

Barcelona, 17/07/2023

Dear Dr. Loftus,

Please, find attached our responses to the reviewers' comments (in italics following each comment). I hope you will find these, and the changes made to the manuscript, satisfactory.

Looking forward to hearing from you.

Best regards,

Abel Ruiz-Giralt

(on behalf of all co-authors)

Review by Tanya Hattingh, 24 May 2023 20:48

### Summary of work and overall impressions

This article highlights the problems archaeologists face when trying to trace the origins and spread of agriculture. It gives a clear and concise overview of the Aksumite period and gives valuable information about the subsistence strategies used by Aksumite communities. It also gives information on the environmental changes that occurred prior to and during the sites' occupation. This article explores the use of models which can accurately predict the areas and extent of finger millet and sorghum cultivation at Aksumite sites in the horn of Africa. These models were developed using data from various sources, for example ethnographic fieldwork and literature on modern day farming practices, as well as published GIS environmental data. The authors show the accuracy of the models used for the study and shares new information on factors that influence where crops were cultivated. Phytolith analysis is used to give information about which crops may have been cultivated, as well as give information about whether or not irrigation was used by Aksumite communities. Overall I find this article to be well written, with simplistic language that makes it easy to read and understand. The goals of the article are clear. The authors are well informed on current literature and methods, and the data is well presented and discussed.

### These items need attention:

- Abstract-Include Scientific names for Sorghum and Finger millet

*Scientific names included in the abstract.*

- Line 52 and 53- Add e.g. before list of references.

*Added.*

- Suggestion- Add a map showing the location of study area in Africa (for people unfamiliar with African geography). Alternatively add an inset in Figure 2 showing the location of the study area within Africa.

*We have included an inset of the African continent in figure 2.*

- Line 122- Define masl for people unfamiliar with the term.
- Line 134- Replace "the" with "a".
- Line 135- Replace "Whereas" with a more appropriate word.

*Fixed.*

- Line 220- "Larger buildings". Please rephrase for clarity.

*We have removed the word "larger". Line 220 now reads: "The site has buildings with stepped wall construction and ceremonial pottery that suggest the presence of elite residences".*

- Line 245- “De” should not be capitalized. Check throughout article. It’s capitalized in some places and not capitalized in others.

*Fixed.*

- Line 250- Define casual, extensive and intensive agriculture for clarity.

*Table 1 has been added with definitions for casual, extensive, intensive agriculture, as well as rainfed, décrue (floodplain) and irrigated agriculture.*

- Line 267- Fix spelling of Nenzen.

*Fixed.*

- Line 337- Define topsoil.

*The data on the specific deepness of topsoil and subsoil as according to the authors of the environmental datasets used in this study have been provided in the text.*

- Line 388- Explain why length of growth cycle was used as a significant variable for SB but not FM.

*A note was added in the caption of Table 3, explaining that it was not included because the variable was not found to be statistically significant by the models. In any case, the variables that were identified by forward selection in each model are presented in lines 342-347.*

- Suggestion- Define terms extensive rainfed and intensive rainfed. It is unclear what the difference is between the two.

*Table 1 was included with the definition of each type of agriculture. Extensive-Rainfed, and Intensive-Rainfed, represent combinations of those. We consider that the difference is evident after having included Table 1.*

- References- The referencing needs extensive work. Breton 2018; D’Andrea et al. 2008; Harrower et al. 2019; Lucarini et al. 2016; Gonzalez-Rabanal et al. 2022 are included in text, but not in the reference list.
- Several sources are included in the reference list, but not in text. This includes Cantor et al. 1999; Fick and Hijmans 2017; Lancelotti et al. 2019; Oliver 1980; Manel et al. 2001; Shangguan et al. 2014 and Young and Thompson 1993.
- Other referencing issues- De Contenson is referenced as Contenson, H.de. Hagos et al. is referenced as 2021 in the reference list, but 2019 in text. Vavilov is referenced as 1925 and in the reference list it is referenced as 1926.

*The reference section was completely redone, with special attention to those issues raised by reviewers 1 and 2.*

## Review by anonymous reviewer 1, 12 Jul 2023 09:24

I read Ruiz-Giralt et al.'s work with much pleasure. It is a well-written and comprehensive paper, also respectful of the work already done in this area of extraordinary environmental interest. According to an original methodology, the authors have skillfully declined cross-cultural modelling, ethnoarchaeology and phytolith analysis to propose and test hypotheses about past agricultural practices, mainly focused on finger millet and sorghum agriculture, in the northern Horn of Africa region during the Aksumite Kingdom. They produce an excellent paper highly relevant to Aksumite archaeology that will be much cited in the future. The text is well written, the methodology is well presented, and the results are of great interest, also given the poor environmental data available for this region and chronology that luckily are expanding considerably in recent years. The structure of the paper (Introduction, Study area, Study case, Materials and methods, Results, Discussion, and Concluding remarks) is formally correct. The figures and tables are correct, as well as the Supplementary materials. I suggest revising the list of references and some inline references.

