**Authors' Responses to Reviewer 1**

We thank the reviewer for the constructive comments. In the table below, we provide a point-by-point response to each comment.

| Revier 1 comment | Authors' response |
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| **Major comments:**<br>1. Section 2.1 states that three plots were established within each land-use condition, whereas Section 2.5 and all figure captions report four replicates per combination. Please reconcile this discrepancy and specify exactly what each replicate represents. Report the number of independent sites, plots, soil sampling points, composite samples, and laboratory replicates for each hotspot × land-use combination. Explain how samples were collected within the central sampling area, whether they were composited, and whether any samples were pooled across plots.<br>Please clarify whether the plots were distributed across independently selected areas or located within a single area for each land-use category. The analysis should account for any nested sampling structure, and limitations arising from a single area per land-use category should be acknowledged. | We have revised Section 2.1 (lines 131–141) to clarify the sampling design and reconcile the discrepancy in the number of replicates. Four independent plots (50 × 50 m) were established for each combination of desertification hotspot and land-use condition. Within each plot, a central sampling area (40 × 40 m) was delimited to minimize edge effects. Three soil subsamples were collected at a depth of 0–10 cm and homogenized to obtain one composite sample per plot. No samples were pooled across plots. Thus, each hotspot × land-use combination comprised four plots, 12 soil sampling points, and four independent composite samples, resulting in 48 plots, 144 sampling points, and 48 composite samples across the study. Each composite sample represented one replicate in the statistical analysis. Section 2.5 (lines 186–192) and all figure captions consistently report four replicates per combination ($n$ = 4). |
| 2. The restoration ages, practices, vegetation composition, and previous management are insufficiently described, and the soil classes identified through profile classification are not reported. Please provide a site-characterization table including coordinates, soil classes, landscape positions, vegetation cover, degradation and management history, restoration ages and practices, and known fertilization or liming history.<br>This information is particularly important in Piauí, where forest and restoration areas differ markedly in texture and pH, limiting their comparability. Please explain the site-selection criteria and how comparability among land-use categories was assessed. | We have revised Section 2.1 and added Supplementary Table S1, detailing soil classification, vegetation, degradation history, restoration practices and initiation years, and fertilization history. We have also revised Section 4.1 to discuss soil heterogeneity, particularly the differences in texture and pH in Piauí, and their implications for comparisons among land-use conditions. |
| 3. The study compares current soil conditions across different areas and does not document changes through time. Therefore, claims about recovery trajectories, restoration-induced improvements, or responses preceding TOC recovery should be moderated. Unless additional evidence is available, present the findings as differences associated with the sampled land-use | We have revised the Abstract, Discussion, and Conclusions to avoid causal interpretations and unsupported claims about restoration trajectories. The findings are now presented as differences associated with the sampled land-use conditions rather than demonstrated effects of restoration over time. |

