

Peer Review Report

Review Report on Organic carbon burial in constructed ponds in southern Sweden

Original Research, Earth Sci. Syst. Soc.

Reviewer: Mike Peacock

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EVALUATION

Q 1 Please summarize the main findings of the study.

Six ponds in southern Sweden were cored to measure C content and burial. Yearly carbon accumulation rates range from 24 to 491 g C m⁻² year⁻¹. The authors suggest ponds can therefore bury significant amounts of carbon, but they also caution that methane emissions could be large and offset this burial.

Q 2 Please highlight the limitations and strengths.

Strengths:

- replicate cores taken at some ponds
- C content measured throughout core subsections (rather than one bulk sample per core)

Limitations:

- calculations of net C/GHG balance do not factor in CO₂ or CH₄ ebullition
- small sample size

Q 3 Please comment on the methods, results and data interpretation. If there are any objective errors, or if the conclusions are not supported, you should detail your concerns.

No answer given.

Q 4 Check List

Is the English language of sufficient quality?

Yes.

Is the quality of the figures and tables satisfactory?

No.

Does the reference list cover the relevant literature adequately and in an unbiased manner?

Yes.

Are the statistical methods valid and correctly applied? (e.g. sample size, choice of test)

Not Applicable.

If relevant, are the methods sufficiently documented to allow replication studies?

Yes.

Are the data underlying the study available in either the article, supplement, or deposited in a repository? (Sequence/expression data, protein/molecule characterizations, annotations, and taxonomy data are required to be deposited in public repositories prior to publication)

No.

Does the study adhere to ethical standards including ethics committee approval and consent procedure?
Not Applicable.

If relevant, have standard biosecurity and institutional safety procedures been adhered to?
Not Applicable.

Q 5 Please provide your detailed review report to the editor and authors (including any comments on the Q4 Check List):

The paper by Ljung and Lin investigates the potential carbon storage in constructed ponds in south Sweden. This is a relevant topic; as the authors point out, the potential climatic benefits of small ponds are widely touted, but there is a lack of relevant data (of carbon burial vs GHG emissions) to determine if this is actually the case or not.

The authors take sediment cores from six ponds to measure carbon content and calculate burial rates – which are sometimes high in these ponds. They then use literature values of methane emission to estimate the true climatic effect of these ponds. In Sweden ponds/wetlands are widely constructed in agricultural landscapes either to trap nutrients and reduce downstream eutrophication, or for biodiversity, so this is important data for stakeholders as well researchers.

I enjoyed reading the paper. I can follow what has been done, and the data presentation is ok (personally I would tidy up the figures so they aren't default Excel charts, but this is very much up to the authors), although there are possibly some errors with units on graphs.

One thing I find missing is an estimate of the CO₂ emissions from these ponds. The authors use literature values for CH₄ but ignore CO₂. See for example this pond paper which includes all pathways (burial and GHG emissions): <https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lno.11173>
There is also no mention of methane ebullition, which could lead to underestimates in the authors' calculations.

As mentioned early, many of these ponds are specifically designed and built to trap nutrients (particularly phosphorus). So perhaps we need to accept high GHG emissions as an unintended side effect of reducing downstream eutrophication? This could briefly be explored in the text.

Detailed comments:

L21. "This indicates that carbon storage in constructed ponds is significant and can contribute to carbon mitigation."

Stating that 0.1–0.8% is "significant" is definitely a subjective claim. This is a very small % and I could subjectively claim it's insignificant. I would suggest deleting the "significant" part and simply stating the %, and then the reader can decide its importance.

L25. Typo. Should be "This shows..."

L43. "are effective in removing carbon." From the atmosphere (i.e. as CO₂ sinks)? From water (i.e. as DOC sinks)? Please clarify.

L45. "through air deposition". Is this likely to be a significant route for C burial in ponds? Perhaps in agricultural areas, where bare fields might be subject to wind erosion?

L47. Anderson et al should be dated as 2020.

L52. "This led to a substantial loss of waterbodies in most of Sweden." Presumably wetlands/mires and small ponds mostly? Saying a "loss of waterbodies" without caveat could be read as suggesting a loss of numerous lakes, which I assume isn't true?

L54. I wonder if somewhere around here you need to be explicit that you're mostly talking about wetlands under agricultural land use. There are programs of mire rewetting/restoration which technically fall under the broad umbrella of "wetlands" but which aren't really relevant for this paper.

L55. Here you could quote the figure of 12000–15000 ha of wetlands implemented (from Table 2 in Graversgaard et al) to put the Swedish wetland policy into context for those unfamiliar with it.

L72. Somewhere in the methods/sampling section you should state you sampled six ponds. I don't think this info is there currently.

L81. The word "dams" is barely used in the paper, so I'd suggest changing this to "ponds" for consistency.

L83. "pastures or farmland." Suggest changing to "pastures or arable land" – assuming this is the intended meaning.

L83. Wetland size goes up to 50ha but pond size goes to 60ha. Do the ponds not count as wetlands? If not, how are you defining the wetlands vs the ponds?

