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Hydrology and Earth System Sciences Discussions

Interactive comment on "Eutrophication and Phosphorous accumulation in sediments of Karlskärsviken, bay in Lake Mälaren" *by* G. Olli

Anonymous Referee #3

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1. General comments

The topic of the paper is of interest for scientists dealing with the reconstruction of historical nutrient levels in aquatic systems. It is especially relevant since the establishment of appropriate background nutrient concentrations is required in the context of the European Water Framework Directive. The paper is within the scope of the journal.

However, in my opinion, the current version of the manuscript has a number of deficits:

- Relevant background information is partly presented imprecise or incomplete. This makes it hard to follow some ideas without taking a close look into refer-

enced work. This is unsatisfying since the background information could also be supplied within this paper, requiring a few concise sentences only.

- In many cases, relevant information with respect to methods and data seems to be missing. Thus, traceability of methods and conclusions is not guaranteed.
- Results and discussion are not well separated.
- A discussion on the possible accuracy/uncertainty of results is missing.
- The figures are (in general!) not well prepared. In my opinion, they are unsuitable for publication in a high quality journal.
- In some cases, the references to the figures are misleading, i.e. the figures do not show what they should do according to the text/caption.
- There are errors in document formatting (sectioning, chemical symbols, etc.).
- There are a number of typos, incomplete citations, and missing/superfluous items occur in some sentences.
- A number of sentences is too long, others might profit from rewording.

The manuscript should only be considered for publication in HESS after a serious, very careful revision. In my opinion, a satisfying response to the comment on page 1834, line 13-14 is a precondition for publication. Another precondition is that all methods are presented in a transparent way and that the quality of figures is improved.

2. Specific comments

2.1 Text part

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p 1824, line 7: At this point it is not (yet) clear whether BSi-P refers to P in the sediment or the water column.

p 1824, line 23: You write that P is sorbed and desorbed by vegetation. What is the mechanism behind? Be more precise if necessary.

p 1825, line 6: It needs to be mentioned here that BSi is a suitable indicator only, as long as diatom production is limited by P. A proof should be given, that this is the case in the studied bay.

p 1825, around line 10: Wouldn't it be much more reliable to use species information rather than BSi for estimating historical pelagic P? As far as I know, different species have a different phosphorus affinity (indicator species). But couldn't the settling of different species result in the same BSi? Please make clear, probably in your methods section, why you prefer the use of BSi over species data.

p 1825, line 20-23: In my opinion, this information is incorrect or at least insufficient (please read again Schelske et al. (1986), page 83 and 85). As far as I understand, it is NOT the high BSi content NOR a high BSi/P ratio that indicates Si depletion in the water column! Instead, the DECREASE in BSi or BSi/P following a peak is the indicator! Please clarify this. The problem appears several times throughout the paper and may confuse other readers too.

Note: In my opinion the use of the term 'Si depletion signal' for the peak in BSi is in fact a bit confusing (first part of the first sentence of the discussion in Schelske et al. (1986)). So please don't transfer this confusion into your own paper! I think, the second part of the mentioned sentence, makes the relation between BSi and Si in the water column very clear.

p 1825, line 23: According to my understanding, bio-available phosphorus (BAP) is an important parameter for characterizing the nutrient status of the water column. It should be made clear why it makes sense (in YOUR study) to determine BAP in sediments. In

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other words: What does the BAP fraction tell you, considering the turnover processes during sediment diagenesis?

p 1825, line 24: You mention 'previously found BSi and P relations'. If you refer to other sources, you should provide a citation; If you refer to your own data, I don't understand the use of 'previously'.

p 1826, line 9-10: The sentence is confusing, probably due to bad word order. Furthermore, a lake cannot be 'sensitive to water quality'. Use a more precise formulation!

p 1827, line 4: The information presented in the first section of the 'supporting information' should be presented right here in the methods section. I don't see any reason why it is provided separately! See also comments on that supplement!

p 1827, line 8: It needs to be mentioned what the uppermost sediment is (what depth).

p 1827, line 13: Shouldn't the words 'depends on' be replaced by 'caused by'?

p 1827, line 14-16: The problem from page 1825, line 20-23 appears here again. You should (somewhere) provide a detailed explanation of how BSi in the sediment and the pelagic Si concentration are related.

According to my understanding, a LOW value of BSi reflects a limitation of diatom growth by ONE OR MORE environmental factor(s) (e.g. the pelagic Si and/or P concentration, and/or temperature etc.).