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| categories rather than demonstrated effects or stages of restoration. Revise the abstract, discussion, and conclusions accordingly. | |
| 4. Please verify the unit conversions and effective CEC calculations in Figures 4 and 5. K is expressed in cmolc $dm^{-3}$, whereas Ca, Mg, and CEC are expressed in mmolc $dm^{-3}$. For the forest area in Paraíba, the approximate plotted means are Ca ≈ 12, Mg ≈ 2.3, and K ≈ 8 mmolc $dm^{-3}$ after conversion. Their sum is approximately 22 mmolc $dm^{-3}$, exceeding the effective CEC of approximately 17-18 mmolc $dm^{-3}$ in Figure 5, even before adding Al.<br>These values are estimated from the figures. Please provide the exact underlying concentrations, including exchangeable Al, and demonstrate how effective CEC was calculated after unit conversion. Correct any calculation or axis-label errors and repeat the relevant analyses if necessary. Use "effective CEC" consistently throughout the manuscript. | We have verified the CEC calculations and clarified that the values presented in Figure 5 correspond to potential CEC (T) rather than effective CEC (t). The inconsistency resulted from an incorrect description of the CEC calculation in the manuscript. Potential CEC was calculated as the sum of exchangeable bases ($Ca^{2+}$, $Mg^{2+}$, and $K^{+}$) and potential acidity (H + Al), rather than exchangeable $Al^{3+}$ alone. We have corrected the equation in Section 2.3 and revised the terminology throughout the manuscript, including the Results, Discussion, and Figure 5 caption, to consistently identify the variable as potential CEC. Additionally, we identified minor errors in the units reported for $Ca^{2+}$, $Mg^{2+}$, and CEC. We sincerely apologize for these errors and have corrected the units in the corresponding figures and throughout the manuscript. |
| 5. Please clarify the carbon-fractionation procedure in Section 2.4, particularly the NaOH extraction volume and whether extraction was repeated. Indicate any modifications to the cited Benites et al. procedure and provide a reference for the wet-oxidation method.<br>Based on approximate values read from Figure 3, (FAC + HAC + HC)/TOC is about 49% in the Ceará forest area and 33% in the Paraíba degraded area. Please check these estimates against the underlying data and explain the differences between the summed carbon fractions and TOC, as this would help readers interpret the fractionation results. | We have revised Section 2.4 to clarify the carbon-fractionation procedure, specifying that 1.0 g of soil was extracted with 10 mL of 0.1 mol $L^{-1}$ NaOH for 24 h. We have also included Yeomans and Bremner as the reference for the wet-oxidation method. Regarding the differences between the sum of the carbon fractions (FAC + HAC + HC) and TOC, these fractions are operationally defined by the chemical fractionation procedure. Their sum may differ from TOC because of methodological differences in carbon extraction, separation, and quantification. We have clarified this distinction in the revised manuscript to facilitate interpretation of the results. |
| 6. The manuscript reports a significant hotspot × land-use interaction for every variable, but the corresponding ANOVA results are not provided. Please add a summary table reporting the degrees of freedom, test statistics, and p-values for both main effects and their interaction for each variable. Please also briefly describe the statistical model and how the Tukey comparisons shown in the figures were performed. It would be helpful to summarize the results of the | We have included Supplementary Table S2 with the ANOVA results, coefficients of variation, and diagnostic tests necessary for interpreting the findings. Section 2.5 has also been revised to clarify the statistical procedures. |

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| normality and variance-homogeneity checks and indicate whether any data transformations were used (Section 2.5). | |
| 7. In Section 4.2, please discuss carbon stabilization and persistence more cautiously, consistent with the limitations acknowledged in the Introduction. Higher HAC or HC indicates differences in operationally defined carbon fractions, but does not directly demonstrate greater stabilization or persistence. These mechanisms could be presented as possible explanations for the observed patterns.<br>Please also use "carbon concentrations" when referring to the measured results, as carbon stocks were not calculated. | Section 4.2 has been revised to clarify that differences in operationally defined carbon fractions do not directly demonstrate carbon stabilization or persistence. Potential mechanisms are now discussed cautiously, and the terminology has been standardized to refer to carbon concentrations rather than carbon stocks. |
| 8. In Sections 3.4 and 4.3, it would be helpful to briefly discuss the suitability and limitations of Mehlich-1 across the contrasting soil conditions. Where appropriate, describe the measured values as Mehlich-1-extractable P. Previous fertilization could explain the high P concentrations in some restoration areas, but this should remain a possible explanation unless supported by management records. | Sections 3.4 and 4.3 have been revised to clarify the suitability and limitations of the Mehlich-1 method under contrasting soil conditions. Phosphorus values are now referred to as Mehlich-1-extractable P, and previous fertilization is discussed only as a possible explanation for the higher concentrations observed in some restoration areas. |
| **Minor comments:**<br>1. Please add the Piauí results to the description of effective CEC in Section 3.4, as these represent the largest contrast in Figure 5.<br><br>2. Please clarify what is meant by "privacy restrictions" in the Data Availability Statement.<br><br>3. Please address the following minor editorial issues:<br>• Line 333: Please replace "base cátions" with "base cations."<br>• Line 405: Please replace "136% Higher" with "136% higher."<br>• Abbreviations table below line 544: Please replace "Exchange capacity" with "Cation exchange capacity" for CEC.<br>• Lines 688–689: Please remove the empty reference entry 65 and the placeholder reference entry 66. | All minor comments have been addressed, and the corresponding corrections have been incorporated into the revised manuscript. |