Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2019-1-AC3, 2019


Biogeosciences Discussions

# *Interactive comment on* "Weathering rates in Swedish forest soils" *by* Cecilia Akselsson et al.

**Cecilia Akselsson et al.**

cecilia.akselsson@nateko.lu.se

Received and published: 3 May 2019

Below we list the comments from the Editor, followed by our answers. We also attach a pdf with this text, but formatted in a way so that it is easier to separate between comments and answers.

General comments Overall, the manuscript is well written and clear, although several sections are longer and a bit more tedious than others. In particular section 5 on "Potential for biological weathering", and section 8 on "Future research" could be streamlined. We will rework the chapter "Potential for biological weathering", so that the main conclusions from the paper about biological weathering are highlighted and details are removed. This will shorten the chapter by about 30%. The main measures are: -Shorten the introduction in the first paragraph by removal of the three first sentences on p14, line 19-22. -Removal of details about the capacity of EM fungi



to allocate C selectively to different minerals, by removal of 2 sentences starting on p15 line 34, describing results in three studies (Smits et al., 2012; Leake et al., 2008; Schmalenberger et al., 2015). -Removal of redundant first sentences in paragraphs starting on p 16, line 17 and 25. -Removal of paragraph starting on p16, line 33 and ending on p17, line 6, about the study by Smits and Wallander showing the effect of vegetation on apatite weathering. It is enough to mention that the effect of vegetation is partly but not fully built in to the models in the following paragraph. -Removal of the last two paragraphs, starting on p17, line 26 and ending at p18, line 9, which are based on on-going work, and thus would have needed even more explanation for the reader to be able to evaluate it. We agree that the section about future research is too long and insufficiently focused. This is in line with comments from Referee 1, and our answer here therefore overlaps to a large extent with our response to Referee 1. We will shorten it substantially, so that only the parts describing actual future research are kept. We list our major changes below: -The first paragraph will be replaced by one sentence which introduces the chapter. -The chapter "8.1 Model development: Biological weathering" will be more straight forward towards actual model development. Thus, the first paragraph will be removed, so that the chapter starts with the sentence "Existing models. . .". Minor adjustments are required in that paragraph, since it refers to the paragraph that will be removed. The last paragraph will be removed. -The chapter "8.2 Model development: Higher resolution chemical reaction" is repeating some of the results presented in chapter 6. The repetitive text will be removed (large parts of the first paragraph). -The chapter "8.3 Model development: Implementing weathering brakes" will be shortened, by removing the first part, going directly to the actual work that needs to be done to better model the saturated zone. -The chapter "8.4 Model development: Weathering below the root zone – for surface water quality assessments" will be shortened by removing most of the first paragraph, jumping directly into the further testing and improvement of the ForSAFE-2D model. -In the chapter "8.5 Reducing uncertainties in model input data", a few parameters that are of key importance but where the uncertainties are large, are gone through. This chapter will be shortened

by removing much of the text describing results from a number of studies, and instead going directly in to what needs to be improved. -The first paragraph of the chapter “8.6 Comparison between modelled weathering and other estimates of weathering” will be removed. The last paragraph will also be removed, but parts of it will be incorporated in the chapter were the results from the site level approaches are presented. The challenge addressed in the manuscript is whether the losses of nutrients due to forest harvest can sustainably be balanced by release of nutrients by chemical weathering. This simple mass balance could be illustrated with a conceptual diagram showing the relevant fluxes at the beginning of the manuscript. Such a diagram might help focus on the important sources of uncertainty in long-term predictions of sustainability. We will add a figure in the Introduction, showing the relevant fluxes in the simple mass balance of base cations in the forest (weathering, deposition, harvest losses and leaching), to put our weathering results and the sustainability assessments in a context. The most important question the manuscript, and indeed the QWARTS program addressed is if weathering rates, as computed by different models, are greater than or less than rates of harvest loss. The range of weathering values from different models gave a sense of uncertainty in weathering rates, but harvest losses were presented as a single value at each site. There must be uncertainty in export losses due to harvesting, and it seems important to convey what these uncertainties are. We agree that the sustainability of harvesting is an important part of this paper, and that the uncertainties in the harvesting estimates should be mentioned. Research related to those uncertainties were not included in QWARTS, which focused on the actual weathering rates, but we will add a paragraph about the uncertainties, based on results from other studies, e.g. Zetterberg et al. (2014) in Science of the Total Environment. Two aspects of weathering that I would have expected to be important (and that might be highlighted in the conceptual diagram I suggest above) are rock type and depth of weathering. The first of these is perhaps simpler to consider. Rock type or soil substrate was not described anywhere or for any site. I could not tell if this was because all of Sweden has the same rock type, and so is dismissed as playing any role in variations in weathering rate



or nutrient release, or if something else was going on. I would expect rock type to be the very first control on weathering rate, as nutrient availability on basalt vs limestone vs serpentinite vs : : :. is quite different. The depth of weathering is a more difficult problem to address, yet could also be important. Weathering often occurs at depths below the top 30-50 cm. Yes parent material is of key importance for weathering rates. We will include a table describing parent material, possibly as a supplementary table. For the sites in which some of the authors have been involved in the weathering estimations, we have thorough databases from which we can get the information. For the other sites, we will extract information from published papers. We have focused on the root zone in this study, since we are interested in the sustainability of forestry. Therefore, for this study we see the depth of the root zone as more interesting that the weathering depth, therefore we haven′t discussed the weathering depth. In Swedish applications the depth 50 cm is often used, based on studies in Sweden. In this paper, where one important aim is to compare different approaches, we have included sites where weathering rates have been calculated to deeper depths, up to 1 m, but we have only accepted sites where the different approaches have been run to the same depths. In the sustainability calculations only sites with depths<0.7 m are included. The uncertainties related to how much of the soil profile the roots can reach are large. We address this in the section about sustainability: “Currently there is even less research on weathering rates in relation to root depth. . ..than on weathering.”

A few detailed comments: Acronyms should be deïňĄned at their ïňĄrst use. Several are not deïňĄned at all, or only after their ïňĄrst use (this list may not be exhaustive): UNECE, CLTRAP, EMF, A2M Will be done! Whole-tree harvesting is deïňĄned on p3 as being “harvesting of branches”. Does this imply that stems are not included in whole-tree harvesting? This seems contradictory. Stems are included in whole-tree harvesting, we will clarify that! Total-regression analysis: what is the temperature sum? The temperature sum is a measure often used in forestry. It is the daily mean temperature above a threshold value, in Sweden often +5°C, summed during the growing season. We will develop this a bit in the text. Now we only refer to a

paper (Morén and Perttu). Figure 5: The boxes in the key are so small that they are indistinguishable. The gray patterns all look very similar. We will improve Figure 5 based on the comments. Figure 5 is now written twice in the figure caption, we will correct that. p 8, line 5: Casetou-Gustafson's name is incomplete. Will be corrected. p10, line 4: cation, not carion Will be corrected. p 12, line 9: Ca, Mg and K at 640 sites, not Ca, Mg and K on 640 sites Will be corrected. p. 17, line 2: to sparse grass, not via sparse grass Will be corrected. p. 17, line 2: naturally lead-contaminated, not natural, lead-contaminated. Will be corrected. p. 18, line 23: However, in 1996..., not However, already in 1996.. Will be changed.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2019-1/bg-2019-1-AC3-supplement.pdf

---

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2019-1, 2019.