In contrast, a HIGH value of BSi, first of all, indicates that ALL environmental factors controling diatom growth were, at least temporarily, in the optimum range. That is, sufficient P, BUT ALSO Si were present!

A depletion of pelagic Si (indicated by a decrease in BSi) may follow, if the water column's Si reservoir is exhausted due to mass developments of diatoms and slow recycling of the settled BSi.

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Thus, the relation between the pelagic Si concentration and sediment BSi is a *dynamic* one! This should become clear in your paper. Furthermore, information should be provided, how these dynamics are reflected by the sediment stratigraphy. Especially, you should inform the reader on the time scale of these dynamics. Are diatom blooms (sediment BSi peak) and the following Si depletion (decrease in sediment BSi) a phenomenon that occurs within a single vegetation period, or does the depletion of pelagic Si last over a longer period of time?

p 1828, line 2: In which year were the core samples taken?

p 1828, line 9: What restricted the length of the cores?

p 1828, line 13: You say that the samples were further prepared but you don't say how. Remember that all methods need to be presented transparently.

p 1828, line 17: If you used the method by De Master (1981) in a modified way, you must present the reason for modification!

p 1828, line 18: You say that anomalous samples were repeatedly analyzed 2-3 times. Does that mean that samples with 'plausible' analysis results were not analyzed a second time? Isn't repeated analysis (at least one repetition) required for getting reliable results that allow for the interpretation of small differences?? In my opinion, you work with rather small differences (e.g. when comparing the values in the first two rows of Table 1).

p 1828, line 24: You should provide more information of the properties of the sediment (at least content of organic matter).

p 1828, line 25: What do you mean by 'empty'? Does that mean that the most recent deposits were lost somehow? If so, how can you compare the results for this core with the others? (You do so.)

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p 1829, line 6-9: If the P content of the sediment is not a useful indicator of the past P concentration in the water column, what information can then be derived from the BSi/P ratios? Are these ratios not meaningless then? Please clarify this! Furthermore: How can you be sure that Si depletion is/was actually responsible for changes in BSi/TP or BSi/BAP? What about P limitation?

p 1829, line 8: You say that the BSi/P ratios were used for controlling whether Si limitation is/was likely. However, you should present details of how this was done. Otherwise, the methods are not traceable.

p 1829, line 13-14 and following: I presume that the TP/BSi ratios determined for the individual cores were used for deriving the BSi-P values presented here (and in Table 1). However, according to the supporting material, the observed (current) TP/BSi values range from 0.68-3. This raises the question of how reliable the estimated BSi-P values are, if TP/BSi is that variable. Can you really estimate BSi-P with the presented precision (16-18 and 20-22 microgram per liter). Information on the uncertainty of your results must (at least) appear in the discussion section.

p 1829, line 18: What is a 'safe' trigger in this context?

p 1829, line 24: You start a very long sentence here. Couldn't it be split? Furthermore: The explanation is not clear to me. Where does the loading in the outer bay comes from? Also: Doesn't this sentence belong to the discussion, not the results?

p 1830, line 2: You use the word 'may' here. What do you think how uncertain this statement (based on rows 1 and 2 in Table 1, I guess) is?

p 1830, line 16: You write '... may be put higher...'. By what approximate quantity? I.e. how sensitive is BSi to changes in temperature? You should have an idea of that because, otherwise, you can hardly use the BSi data to precisely reconstruct nutrient levels.

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p 1830, line 17: I suggest you remove this line.

p 1830, line 6-17: In my opinion, the entire section 3.3 needs to be moved to the discussion section. The latter might need to be divided into subsections.

p 1830, line 23: What is a 'marina'?

p 1830, line 24: Rewording of the paragraph's final sentence is suggested. For example: 'The respective layer was excluded from the analysis.'

p 1830, line 19-25: I think the contents of 3.4 does not require an individual section. It should be merged with 3.2.

p 1831, line 1: In the first sentence of this page causes and consequences are not properly separated or possibly mixed. It is very confusing. Furthermore: Information on the frequency of diatom blooms and following Si limitation should be given. What is the typical time scale of this oscillation?

p 1831, line 8: I can't see the expected information in the referenced figure 3b.

p 1831, line 9: You mention your attempt to calculate a 'levelled out P content'. I cannot find any information on the applied method. Either details are presented or the sentence as well as the corresponding figures must be removed.

p 1831, line 14: I would not use the term 'P enrichment' here. What you are talking of is simply the P concentration in the pelagic zone, isn't it?

p 1831, line 17: What do you mean by 'even over time'. Invariant? You should underpin this statement by examples/citations!

p 1831, line 14-17: I don't see the point in these sentences. Could they be deleted?

p 1831, line 19-20: The sentence split over these two lines is confusing. I agree, Fig.

