

## ***Interactive comment on “From soil water to surface water – how the riparian zone controls the transport of major and trace elements from a boreal forest to a stream” by Fredrik Lidman et al.***

**Anonymous Referee #1**

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General Comments:

I read the manuscript “From soil water to surface water – how the riparian zone controls the transport of major and trace elements from a boreal forest to a stream” by Fredrik Lidman and coworkers. Generally, I think that this manuscript quite good structured and provides new ideas/insights on the role of the riparian zone in chemical transport (affinity to organic carbon). Many of the graphs provide creative ways to explore the large dataset. This way, new insights into transport mechanisms related to the riparian zone are provided.

Generally, the abstract could highlight the main findings of this study more clearly. Additionally, the abstract could more clearly point out the “limits” of the state-of-the-art.

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Currently, the start of the abstract reads more like an introduction that points out the aim, but somehow does not strongly motivates the innovation/importance of the current study. Altogether, such changes to the abstract would be beneficial for the article, as it could attract more potential readers.

In several cases, clarifying the text, shortening sections and being more “to the point” might help to convey the message (especially in cases where the same message is repeated several times in a row). Overall, I think the article is creative, innovative and would be very suitable for publication. Most of the comments are meant to improve the general understanding and readability of the paper. Please consider my comments as minor revisions to the manuscript.

Small overall comments:

- A s some of the graphs do not provide additional information, the number of graphs could be decreased.
- A shortened title for the manuscript would certainly be beneficial. The title could also be a more direct sentence regarding the key finding in the paper.
- I sometimes miss direct comparison to other papers with a large amount of elements, e.g. what new message does this bigger data set provide e.g. in comparison to Lidman et al., 2014? Perhaps this could be more clearly expressed in the discussion of the results.

Specific Comments:

Abstract:

1. The abstract could be improved by stating the current gaps/limitations in one sentence in the abstract, e.g. the reason for investigating the large group of trace and major elements.
2. One of the strongest messages in the manuscript is probably that the enrichment of

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water in riparian zones is linked to the affinity with organic C, as the authors wrote in L. 20 – 22 (P1). I believe it would improve the manuscript if the results could stand out more clearly in the abstract.

3. The last two sentences of the current abstract are quite general (L. 24 – 26, P 1). In general, the fact that the riparian zone plays an important role in chemical transport is not new (Authors even cite this themselves in L. 3-5 (P2, Introduction)). It would be great if the implications of the study (summarized) could be closer related to the results, e.g. would focus more on the innovations. There are sufficient other interesting mechanism-ideas and results in the paper that do not really appear in the abstract.

Introduction:

4. In the first paragraph, the importance of the riparian zone is mentioned multiple times. This is okay, but sometimes the reasoning for different sections is relatively similar (e.g. the importance of the riparian zone on river water quality and lake water quality is mentioned in L. 3-5 (P2), L 11-13 (P2) and L13-15 (P2). I would advise to shorten this section of the introduction. If the focus of these sentences was meant differently, and the information is crucial for the introduction, authors need to rewrite this to make the difference in “emphasis” of both sections clearer.

5. Although the second part of the first paragraph is more focused on the “state-of-the-art”, L. 23 -25 (P2), closes the section again with the conclusion that the riparian zone is important for stream water chemistry. As read from comment 4, it might be nicer to end this section with a conclusion related to the literature. Improvements as proposed in comment 4 and 5 could make the text more concise and to the point.

6. In L. 26 the authors state that the role of a large amount of elements remains unexplored in the riparian zone, after summarizing a large group of elements in L 13 – 20 (P2) that already have been studied. Although I understand that there are indeed many more elements that have not been explored, the importance of a large amount of these elements is not discussed and might be limited for this type of system (e.g.

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raises the question: why would we care?). Here, I miss the link to the hydrological importance of other elements that have not been studied. This would also strengthen the statement afterwards that the riparian zone also plays an important role for other substances (this is important, because?).

7. Related to comment 6, the general reasoning that this study tries to obtain a more over-arching understanding of the riparian zone and the transport of elements is much stronger and could be more in the foreground as a reason to do this research. In that perspective, it would be useful to add relevant background-literature that already tries to understand and connect the transport of different elements (this is currently missing in this section).

Materials and methods

8. The authors describe the sampling locations in relation to the flow pathways of the groundwater. How are these flow pathways defined? What do these flow pathways look like? It would also be great to see the flow pathway along the 22 – 12 – 4 m transect. This would also be interesting related justification for using the stream water chemistry station 300 m. downstream.