L84. I think some info is needed about the vegetation within the ponds. Floating, submerged, emergent? Or are they unvegetated?

L85. Is this mean water depth, or depth at the coring location only?

L88. How were the coring locations chosen? From the centre of the ponds? Deepest points?

L88. What year did sampling take place? This is obviously important to put the C burial rates in context.

L90. I think a little extra detail is needed here. Presumably you sampled only the accumulated organic matter, and discarded the mineral sediment that was already there when the ponds were constructed?

L104. Here we get a mention of some ponds having two cores. This needs to be moved up to the sampling section (L88), and some explanation of why some ponds were cored twice added.

L106. Why the upper six cm? An explanation is given in the results but it should be here.

Figure 2. To me it would make more sense to have cores taken from the same pond on the same figure, so readers could visually compare within-pond variation. It would also be easier to compare different panels if the axes were scaled the same way.

L116. H47x also seems to deviate from your general relationship.

L124. "The top six cm is used because this is the depth of the shortest core". This should be part of the methods. But I'm not sure I really see the value of this approach.

Figure 3 and 4. What do the error bars represent? Please state this in the legend.

L125. "Average carbon densities range from 3.1 to 50.1 mg C cm⁻³." Figure 3 shows them as ~2000 mg C cm⁻³. The values in the text seem plausible, the values on the figure less so. What's going on here?

Figure 4. If you want to keep the 6cm analysis in, then why not also add to Fig 4 the full core C stocks too (as you do for Fig 3)? That would give the reader some useful extra information.

L137. Is this calculation done using the mean carbon stock from the study ponds multiplied by total pond area? If so, please state the mean in the text.

L141. "Yearly carbon accumulation rates range from 24 to 491 g C m⁻² year⁻¹." But fig 5 shows about 2.5 - 45 g C m⁻² yr⁻¹. Why are the text and figure different, like they were for figure 3?

L153. Perhaps some more information is needed here - did you run Spearman, Pearson correlations? Did land use (arable vs pasture) make an obvious difference? What about age? This recent paper found increasing burial rates with pond age: <https://www.nature.com/articles/s43247-022-00384-y>

L157. Does seasonal flooding imply that this pond dries out a lot? Or just that its surface area increases during the flooding?

L158. Typo. "rewetted" should be "rewetting".

L164. Low PP after construction makes sense, because there are no plants yet established. But why should deposition be particularly high just after construction? Also, could this effect be because there is more time for further decay of organic matter at deeper core depths, simply because these layers are older?

L165. Sediments, rather than soils?

L170. The term "sediment focusing" should be explained here.

The high deposition/low PP explanation is repeated three times, on L164, L176, and L182. Some of this can be condensed to avoid repetition.

L184. Here you suggest that organic deposition was high, but on L164 you talk about high minerogenic deposition.

L191. "Thus, the carbon storage must be higher than the increase in CH₄ emissions in the restored ponds." This sentence doesn't make any sense to me. Unless you mean to say something like: "For ponds to be net GHG/C sinks, the carbon storage must be higher than the increase in CH₄ emissions in the restored ponds."

L201. Typo in the units, should be g not mg.

L193 - 201. This section is a nice attempt at calculating the true C/GHG source/sink behaviour of these ponds. However, the fluxes that you quote from Stadmark and from our paper are diffusive fluxes only. Our 2021 paper that you cite also has some ebullition data, where mean fluxes were 257 mg/m²/d. Similarly, Natchimuthu et al (2014) showed that ebullition was responsible for 91% of total CH₄ flux in a pond in Linköping, and van Bergen et al (2019) found this figure to be 75% in a pond in the Netherlands. We have some currently unpublished data from Swedish agricultural ponds showing ebullition to be important. So I think it likely that CH₄ emissions from these ponds is likely to be significantly higher once ebullition is properly measured, and this should probably be mentioned in the text.

<https://link.springer.com/article/10.1007/s10533-014-9976-z>

<https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lno.11173>

L202. This section is a bit muddled to me. Shouldn't you also be including diffusive emissions of CO₂ from the ponds in order to estimate the full source/sink balance? E.g.

<https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lno.11173>

L223. Why should shallow edges promote methanogenesis?

L228-241. Much of this paragraph seems a bit out of place and irrelevant. The discussion on coastal systems here is irrelevant - I'd personally suggest deleting it. Then there is text like "small agricultural impoundments have been shown to have particularly high C burial rates" and "Given that the ponds studied here have been created or restored, have high allochthonous carbon input, high nutrient status it can be assumed that they

are also relatively efficient carbon burial sites.” Why are you saying “assumed”? You’ve just measured and reported the burial rates so you don’t need to assume anything. I’d suggest rewriting/condensing much of this.

L253. Is dredging the usual management of ponds in southern Sweden?

L265. See my earlier comment about this being an subjective view.

L448. Typo. “he depth” should be “the depth”

QUALITY ASSESSMENT

Q 6 → Originality	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 7 → Rigor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 8 → Significance to the field	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 9 → Interest to a general audience	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Q 10 → Quality of the writing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 11 → Overall quality of the study	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>