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5 shows an increase not a decrease. BUT: I can also see no decrease in the BSi contents (Fig. 2, upper panel)!

p 1832, line 3 and 7: Please clarify whether the water depth or the water surface (elevation) was lowered! I presume the water surface elevation cannot be lowered due to land upheaval.

p 1832, line 15: You write 'After that...'. After what?

p 1832, line 18: You state that the nutrient trophy has decreased during the last decades. Based on which information do you draw this conclusion? I can see no clear trend in BSi in Fig. 2.a. Based on Table 1 (rightmost column), the decrease in BSi is about 3 percent. Isn't that within the range of uncertainty of the analyses? I think, you must prove that the difference in the values of row 1 and 2 is *significant* using appropriate statistics. If you cannot prove that (e.g. because you don't have enough data to compute reliable confidence intervals), you should reconsider your statement.

p 1832, line 28: I cannot follow this idea. If the residence time of the water is short, doesn't that guarantee a sufficient supply of 'new' Si? What is the major source of Si?

p 1833, line 1-3: Doesn't that mean that BSi is unsuitable for indicating nutrient trophy (P levels) in the studied system?

p 1833, line 23: 'Bad' is not an appropriate attribute here.

p 1834, line 4: See comment on page 1831, line 14.

p 1834, line 13-14: Do you want to say that the lake was brackish in former times? If so, I am in doubt about the sense of this investigation. If the diatom flora is different in freshwater and brackish/marine systems (is it?), BSi in old deposits (deep layers) cannot be compared with BSi in recent sediments (upper layers). Why did you compare the data anyhow (by not handling them separately)?

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p 1834, line 22: How do you define eutrophication? Are diatom blooms not signs of eutrophic conditions?

2.2 Supporting information, section 1

The information needs to be provided in the methods section! Also, a revision is necessary focusing on the following issues:

1. A definition of 'uppermost sediment' is missing.
2. I don't understand what you mean by 'consistent'. Be more precise!
3. There is a format error (-1 is a superscript).
4. You cite a lot of papers presenting 'similar approximate values'. But values for what? TP/BSi?
5. Do you present mass ratios or molar TP/BSi ratios? I guess the first. Make that clear by presenting the unit of the quotient. Is it (micro-g P / L) / (mg BSi / g DW) or what?
6. You should provide more parameters (e.g. a mean value and the standard deviation or quantiles) not just the range of TP/BSi.
7. You should provide an explanation for the variability of the ratio TP/BSi. How does this variability affect the reliability of your results, i.e. the estimated past P level?

3. Technical corrections

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3.1 Text part

Document title: Bad comma position; Suggestion '... in sediments of Karlskärsviken bay (Lake Mälaren, Sweden)'

p 1825, line 2: Append an 's' to 'increase'.

p 1825, line 16: Replace one occurrence of the word 'events'.

p 1825, line 19: Replace 'diatom decrease' by 'a decrease in the abundance of diatoms' or something similar.

p 1825, line 20: Reference is incomplete.

p 1825, line 20: Insert 'a' before 'high BSi' or delete 'content'.

p 1826, line 13: Insert 'in' before the time period.

p 1826, line 17: Is 'slope gradient' the proper terminus?

p 1826, line 20: Insert comma after 'At present'.

p 1826, footnote: Add this submitted paper to the bibliography and remove the footnote.

p 1827, line 5: Replace 'has' by 'have'.

p 1827, line 7: Replace 'trophy state' by 'trophic state'.

p 1827, line 12: Insert 'The' before 'P concents'.

p 1828, line 11: Change 'was' to 'were' and replace 'without...' by 'could not be dated'.

p 1828, Before line 15: The section numbering is wrong. Should it be 2.4? It doesn't make sense to start a section 2.3.1 if it is not followed by section 2.3.2!