9. At L. 25 (P3), there is a detailed description of the soil type of S22, but soil type information from the other two stations does not follow. It would be good to also mention this information for the other lysimeters. Now you have to somehow obtain this from L. 28-29, but this is not written directly. It would be great to have a profile description for S4, 12 and 22, so that you know in which soil layers the sampled water is located.

10. There is information about the depth of the organic layer, but the data is not 100% consistent, e.g. the exact depth of the organic layer for S22 is not directly given (e.g. L 26, is rather indirect with just giving a % below a certain depth). Additionally, I was wondering if there is a general soil map of the catchment. This is also related to the validity of the downstream water chemistry station. For example, Stockinger et al., (2014) (Seasonal soil moisture patterns: Controlling transit time distributions in a

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forested headwater catchment, WRR) reported about differences in transit time for a 38.5 ha stream with sampling stations that have relatively small distances. The map does not give any information about the differences in width of the riparian zone – soil type distribution.

11. Table S1 (not 2 as mentioned in the text) shows the porosities of the soil for different depths. Generally it is not clear why (1) porosities for certain depths are given (2) certain depths in the lysimeters are sampled. Is this related to soil layers/ groundwater conditions? In 2-3 (P4) the authors mention that the concentrations at S4, 12 and 22 are typical and refer to Figure S2. Some questions arise when looking at this graph. First of all, at what depth is the organic content measured and what do the quantile values represent? Secondly, in relationship to this 20 m. “catena” approach, where would the concentrations at the lysimeters show up?

12. The second part of section 2.1 represents more general information about the region, whereas the first part presents more specific information about the lysimeters. Would it not be more logical to twist this around, e.g. more general information first, specific information about the lysimeters after that?

13. Related to the profiles, the description of the sampling positions, including the depths that are not/ more frequent saturated (highest groundwater), it would definitely help the paper to schematically show the profiles, the sampling locations, the soil layers (as mentioned before) and the groundwater levels during different flow regimes (as presented in the results).

Results and Discussion:

14. Regarding table 1 and S3: an ANOVA analysis could be useful to determine the differences in concentrations for the different depths are significantly different.

15. I am not sure if Figure S6 and S7 are really necessary. An addition to table 1 with information on the trend of all measured elements would be more useful. The results

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as shown in S6 S7 could just be presented in written text, with a reference to the table.

16. L 15-17, P 8: As the authors are referring to Table 1, to state that certain elements have higher concentrations in the riparian zone. It would be great if Table 1 could somehow summarize which elements have higher/similar concentrations in the riparian zone, perhaps even with significance (significant difference, e.g. ANOVA). I like that Figure 4 summarizes this, but providing such information in Table 1 would definitely help (e.g. give the enrichment in the table).

17. Figure S4 presents interesting results, which might be important enough to bring to the main figures.

18. Section 3.6: the title of this section is a bit misleading. The section mainly discusses the more general implications of this study. It would be great if the title of this section could indicate this. One could additionally argue if part of the text here could be shortened – more to the point/ part of this section is more appropriate for the conclusion session.

General:

19. The manuscript contains several phrases with unprecise wording in it, such as “more or less”, which makes statements in certain sentences sound less precise. An example can be found in the second sentence of the abstract: “In the boreal region the riparian zone of headwaters often tends to be -wetland-like with high concentrations of organic matter, low pH and more or less reducing conditions.” Please consider rephrasing such sentences, especially in “fact-based” cases.

Technical Corrections: T1. Line 18-19 and 20-21 P3. Name of the measurement locations is clear and does not need to be justified (would be too much off track). Additionally, in L. 23 (P3), the station names are again introduced, but now with more detail. Information about the station names could just be directly added to the sentence in Line 18-19 (P3). Explanation on depth could come around L23, but does not need

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to be explained in detail afterwards.

T2: Line 4, P5: change "draught" to drought.

T3: Figure S1 is introduced after S2, please reorder figures according to order of occurrence.

T4: Add Loss on ignition (LOI) to the caption – as far as I could trace back LOI was not given before. This also occurred in other cases (e.g. S6 and 7 mentioned before S4) and should be avoided.

T5: P6, L 27, rewrite last sentence.

T6: P7, L 3-4. From the rest of the text, I understood that there is one profile with different sampling depths that are sampled during 10 different events. Here, it reads as if at location 22, there are multiple profiles. Please consider rewriting.

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