

SOIL Discuss., author comment AC3
<https://doi.org/10.5194/soil-2022-1-AC3>, 2022
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Reply on RC2

Collin J. Weber et al.

Author comment on "Meso- and microplastic distribution and spatial connections to metal contaminations in highly cultivated and urbanised floodplain soils – a case study from the Nidda River (Germany)" by Collin J. Weber et al., SOIL Discuss., <https://doi.org/10.5194/soil-2022-1-AC3>, 2022

Reply on RC2 (soil-2022-1)

Dear Reviewer 2 (RC2),

Thank you for your effort to read our manuscript! Thanks for your recommendations and the general commendation of our work. We would like to respond to some of the comments below and clarify open questions one after the other. The mentioned typos and other minor corrections that do not require any further comment, were indicated by "[will be implemented during revision]"

Thank for your support. Best regards,

Collin (on behalf of all co-authors)

General comments:

- Thank you for raising our attention to the important points mentioned within your general comments. Regarding the introduction of our manuscript, we will formulate a clear objective within the revised version of our manuscript and will shorten the introduction consequently. For this reason we will follow your recommendations about the introductions focus also in accordance with the comments of RC1 as well as CC1.

Specific points:

Abstract: Try avoiding acronyms, explain enrichment factor

- "[will be implemented during revision]"

Line 17: lower range of known concentrations where? In soils, floodplain soils, ...? This sentence does not make sense if you haven't read the manuscript.

- We will add "lower range of known concentrations within floodplain soils, ..."

Lines 21 f: Why do we need info on spatial microplastic distribution for floodplain management?

- In contrast to so far “recognized” pollutants, microplastics are not considered within measures for floodplain management. The found effects of direct anthropogenic impacts, raising questions about future floodplain management. We may add “... for future floodplain management, regarding contamination assessments” to illustrate this background.

Line 30: correct typo “scapes”

- “[will be implemented during revision]”

Line 38: check wording of this sentence

- Thanks for this hint! We have checked the wording and will change it within the revision.

Lines 52-59: one might expect that this paragraph leads to a hypothesis of an objective, something like: “Therefore, we wanted to find out...”.

- You are right, that the “metal” part of this paragraph suggests an objective. Within the revised introduction, we will add an objective at the end of the shortened paragraph.

Lines 70-72: not sure I understand the differentiation here in small-scale inputs and spacious inputs

- We will change the wording here from small-scale inputs to “point or local inputs”. Thus, the difference between point inputs (for example, input on a specific field) versus input from a flood (widespread) should become clearer

Line 75: “plastic abundance” instead of “spatial distribution of plastics”?

- “[will be implemented during revision]”

Lines 82-92: this should be part of the discussion: putting own findings into context with literature

- The own findings compared here with other studies clearly belong to the previous preliminary work on microplastics in floodplain soils and should therefore also be mentioned here. They are taken up again in the discussion and compared with the findings of the study presented here.

Lines 97 f: not sure this is the correct reference. Also, I don't agree with this statement. Altered soil functions have only been found in the lab so far.

- It's the correct reference here. We will formulate the statement less strongly by referring to “may be affected by plastic particles in soils” and add an additional review reference here.

Lines 101-108: is this a goal of this study? The temporal aspect is not really investigated here. Or can the sampled soil strata be somehow related to the time the sediment has been deposited?

- No, the temporal component is only considered based on EPO-ages, but is no general objective of the study. The information about the temporal aspects, will be shortened and given just as side information within the revised introduction.

Line 112: replace “clear sequence” with “gradient”

- "[will be implemented during revision]"

Lines 115 f: this sounds like a weak argument for the study. is it possible to find a stronger point?

- We will change the argument to "As the sink function of floodplains and depositional dynamics are already well studied for so-far recognized contaminants like metals of interest, a combined consideration of recognized metals and the new contaminant plastics, will be performed."

Lines 119 ff: These aims and hypotheses are coming somewhat "out of the blue". It would be nice if the introduction would be more funneled from the general knowledge via the knowledge gaps leading to the research goal.

- Thank you for this recommendation. As stated before, we will revise the introduction accordingly and refocus on our objectives, based on the knowledge gaps.

Lines 123 f: the terms spatial relationship and spatial correlation seem a bit misleading, since one would expect that spatial analyses are being conducted that are commonly defined as (statistical) analyses of georeferenced data.

- Thanks for this suggestion. Maybe the wording "correlation" leads to the assumption of a geostatistical analysis. We will change the wording here to "... investigating spatial similarities and differences between..."

