

Title: The impact of agriculture on tropical mountain soils in the western Peruvian Andes: a pedo-geoarchaeological study of terrace agricultural systems in the Laramate region (14.5°S)

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MS type: Original research article

The Manuscript contains new information; the Title corresponds to the content. The introduction reflects the content of the problem in the substantiation of the work, the literature reflects the world level of the study of the problem. The methods are described quite fully.

The Manuscript can be recommended for publication after some revision.

GENERAL COMMENTS

The authors obtained important conclusions: Examining soil quality indicators of terrace soils reveals no significant signs of severe degradation, even with long-term use. The final abandonment of the cultivation system is not attributed to soil exhaustion or terrace structural instability.

The reviewer believes that in conclusion, the Authors could make a breakthrough if they separated relict, agrogenically determined responses, and recent postagrogenic properties.

In contrast to the numerous processes that are united by the phrase “agricultural soil degradation”, and for which there is a Mont Blanc of scientific facts, progressive Agropedogenesis, called progradation, is sometimes noted.

A comparison of Agrosols that differ in the duration of agricultural load with the supposed alternation of land use practices (including those that, to one degree or another, contained agrotechnical components of a soil-saving orientation, and not always consciously applied), makes it possible to establish inherited signs of progradation. Moreover, their contradictory nature may have features of pseudo-progress [Lisetskii F.N. Agrogenic transformation of soils in the dry steppe zone under the impact of antique and recent land management practices // Eurasian Soil Science. 2008. Vol. 41. No. 8. P. 805–817.]

Specific Comments:

Keywords. phytolith analysis. The reviewer draws the attention of the Authors to the fact that in the corporate community of scientists of this profile, the term phytolith is considered obsolete (due to the fact that it is narrowed), and the normative term is biomorphs.

Abstract. The reviewer does not believe that the logic of this important component of the Article is ideal. For example, should I write in detail about three WRB Reference Soil Groups?

Abstract must be formatted according to international standards and include the following points.

Introductory speech about the research topic.

Purpose of scientific research.

Description of the scientific and practical significance of the work.

Description of the research methodology.

Main results, conclusions of the research work.

The value of the research conducted (what contribution this work made to the relevant field of knowledge).

The final part of the Introduction section also does not formulate the purpose of the study, but rather a list of what will be done. **[But in the Conclusion section the reader finally learns about the purpose of the study].**

1 Introduction.

a) Given the fact that terrace agriculture was widely practiced in ancient times in the foothills and mountains of various regions of the world, it would be good to provide a global context in the introductory paragraph without limiting it to the Andes. As a hint, you can indicate specialized studies of ancient terraces lands (The Negev Highlands, Israel) or (Eastern Caucasus), etc.

Stavi, I., Eldad, S., Xu, C., Xu, Z., Gusarov, Y., Haiman, M., & Argaman, E. (2024). Ancient agricultural terrace walls control floods and regulate the distribution of *Asphodelus ramosus* geophytes in the Israeli arid Negev. *Catena*, 234, 107588.

Sapir, T., Mor-Mussery, A., Abu-Glion, H., Sariy, G., & Zaady, E. (2023). Reclamation of ancient agricultural terraces in the Negev Highlands; soil, archeological, hydrological, and topographical perspectives. *Land Degradation & Development*, 34(5), 1337-1351.

Borisov, A. V., Kashirskaya, N. N., El'tsov, M. V., Pinskoy, V. N., Plekhanova, L. N., & Idrisov, I. A. (2021). Soils of ancient agricultural terraces of the Eastern Caucasus. *Eurasian Soil Science*, 54(5), 665-679.

b)The authors of the text Article actively (14 times) use the works of Sandor, J. A. and Eash, N. S. This is scientifically correct, because the pioneering contribution of one of these scientists to the development of this topic is significant. **Jonathan A. Sandor (Department of Agronomy, Iowa State University, Ames, Iowa, USA)**

However, the Reviewer would like to point out that both works in References are from 1995, and the key author has more recent Articles.

Eash, N. S. and Sandor, J. A.: Soil chronosequence and geomorphology in a semi-arid valley in the Andes of southern Peru, *Geoderma*, 65, 59–79, [https://doi.org/10.1016/0016-7061\(94\)00025-6](https://doi.org/10.1016/0016-7061(94)00025-6), 1995.

Sandor, J. A. and Eash, N. S.: Ancient Agricultural Soils in the Andes of Southern Peru, *Soil Science Society of America Journal*, 59, 170–179, <https://doi.org/10.2136/sssaj1995.03615995005900010026x>, 1995.

In this regard, the Reviewer believes that in addition to priority works, one cannot ignore the most generalizing previous research of the Author (J. A. Sandor) and the large Chapter 2006, as well as the most recent Article on ancient terraces lands in the Chile region.