The following inline references are missing in the reference list at the end of the paper:

- line 77: Lucarini et al. 2016
- line 154: D'Andrea et al. 2008
- line 171: Breton 2018;
- lines 172-173: Schmidt et al. 2008b
- line 281: Harrower et al. 2019
- González-Rabanal et al. 2022

*Fixed.*

The following papers are listed in the reference list at the end but their inline references are missing:

- Cantor, S.B., Sun, C.C., Tortolero-Luna, G., Richards-Kortum, R., Follen, M., 1999. A Comparison of C/B Ratios from Studies Using Receiver Operating Characteristic Curve Analysis. *Journal of Clinical Epidemiology* 52, 885–892. [https://doi.org/10.1016/S0895-4356\(99\)00075-X](https://doi.org/10.1016/S0895-4356(99)00075-X)
- Fick, S.E., Hijmans, R.J., 2017. WorldClim 2: new 1-km spatial resolution climate surfaces for global land areas. *Int. J. Climatol* 37, 4302–4315. <https://doi.org/10.1002/joc.5086>
- Lancelotti, C., Biagetti, S., Zerboni, A., Usai, D., Madella, M., 2019. The archaeology and ethnoarchaeology of rain-fed cultivation in arid and hyper-arid North Africa. *Antiquity* 93, 1026–1039. <https://doi.org/10.15184/aqy.2019.109>
- Manel, S., Williams, H.C., Ormerod, S.J., 2001. Evaluating presence-absence models in ecology: the need to account for prevalence: Presence-absence

modelling. *Journal of Applied Ecology* 38, 921–931.  
<https://doi.org/10.1046/j.1365-2664.2001.00647.x>

- Oliver, J.E., 1980. Monthly Precipitation Distribution: A Comparative Index. *The Professional Geographer* 32, 300–309. <https://doi.org/10.1111/j.0033-0124.1980.00300.x>

- Shangguan, W., Dai, Y., Duan, Q., Liu, B., Yuan, H., 2014. A global soil data set for earth system modeling. *Journal of Advances in Modeling Earth Systems* 6, 249–263. <https://doi.org/10.1002/2013MS000293>

*Fixed.*

If the cited papers have to be listed in alphabetical order and from the more recent to the older in the reference list at the end, as it seems to me, you should move:

- Schimdt, P.R., Curtis, M.C., Teka, Z., 2008. *The Archaeology of Ancient Eritrea*. The Red Sea Press, Asmara.

after

- Schmidt, P.R., 2009. Variability in Eritrea and the Archaeology of the Northern Horn During the First Millennium BC: Subsistence, Ritual, and Gold Production. *Afr Archaeol Rev* 26, 305– 325. <https://doi.org/10.1007/s10437-009-9061-5>

*Fixed.*

Some typos are present:

- Line 52: (Vavilov 1925) is “Vavilov, N.I., 1926. Studies on the origin of cultivated plants. *Bulletin of Applied Botany and Plant Breeding, Leningrad.*” in the reference list;

- Line 56: (Winchell et al. 2018) is Winchell, F., Stevens, C.J., Murphy, C., Champion, L., Fuller, DorianQ., 2017. in the reference list;

- Line 120: (Hagos et al. 2019) is “Hagos, H., Abrha, H., Hadgu, M., 2021. Agroclimatic zonation of Tigray region of Ethiopia based on aridity index and traditional agro-climatic zones. *J. Agrometeorol.* 21, 176–181. <https://doi.org/10.54386/jam.v21i2.229>”, in the reference list

- (R Core Team 2022) is “R Core Team, 2021. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria”. in the reference list.

- Line 132 Tierney and de Menocal in 2013. Erase “in”

- Line 195: According to Sulas (2009, 2014). Is the first (et al. 2009)?

- Vavilov, N.I., 1951. The Origin, Variation, Immunity and Breeding of Cultivated Plants. *Chronica Botanica* 13, 1–366. <https://doi.org/10.2134/agronj1952.00021962004400020016x> I think you can erase the doi, it links to a review of the work of Vavilov.

*Fixed.*

Please revise these. Some other useful references should be added:

- D’Andrea et al. 2011, Stable isotopic analysis of human and animal diets from two pre-Aksumite/Proto-Aksumite archaeological sites in northern Ethiopia. *Journal of Archaeological Science* 38 (2011) 367e374.

*This reference was added in the introduction to highlight the importance of C4 plants in local diet since the 1<sup>st</sup> millennium BCE despite the absence of macrobotanical remains of grasses associated to this group (lines 66-68)*

- Delle Donne 2021, Cereal ears on Aksumite coins: Reflections between numismatics and archaeobotany. *Rassegna di Studi Etiopici*, 3° serie, 5 (LII): 269-311.

*This reference was added to the list of references describing the Aksumite agricultural package (line 191).*

In my opinion this paper can be published, provided the author solves the formal problems in the inline references and the References at the end.

*The entire reference section was redone, paying special attention to the issues raised by reviewers 1 and 2.*

*Besides all these modifications, some changes were added to fix a number of typos and small mistakes throughout the text. A tracked-changes copy of the paper is included to show all the changes with respect to the original submission.*