2.1 Study area: This can be shortened to the points relevant for the aim of the study

- "[will be implemented during revision]"

Lines 169 f: "geospatial approach" - this term is used here in a somewhat blurry way. Also, why does a landscape consist of soilscape? The term soilscape should be defined at first mention.

- The term "geospatial approach" with regard to (micro-)plastics research was introduced by Weber et al. (2020) <https://doi.org/10.1002/ldr.3676>; The core idea of this approach is a study and sampling design oriented to respective land- and/or soilscape features. We will cite the reference here and will define the term "soilscape" after its first mention within the introduction.

Line 235: replace "as control" with "for correction"?

- "[will be implemented during revision]"

Past and present tense are used inconsistently (e.g. in results section) – please correct throughout the manuscript.

- "[will be implemented during revision]"

Terms are used inconsistently: plastic concentration, plastic load: I'd suggest to change these to "plastic particle abundance", since the results are based on number and concentration is more commonly used for masses.

- Thanks for this recommendation. We will consistently use the term plastic load, as the results are reported as a number per kilogram soil dry weight.

The order of subsections is vice versa in the methods and results chapter.

- The order of subsections within the methods is oriented from “known” standardized methods (soil and metal analysis) to non-standardized (micro-)plastic analyses. We would like to keep the order of subsections within the results.

Line 318: replace “organic (non-polymeric) with “natural organic matter”?

- “[will be implemented during revision]

Figure 2: Please explain the box plots (what quantiles are shown?) and increase the fonts. Replace “particle type” with “particle shape”

- We think, that a standard boxplot didn’t need an explanation of quantiles as these are generally known. We would like to keep the term “particle type” as particle shapes are often associated with properties such as edges (e.g., broken)

Line 404: Mean values averaged over what?

- We are not sure where this question is aimed? Are the proximal and distal floodplain sites meant? If yes we will add: “... mean values of proximal (near-channel) floodplain sites to mean values of distal (remote-channel)...”

Figure 3: I am not sure I understand the meaning of cumulative sums. I suppose these are the abundances shown in table 1 summed up over the three depths. But that would mean that 5, 2, and 3 samples are summed up for the 0-50 cm, 50-100 cm, and 100-200 cm, respectively, so the upper stratum is overrepresented. Wouldn’t it be more intuitive to show mean abundance across each profile to compare the sites?

- Thank you for raising this question. The cumulative sums are the abundance of particles per soil section summed up over the three depths, as you correctly stated. As the mean abundance (vertical) is already displayed within Figure 5a, we want to illustrate the complete plastic abundance over the entire soil column (0-2 m) per sampling point in Figure 3. We think that both the significantly lower contents in subsoils and the sites with the highest abundance are made clear by this type of illustration.

Figure 6: I like the panel a a lot. But it might be clearer if the zoomed-in plots were removed. Also, consider to only keep 6a in the main paper. Instead of 6b, I'd rather like to see soil depth plotted against EPO age. Also, the gap in the size range from 2-10 mm strikes me. Is this an artifact of the analysis method? It should be discussed.

- Glad you like the illustration and thanks for the suggestions. We will remove the zoomed-in plots, also in accordance with RC1 comments, even if it becomes more difficult to track the lower size range. The gap within 2-10 mm range, is not an artefact of the analysis. It is due to the fact that many macroplastic particles were introduced into topsoil at two locations. We will add a brief discussion on this point.

Lines 476 f: Please delete: “with individual increased concentrations in deeper soil layers”

- “[will be implemented during revision]

Lines 494 f: replace “association” with “correlation”

- “[will be implemented during revision]

Lines 496 f, 506 f: according to figure 5a, the relationship between soil depth and number of MP is not linear, or only linear down to approx. 60 cm and then rather constant. Could

this be included in the model?

- Thanks for this suggestion. As stated within l. 490-492 we found a significant regression between plastic loads and soil depth, just within the linear regression model. As we would like to keep the model as simple as possible, we think that a linear examination is sufficient here.

In the discussion, where the results are put into context with literature, I am missing the point that in general, particle abundances in different locations are hard, if not impossible to compare, since size and mass is not accounted for that can vary greatly depending on the origin, time of accumulation etc. of the plastics.

- Special thanks to raising our opinion again to this important point. In general, we agree with the statement that comparisons of the abundance is always limited. but not impossible, as long as spatial relationships but also differences are considered in the interpretation of the obtained data. We will add an respective sentence within the discussion to state the given limitations of such spatial approaches clearly.

Line 533: But Piehl et al found lower abundances

- Yes this is correct. The reference was set incorrectly here and will be removed.