Sandor, J. A. (2006). Ancient agricultural terraces and soils. In (Ed.) Warkentin, B. P., *Footprints in the soil: People and ideas in soil history* (pp. 505–534). Elsevier

Sandor, J. A., Huckleberry, G., Hayashida, F. M., Parcero-Oubiña, C., Salazar, D., Troncoso, A., & Ferro-Vázquez, C. (2022). Soils in ancient irrigated agricultural terraces in the Atacama Desert, Chile. *Geoarchaeology*, 37(1), 96-119.

L 105-106: «The altitude of the mountainous region ranges from 2000 m to 4200 m asl.». This amplitude is of a “background” informational nature, while the reader, if he looks at the three lower insets of Figure 1, then they all reflect valley-river landscapes, which obviously have a significantly lower altitude, which, if indicated, are more useful for understanding geomorphology of study sites.

It is strange that the Authors, speaking about landscapes where there were terraces, limited themselves to section 2.2 Geology. The reviewer believes that this block needs a Relief (Topography) section, where a full-fledged geomorphological analysis is very important: with a range of heights, where there are terraces, slopes, exposure, shape of slopes, etc.

The historical-agrarian section is missing; what agricultural technologies were used in the past? (depth of processing, crops, etc.). For example, Table 2: 50-70 cm = 1 grain Zea Mays. Why at such a depth? Is this the result of formation turnover? [L 856: «terric horizons with a total thickness of 50 cm»].

With the indicated phase of aridization and the emergence of river valleys, did the contribution of irrigation manifest itself in the transformation of the agricultural system?

Figure 5. Between 0 and 85 cm I would like to see the depth values at the boundaries of the horizons.

L 195. Anthrosols. This most important component of the study is described very sparingly. The reviewer believes that it is important to show that there is a dual nature of Soils of ancient agricultural terraces, on the one hand, as cultural soils that are formed as a result of Agropedogenesis [Kuzyakov, Y., & Zamanian, K. (2019), and on the other hand, these are postagrogenic soils with inherited characteristics from their prehistory.

Kuzyakov, Y., & Zamanian, K. (2019). Reviews and syntheses: Agropedogenesis—Humankind as the sixth soil-forming factor and attractors of agricultural soil degradation. *Biogeosciences*, 16(24), 4783–4803. <https://doi.org/10.5194/bg-16-4783-2019>

L 265. Above The authors have used WRB many times and a reference to it earlier would have been more appropriate. And so this is a repetition of what has already been used.

L 284: Mg²⁺, Kalium (K⁺), Calcium (Ca²⁺). All valences must be given in uppercase Mg²⁺...

5.2.2 Soil acidity, nutrient availability and soil quality. The application in the section on soil quality characteristics was not implemented (an integral assessment was not obtained based on the available indicators of potential fertility).

References.

When comparing 1260 and 1265 onwards: why is the Title Article given either in capital or in lowercase letters?

Supplementary. SuppFig1 (b). The reviewer stubbornly does not see the boundary of the transition to the AC horizon.

Pe10- 30/3	Ah	35-65	10 YR 2/3
Pe10- 30/4	AC	65- 100	10 YR 2/3

Look, you have an OM of 2.2% and below 2.2%, Munsell color = the same, so the photo objectively shows that there was a clear error in determining the boundary. Perhaps this is a buried humus layer. (Very bad photo? Crooked ruler, half of the profile in the shadow).

Supplementary Table S1: Pedochemical analysis.

Why are commas used and not periods as separators for numbers?

[cmolc Ca²⁺/kg]. Hereinafter, valences must be in upper case (Excel will allow you to do this). Ca²⁺

The authors show Munsell color (moist). This is “field” humidity, which will change color at different sites and at different Depths. In this regard, comparability can be maintained by giving Munsell color (dry). The reviewer recommends that the authors, if such data are available, provide a replacement.

The authors create confusion with the designation of carbon: C [%]; Corg, Ctot/N (Compare to L 290: «The carbon/nitrogen (C/N) ratios»).

What is the difference between C and Corg, and where does Ctot suddenly appear? (the C and Corg data differ slightly, is this due to different determination methods?). The text indicates DIN 19684-2, 1977 and CNS analyzer vario MAX (and if the values turned out to be close, what does this add scientifically?)

Typically, the ratio Ctot/N is the same as Corg/N, and more elegant (by default, they write C:N, rounded to whole numbers (under a well-known rating scale).

If in the 1st line OM = 2.1*0.579=1.216 Corg, but not 1.0. It is necessary to clarify how the transition from OM to Corg was made (and in principle, Corg alone (without OM) would be enough).