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EGU

p 1828, line 15: Start the sentence with 'The'.

p 1828, line 17: The chemical symbol for sodium carbonate is not properly formatted. Use subscripts.

p 1828, line 17: Move 'accordingly' to the end of the sentence or enclose the word by commas.

p 1828, line 21: Change 'in respect' to 'with respect'.

p 1828, after line 23: This might be section 2.5 now if the numbering of the previous header was adjusted. Furthermore: It doesn't make sense to start a new section for only two sentences (if it is not filled with more information).

p 1829, line 2: Missing unit after '37'.

p 1829, line 8: Insert 'pelagic' before 'Si'. In general, it should always become clear whether you refer to concentrations in the water column or the sediment.

p 1829, line 8: Replace 'if' by 'whether'.

p 1829, line 8: Symbol 'BSi' must not be split across lines.

p 1829, line 17: Change 'nutritious outlets' to 'nutrient loading'.

p 1829, line 24: Insert 'of the bay' after 'inner section'.

p 1830, line 1: Insert a comma after 'On average'.

p 1830, line 8-10: The sentence starting with 'From 1850' should be reworded.

p 1831, line 1: Insert comma before 'and'.

p 1831, line 2: Delete the first occurrence of 'and'.

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p 1831, line 6: Append ’s’ to ’indicate’ and insert ’a’ before ’Si deficit’.

p 1831, line 15: Insert a comma after ’elements’.

p 1831, line 21-24: Change ’increased with’ to ’increased by’ (3 occurrences).

p 1832, line 5: Start the new sentence with ’The’.

p 1832, line 6: Replace ’feeder streams’ by ’tributaries’.

p 1832, line 13: Replace ’with’ by ’by’.

p 1832, line 17-21: The sentence running from line 17-21 should be split.

p 1833, line 21: Insert ’concentrations’ after ’Si’.

p 1833, line 19-22: The sentence running from line 19-22 is confusing as it is too long.

p 1833, line 23: Insert ’of’ before ’about’ and remove the comma before ’causes’.

p 1834, line 3: Unit is incomplete.

p 1834, line 5: Missing commas before and after ’above all’.

p 1834, line 6: Replace ’outflow’ by ’loading’.

p 1834, line 16: Insert ’of’ before ’about’ and delete ’to’.

3.2 Figures and Tables

Table 1

- Unit in the caption should be in parenthesis.
- What are the labels (a) and (b) good for? Are they referenced?

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Figure 1

- Font in figures and legends is much too small.
- Caption needs to be checked (strange order of labels).

Figure 2

- Enlarge the space between axis labels and plot region.
- Unit 'cm' should be in parenthesis.
- Remove box around legend.
- Core length in upper and lower panel is not consistent (core 1, 4, and 5).
- Subfigures are incomparable due to different scaling of the y-axis. Use equal scaling! If they are scaled to be comparable with respect to time, you should mention this and ignore the suggestion.
- A second y-axis should be provided showing time (age) instead of depth.
- Caption: (1) Typo in 19-th century. (2) Missing parenthesis in units around 'g DM'. (3) When you say that BSi starts with about 25 mg / (g DM) you should mention where, i.e. you should mention a depth or time.

Figure 3

- Enlarge the space between axis labels and plot region.
- Unit 'cm' should be in parenthesis.

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- Subfigures are incomparable due to different scaling of the y-axis. Use equal scaling! If they are scaled to be comparable with respect to time, you should mention this and ignore the suggestion.
- A second y-axis should be provided showing time (age) instead of depth.
- Caption: (1) I presume the correct term is 'epilimnetic', not 'epilimnic'. (2) Replace 'estimated' by 'as indicated'. (3) The last two sentences of the caption should be positioned before label (b) because there is no visible trend in the lower panel (Fig. 3.b).

Figure 4

- Enlarge the space between axis labels and plot region.
- Unit 'cm' should be in parenthesis.
- Subfigures are incomparable due to different scaling of the y-axis. Use equal scaling! If they are scaled to be comparable with respect to time, you should mention this and ignore the suggestion.
- A second y-axis should be provided showing time (age) instead of depth.
- The scaling of the x-axis should also be equal in all subfigures!
- A single legend may be sufficient for each row of figures. Remove box.
- Caption: I think it must be 'BSi/TP OR in BSi/BAP' instead of 'BSi/TP AND in BSi/BAP' (see Schelske et al, 1986).

Figure 5

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- Enlarge the space between axis labels and plot region.
- Legend is superfluous (single graph). Provide unit information in the caption.
- Let the x-axis start at zero.
- Remove chart title (by the way: you show a rate, not the deposit)
- Make individual data points visible. How many data are 'behind' the graph?
- Figure is too small.

3.3 References

- Farmer et al: Typo
- Psenner et al: 'Phosphorverbindungen' is one word; Check journal name (see Ahl, 1979)
- Stoermer: Typo

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