Lines 566 ff: consider citing Koutnik et al. (2021) for a review of MP abundance in different soil types

- Special thanks for this nice literature hint. As CC1 already mentioned that we should reduce our reference list, we will add this reference and argue here shortened with reference to the review.

Lines 659 f: high levels of plastics in topsoil cannot explain accumulation in topsoils if the amount of translocated plastic is not known

- Yes, this is correct. We will delete the second half of the sentence and will just argue with the studies containing data on plastics in subsoils.

Line 669: "The direction of movement of the plastic deposits must therefore originate from the river" – why? What about agricultural activities, as stated earlier?

- Thanks for mentioning this point. The statement seems to be a little one-sided here. We will change to "Beside agricultural activities contributing to plastic deposits, plastic can originate from the river and deposited via flood water since further, laminar sources are excludable"

Lines 675 f: but what about bioturbation, translocation to deeper soil?

- Yes of course, this point is important and already discussed within Weber and Lechthaler (2021). The idea of an "general marker" assumes that a significant increase in content is indicative of deposition after 1950. Of course, parts of the plastic content can be displaced, as is possible with other dating methods, e.g., Pb-Cs. However, we know only little about the mass of "mobile" plastic in soils, especially for comparatively "large" microplastics. We will add a statement on the limitations due to relocation processes with regard to particle sizes.

Lines 682-690: this is in logical contrast to the theory of sediment dating.

- We do not think, that a translocation of plastic particles within soils or sediments, is

contrary to dating theory. Each environmental archive (which could be dated, regardless of the used method) is influenced by dynamic processes (e.g. vertical displacements in the pore space or bioturbation). Within the results of this study, we identified a frequent accumulation within upper soil sections and significant lower loads within deeper soils, assuming that the deeper-plastics have to be relocated. Nevertheless, if you look at the total contents or the peaks (as in radionuclide dating methods), an estimation is still possible.

Line 698: delete "spatial or statistical"

- "[will be implemented during revision]"

Lines 700 f: meaning the emission of heavy metals from plastics?

- Yes, thanks for this question. We will change the wording here to make this point more comprehensible.

Lines 701 ff: I'm not sure what is intended here. If heavy metal as additives in plastics likely play no role, why should it be further studied?

- This is a misconception here. Based on our method approach we were not able to identify the influence of heavy metal emissions from plastics, may due to the comparatively slight plastic loads found or the already existing geogenic as well as anthropogenic contamination of the floodplain with metals. Therefore, further studies should focus on the geochemical interactions. We will state this point clear within lines 700–704 within the revised version.

Line 707: What is the meaning of "significant outliers"?

- We will change the wording to "high accumulations" here.

Line 723: What is the meaning of "(functions of some plastic pieces still recognizable)"?

- Thanks for this question. This term means that the origin and the function of some plastic pieces is still recognizable. We will change the wording to "origin ... still recognizable"

Line 734: Consider replacing "plastic content in floodplain deposits" with "the microplastic abundances found in this study"

- "[will be implemented during revision]"

Lines 744 ff: I am not sure I understand this. In the discussion the authors state that the MP abundance even in the upper soil layers is low compared to e.g. agricultural soils in literature. So, it seems that MP are not a prominent issue in flood plains, as other pollutants like heavy metals.

- We believe that at this early stage of research it is not possible to say whether microplastics are a prominent issue in floodplains. Basically, the sole occurrence is to be considered negative, regardless of the quantity. As stated within the manuscript (methods, discussion), our method approach is limited through the analysed plastic size range. As many other studies have also analysed smaller particles, the contents are difficult to compare and it can be assumed that higher contents also occur in floodplain soils if smaller particles are included in the analysis.

Line 754: a risk assessment usually does not follow legislation, but legislation follows an

assumed or assessed risk

- Risk assessments by monitoring programs can only be carried out if there are limit values (by legislation). Of course, an assumed or assessed risk must be given for legislation as well, but the simple proof of risk is not provided by area-based risk assessments.

Lines 768-770: this is true and a well-known problem, but it doesn't relate to the study.

- This point will be deleted within the revised manuscript.

Lines 771-773: I think this is a little far-fetched in light of the comparably low levels of plastic contamination found in this study, and the positive effects on biodiversity and flood mitigation of river bed restoration.

- As stated before, our study does not claim to provide a complete analysis of plastic content in relation to size. However, the presence of plastic, regardless of loads, should be cause for the influence of, for example, renaturation on the deposition of plastic. Here we are not referring to restrictions on restoration, but to considerations of how to deal with it. We will revise the point and make our implications more explicit

Lines 774-776: Also, this statement is general and not concluded from the study results.

- This point will be deleted within the revised manuscript