (Table 1, A1-A2) here please include what is statistically significant.
Reply: in this part we only describe the general ranges values. Significant differences between land use types are shown in Figure 4-5, 6 and described in the next sections.

Figures:
General: make fonts larger, hard to read
1a - numbers inside of pie charts are hard to read - increase font size of pie chart numbers
Reply: We re-arranged the Figure 1 to enhance readability

1d - not clear what the CONEAT numbers are referring to, and what do the letters next to numbers mean in the legend? I see you describe these around L 167 but having a short description in this caption to help the reader remember would be helpful
Reply: we added a short explanation here and refer to the main text as follows: "The Uruguayan CONEAT index provides a detailed classification that takes into account soil type, texture, natural vegetation, altitude and geology (see details in chapter 2.3)."
In the Chapter 2.3: this is explained in detail: "We intersected the coordinates of the centre of the plots with maps containing geospatial information on the classification of the Uruguayan soils using ArcGIS 10.3 (ESRI, 2018). For Soil Groups classification, we used the of the World Reference Base for Soil Resources (WRB; IUSS Working Group, 2015); for Soil Orders, the USDA soil taxonomy (Soil Survey Staff, 1999); and for the local Uruguayan classification, Soil CONEAT (Comisión Nacional de Estudio Agronómico de la Tierra) Groups categories, which include productive capacity of cattle and sheep (MGAP, 2020). The CONEAT groups are defined by their productive capacity in terms of beef, sheep and wool expressed by an index relative to the average productive capacity of the country, to which the index 100 corresponds. The classification is based on photo-interpretation at a scale of 1:40,000, field verifications and physico-chemical analysis of the soils. The productivity indices correspond to soil groups. The CONEAT groups have been defined by the dominant and associated soils according to the Soil Classification of Uruguay. The groups are related to the units of the Soil Reconnaissance Chart of Uruguay at a scale of 1:1,000,000. For each group, some important soil properties and associated landscape characteristics are indicated. The nomenclature of the CONEAT groups correlates with the Soil Use and Management Zones of Uruguay. The Soil Groups are superimposed on the rural parcel and

are represented in the CONEAT cartography at a scale of 1:20,000 (for more details see MGAP, 2020).”

Figure 2:
The caption leads reader to believe that there are three subfigures (alb, c) but this is a single figure, can you clarify if there are supposed to be additional figures here? It appears the information you state is there, but this is a formatting issue.

Reply: Sorry, we changed the Figure accordingly adding the missing (a), (b) and (c).

"Colour intensity and the size of the circle are
741 proportional to the correlation coefficients (ρ)" The size and the color of circles is proportional to correlation coefficients? The smallest circles are all blue, but the orange circles are lower (read - negative) this is not worded clearly, please be specific about what the size and color represent. Perhaps you mean the size of the circle refers to the absolute value of the correlation coefficient and the color refers to the direction (positive or negative) of the correlation.

Also a comment on methods: Fig.3 what do the colored circles and oblong shapes represent? A certain statistical threshold?

Reply: Thank you, we changed this accordingly.