

## ***Interactive comment on “Bioturbation by wild boar increases the stability of forest soil carbon” by Axel Don et al.***

### **Anonymous Referee #2**

Received and published: 3 June 2019

MSbg-2019-113: Bioturbation by wild boar increases the stability of forest soil carbon by Axel Don et al.

General comments:

Axel Don et al. have submitted an original, well written and very interesting draft to BG.

They investigated the effect of wild boar bioturbation on soil organic carbon (SOC) dynamics in a 6 year study in two forests of Germany (focusing on coniferous plots in one forest and coniferous + deciduous plots in the second forest), both on acidic and sandy soils.

The experimental design is nice and sound, the authors have manually simulated wild boar bioturbation (each year, which is a high frequency). They discuss in a clear way

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the advantages and limitations of the chosen design. Yet, I think that in many sentences of the manuscript and also in the draft title, the fact that wild boar were not part of the game should be more clearly stated (see below my specific comment 1 on this topic).

SOC dynamics is studied in paired-plots (control vs. bioturbation) by focusing on SOC stocks (using equivalent soil mass for litter + 0-5/5-10/10/15 cm soil layers) and SOC physical fractionation to separate particulate SOC from mineral associated SOC (0-5/5-10 cm soil layers + C content of the mineral fraction of the O layer of bioturbed plots). The results show that SOC stocks were not affected by bioturbation but that the fate of litter SOC was affected by bioturbation: 1/ a part remains in the litter (as litter), 2/ a part is incorporated as particulate/light organic matter in the mineral topsoil layer, 3/ a part remains in the litter layer, but is associated to minerals.

The authors finally state that the part of the litter SOC that has been associated to minerals (in the litter layer) has been "stabilised" by bioturbation. I suggest that this statement on carbon "stabilisation" should be avoided. We indeed lack evidences regarding the residence time of mineral-associated SOC above the topsoil (i.e. in the litter layer; see below my specific comment 2 on this topic).

Specific comments:

1/ Wild boars were not involved in this study :)

I suggest to state more clearly in the title and in the text that bioturbation by wild boar was simulated. - "Simulated wild boar bioturbation..." for the title. - in the text this could be done for instance p5 line 17 "[simulated] wild boar bioturbation" and in many other sentences of the draft.

2/ Mineral-associated C in the litter layer (above-ground) cannot be called "stabilised"  
C

First, I would like to remind that in (mineral) soils, a large part of mineral-associated SOC is not stabilised. This has been clearly shown in e.g. long term bare fallows trials

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where the fine soil fraction loses SOC at a relatively high rate. So transferring litter SOC to the mineral-associated SOC fraction does not mechanistically imply that all of it has been stabilised. A part of it may be stabilised if this transfer would have taken place in the mineral soil layer (i.e. below the soil surface). Indeed the mean residence time of mineral-associated SOC is generally higher than the one of the particulate organic matter SOC in mineral soil layers. But here the bioturbation transfer of SOC from litter to the mineral-associated C fraction occurred in the litter layer (i.e. above the soil surface), where there is no evidence that this above-ground mineral-associated C would have a slower turnover than litter C from the F/H O layers.

This should be acknowledged in the manuscript.

- The title of the manuscript should be changed, avoiding the confusing term (and not properly measured for litter layers) "stability". The expression "increases mineral C loading" should be preferred and would better represent the findings of the study.
  - The title of section 2.2 should be changed. Stability of SOC was not assessed, but "SOC distribution in physical soil fractions".
  - The title of section 2.3 should be changed to "Associating C on minerals with bioturbation".
  - The title of section 3.2 should be changed to "Contact [...] facilitates the association of litter C with minerals in the litter layer"
  - The abstract/conclusion should be re-written: bioturbation has a positive effect on "C association to minerals" or on "mineral C loading in the litter layer", not on C stability, we do not know if this C is "more stabilised", it is more linked to minerals, and research on the turnover of mineral-associated C in the litter layer is therefore needed.
- 3/ The effect of wild boar on plant biodiversity and forest ecosystem C cycle is questionable

In the introduction section, the authors insist on the "mainly positive effects in forests"

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(p2 line 15) of wild boar bioturbation. However, other studies are questioning this statement, presenting the effect of ungulate populations as :

- "jeopardiz[ing] forest regeneration process"
- "detrimental to the peculiarity of forest plant communities"
- leading to "landscape-level biotic homogeneization" (see e.g. Boulanger et al., 2017 in Global Change Biology)

If forest regeneration process is actually jeopardized by wild boar invasions, then the fate of the global ecosystem C stock and cycle is not clear... This should be acknowledged in the manuscript.

4/ No positive grubbing effect on total SOC stocks were found

Please correct this mistake at p8 lines 9-10

Technical corrections:

p1 l26: "an[d]" ?

p5 l17: "due [to] six"

p7 l2: "significant[ly]"

p8 l20: please replace "mainly" with "only"

p9 l16: please reverse "forest floor" and "mineral soil" : mineral soil mixed into the forest floor almost doubled the C load (not the opposite)

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Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2019-113>, 2019.

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