

Interactive comment on “Surface water acidification and critical loads: exploring the F-factor” by L. Rapp and K. Bishop

Anonymous Referee #3

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General Comments

This is a really well written and carefully argued paper which compares empirical F factor calculations to F factors from the SAFE model. It very effectively describes the derivation and assumptions of the empirical F factor approach and evaluates the dynamics of the F factor through the acidification and recovery. The paper discusses the implications of these dynamics and provides an evaluation of the potential impact on critical loads assessments at the national scale. The authors have been thorough and logical in their approach, and there is some interesting and important analysis with clear implications for the application of F factor approaches. It is a high quality contribution with wide significance to critical load modelling and assessments, and

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forms an excellent paper for publication is HESS. However, there are some points in the paper where additional clarifications would be useful.

Specific Comments

1. In section 1.2 the authors assume N is negligible, and defend this on the basis that N leaching is small from Swedish catchments. This is not the case in other countries (e.g. UK), and it would be useful in the discussion to pick up this point and briefly outline the implications of the main paper findings for when N leaching is elevated.
2. SAFE is used to provide F factors for soil water at 0.5m depth, whereas the empirical F factors relate to lake water chemistry. The authors should provide a fuller explanation and defence of this approach to re-assure general readers that the two sets of modelled data are comparable, and that the differences are not simply a function of processes causing soil – lake water differences.
3. The authors state that SAFE does not include S adsorption/desorption. Again, the authors should provide a fuller explanation of the implications of this to re-assure general readers that this is not significantly impacting on the analysis.
4. In section 2.2 it would be useful if the authors could briefly outline how each of the empirical equations was derived. Given the thoroughness in which the concept of the F factor is outlined in the rest of the paper, this would provide useful context.
5. The point made at lines 1-3 on page 3930 (section 3.1) (depletion of soil store of BC then S deposition decline) is a key point explaining the dynamics of the F factor and is crucial to the point the paper makes. As such it should be more clearly stressed in the conclusion, and possibly also in the abstract.
6. At section 4.2 page 3933 lines 14-15 the authors could usefully clearly state the direction of difference in CLs.
7. In section 4.3 the authors use scenarios of F factor change to assess implications for CLs assessments. They should more clearly defend the chosen scenarios, with

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particular reference to the findings of sections 3.1 and 3.2 (i.e. are the chosen scenarios realistic in the light of the observed differences between empirical and SAFE F factors).

8. Section 4.3 would also benefit from a slightly more complete description of the changing CLs with the different scenarios. For example, for the 50% F factor decrease scenario the point is made that the proportion of exceedances falls compared with the standard scenario, but the paragraph goes on to state that “The pattern is that high exceedances decrease and low exceedances. . . do not change”. The latter suggests changes in the amount of exceedance rather than the absolute number of exceedances. I think a data table here might help to clarify the changing distribution of CLs with the different scenarios.

9. In the conclusion it would be useful to more clearly and systematically state how estimates of F and CLs would change through the acidification and recovery phases i.e. don't just say there are errors, say in what direction these are. This is a really important aspect of the paper and needs to be clear at this point.

10. The abstract could also usefully emphasise this point by more clearly stating what the directional errors are in using F factors and CLs from contemporary (recovery phase) water chemistry samples.

Technical corrections

This is extremely well presented, and I only spotted a couple of phrasing errors:

1. Section 1 page 3919 lines 17-19: “is the. . . is the” 2. Section 4.3 page 3934 line 4: erase the s on depends

In Figures 3-5 the figure titles could make clearer what the sites in the North and South represent (i.e. low and high cumulative deposition). We all know that folk look at the diagrams without reading the full text. . .

The words ‘North’ and ‘South’ could also be placed next to the graphs on Figs 4 and 5

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(like in Figure 3.

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