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Interactive comment on "Origin, distribution, and characteristics of Archaeological Dark Earth soils – A review" *by* Michael O. Asare et al.

Anonymous Referee #2

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This manuscript sets out to present a review of anthropogenic dark earths in a global perspective. It aims to make generalisations about an archaeological phenomenon, and summarize different dark earths' evolution, distribution, physico-chemical properties, as well as to propose further directions for future research. The presentation and language of the paper are good, however, the remaining two principal review criteria have not been attained. The scientific quality in particular is severely lacking.

While the basic premise of this manuscript could be promising if executed in a systematic manner that takes all the existing archaeological and pedological information into consideration, this is unfortunately not the case. The literature review on which this paper is based is in its own right insufficient to such a degree that it would have to be completely re-executed in order to be of acceptable quality. It contains considerable

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omissions and errors, meaning that its acceptance for publication would be misleading and pose a risk for subsequent scholarship, as researchers unfamiliar with this topic would be considerably misinformed. Thus, I am afraid I must advise to reject this manuscript.

Several key concepts in dark earth studies are omitted or misrepresented, and the manuscript contains significant scientific errors. The authors have failed to engage with the large, existing body of literature, and misrepresent some of the cited data. Concerning European Dark Earths, most of what is written is either based on outdated information, cites authors incorrectly, or is factually incorrect. Important sites have been disregarded. In the case of Europe, only three (!) sites are used for the discussion, while well over 40 can easily be found in published work, not including excavation reports or grey literature. This is partly true for the Amazonian dark earths as well, for instance, recent work on Belize is disregarded. Finally, the sites' evolution nor distribution is correctly represented.

Anecdotal evidence is used to justify incorrect blanket statements. In addition, for several of the archaeological cases, descriptions are confused with interpretation. The term "dark earth" has for the past ten years been used as a descriptive rather than interpretative term, and the statement that "All types of ADE developed as a result of deliberate and/or unintentional deposition of domestic/occupational wastes, charred residues, bones, shells, and biomass ashes from prehistoric up to recent times" is extremely problematic and misleading. For European dark earths in particular, it is well established that many different types of activities, in combination with post-depositional processes, can lead to the formation of dark earths. The ever-growing body of scholarship explicitly contradicts the statement that dark earths are the result of a uniform set of depositional and post-depositional processes, and instead demonstrates that every dark earth must be studied individually to capture their high degree of variability, within their specific archaeological and societal context. As such, it is nonsensical to attempt to establish one set, or even a trend, of physico-chemical properties to characterise

ADE, at least in the case of European dark earths, beyond their descriptive criteria. Also from an archaeological point of view, this manuscript contains major flaws.

A few specific points:

- anthropogenic deposits with a clear interpretation, such as shell middens, should not be included in a review on ADE

- a few recent key works on dark earths have been cited (e.g. Devos et al., Nicosia et al., Arroyo-Kalin et al.), however, next to none of the works cited in these articles, nor other seminal papers on the topic, have been consulted. This manuscript shows a worrying lack of insight into the recent scholarship and research questions regarding European dark earths, and the small number of recent and past references is extremely problematic, especially for a manuscript that claims to be a review article. For instance, the complex and varied formation trajectories, including anthropogenic and natural formation processes, of European dark earths are disregarded, while authors in the field have focused on these for decades.

- examples of anecdotal evidence misrepresented and generalised can be found e.g. in lines 267-274: this division is highly specific for the site(s) in question and may by no means be generalised to dark earths as a phenomenon. This is extremely misleading. As such, table 1 is obsolete; lines 283-288 are only valid for very specific dark earths that have formed in Ca-rich contexts, they can by no means be extrapolated to other European contexts, such as for instance more acidic, sandy soils. The presence of brick and mortar, for instance, is also highly site- and period specific. It is clear that the authors have selected only a very small number of studies on the basis of which generalisations are made. However, these generalisations are invalid, not even taking into account the small number of cases they are based on. Lines 297-298: “A pH value ranging from 6.6 to 8.2 has been reported in EDE by Courty et al. (1989) and Nicosia et al. (2012)”: these are two publications, when there are dozens to be taken into account. Furthermore, the significance of this information is not made clear.

- the study lacks a systematic literature review, preferably presented as a table per geographic region, citing all relevant work that has been conducted. In addition, no systematic review (as a table, map, or in other form) of the specific sites where dark earths have been encountered has been included, which in my opinion counts as a major flaw in a review manuscript. Their spatial variation within Europe, but also within specific towns, is ignored. Hence, the discussion and conclusions are by default invalid.

- no insight in archaeological interpretations, implications or research questions is presented in the text, which seems like a major omission in a manuscript discussing an archaeological phenomenon. For instance, lines 299-304 make no archaeological sense. Several such instances occur.

- the paper fails to demonstrate the relevance of a discussion focusing only on (the highly variable!) physico-chemical properties of ADE. In the least, one would expect a discussion of the methodological frameworks used to study different types of dark earths, and how this has an impact on the type of data collected, and the interpretations reached. In general, the significance of focusing on dark earths' physico-chemical properties is not made clear in relation to archaeological relevance.

- Figure 1 and tables 1 and 2 are problematic. The map presented in figure 1 is not sufficient, and should at the very least also include a more detailed overview for each geographic region that is discussed. Many important sites are missing, or cannot be discerned due to the map's scale. The sites on the map are unnumbered and unlabelled. Table 1 is based on a single site and cannot be extrapolated at all, this this division is highly specific for the site(s) in question and may by no means be generalised to dark earths as a phenomenon. As such, the table is completely obsolete. Table 2 presents 3 sites used for the discussion of European dark earths, while many dozens exist. This is unacceptable for a review article.

- the conclusions are incorrect considering the fact the acquisition and review of the data is highly incomplete and anecdotal. Also, the meaning and implications of the

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statement “The principles leading to the physicochemical formation of ADEs are similar except for certain human activities peculiar to the cultural setting of the regions where ADEs are formed.” are not made clear. “ADEs have higher C, N, P, Ca, Mn, Cu, Zn, Mn, Mg, Fe, Sr, and Ba content than surrounding soils.” – this is only applicable to a select number of cases and can by no means be generalised.

To conclude, this manuscript poses a missed opportunity, since a proper review paper addressing dark earths on a global scale, taking into account their nuances and variation does indeed have potential (with the remark that the inclusion of kitchen middens in this category seems misplaced). However, it would require a truly systematic review including all available literature per region, rather than basing conclusions on a small fraction of the existing data. In its current form, the paper contains a flawed attempt at review, without presenting any novel concepts, ideas, tools, or data. Multidisciplinary methodologies used to study dark earths are ignored, and a one-sided focus on physico-chemical properties results in a complete disregard of other existing methods and their results, as well as in the richness of archaeological data and interpretations. The rationale behind this approach is not made clear. A review of ADE origins or evolutions, as set out in the introduction, is not attained. All this implies that a thorough revision of the research that this manuscript is based on would be needed, including the reading and systematic inclusion of all available published work, as well as a complete re-write in order to mitigate incorrect statements and conclusions.

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