

Interactive comment on “Decoupling silicate weathering from primary productivity – how ecosystems regulate nutrient uptake along a climate and vegetation gradient” by Ralf A. Oeser and Friedhelm von Blanckenburg

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*A note upfront from the submitting person: This review was prepared by four master students in geography at the University of Zurich. The review was part of an exercise during a second semester master level seminar on “the biogeochemistry of plant-soil systems in a changing world”, which is organized by prof. Dr. Michael Schmidt and myself. We would like to highlight that the depth of scientific knowledge and technical understanding of these reviewers represents that of master students. We enjoyed discussing the manuscript in the seminar, and hope that the comments will be helpful for

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the authors.*

1. Summary

Oeser and Blanckenburg (2020) have evaluated the quantitative impact of plants, their nutrient cycle and growth on weathering processes. Therefore, they have explored weathering, nutrient uptake, and nutrient recycling along the “EarthShape” climate and vegetation gradient in the Chilean Coastal Cordillera. There, the lithology (granitoid), tectonic uplift and erosion rates are generally similar. While the mean annual temperature (MAT) is similar, the mean annual precipitation (MAP) has a strong increase from north to south (precipitation differs from 10 mm yr⁻¹ in the north to 1100 mm yr⁻¹ in the south). Within their study they are covering arid (Pan de Azúcar National Park, ~26°S), semi-arid (Santa Gracia Nature Reserve, ~30°S), mediterranean (La Campana National Park, ~33°S), and humid-temperate (Nahuelbuta National Park, ~38°S) areas. Moreover, different vegetation types, controlled by climate, are taken into account. To identify the sources of minerals nutrients to plants, they have quantified the bio-available fraction of nutritive elements in regolith and have measured ⁸⁷Sr/⁸⁶Sr isotope ratios in bulk rock, regolith, and plant samples. Using these measurements, they determined inventories, gains and losses of nutritive elements in and out of these ecosystems, and quantified mineral nutrient recycling.

The following research questions were addressed: Does weathering increase from north to south along the EarthShape precipitation gradient? Can the increase of NPP from north to south be explained with the additional nutrient supply by weathering? They found that the weathering rates do not increase from north to south along the climate gradient even though the four EarthShape study sites feature a steep north-south gradient in MAP and NPP. Instead, the simultaneous increase in biomass growth rate is accommodated by faster nutrient recycling. Moreover, the presence of plants compensates a potential weathering increase along the gradient downward by regulating the hydrological cycle. Furthermore, the vegetation induces the formation of secondary minerals, which in turn promote a microbial community adapted to nutrient recycling

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through weathering. Oeser and Blanckenburg conclude that higher NPP may not be an important driver in the global silicate-weathering cycle due to this nutrient buffering by recycling.

2. General Comments

First of all, it is a very interesting and relevant study with the goal to investigate processes that are not yet fully understood. By investigating four climatologically different locations and corresponding different vegetation, the authors have taken a good approach to their research question, where Chile seems to be an ideal research site. However, in the paper a lot of different aspects and factors were included. We were wondering if some topics go beyond the scope. Therefore, you might consider to narrow down some aspects and factors. The discussion part is really interesting but without a lot of notes and rereading the text, it is really hard to understand and follow the main messages.

Our general opinion is that some parts of the paper are not structured clearly, especially in the beginning, which makes it hard to keep track. By improving that, a lot of our following criticism will be redundant.

We do not comment on the applied measurements and analyses methods, since we do not have the appropriate expertise to evaluate these. However, what caught our eye was that no statistical method was mentioned, which could be included additionally.

Having said that, the structure improved towards the end. We appreciated that in the results and discussion subtitles are used which makes it easier to navigate and keep up with the text. We found that the usage of literature is very good on which the argumentation is based on. Furthermore, we really enjoyed the graphs, they are nicely visualized. We thought that the title may be a bit long but seems appropriate to introduce the study.

Language and definitions:

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We often find that the authors have written in a complicated manner where the sentences are too long and interlaced. It is very hard to follow the statement and thoughts.

- We would suggest coming up with shorter and more precise sentences
- Also you might try to include more topic sentences

Furthermore, we found some concepts, short forms etc. without sufficient references or definitions. This leads to some difficulties during reading, and we propose to be more consistent when introducing short forms and concepts. For example: - p. 3, line 86: for the reader it is not that clear what EarthShape is, maybe introduce it shortly with a few sentences as a long term research project; especially since concepts of that project are important for the presented study

- Wxregolith etc. is not comprehensible = weathering from regolith and bedrock. Would it not be better to call it Wxsupply?

- p. 11, line 316: define new introduced short form U as uptake more clearly similar to the previous paragraphs

Typos:

We found some typos which are listed below, therefore we suggest some revision grammar- and spelling-wise: - p.2, line 50: nutrients budgets

- p.2, line 53: an increase in nutrient supply through weathering with erosion rates → do you mean: with increasing erosion rates?

- p. 4, line 100: along the along the

- p. 5, line 155: soul-facing

- p. 9, line 263: we focus on

- p. 40, Fig 4/A4 emphasize

- Some numbers are different in the text than in then tables, is this intended?

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- p.41, table 5: Value of mean Mg in La Campana is in the table 12'300 and in the text on page 10 line 313 it is only 12'000

- p.41, table 5: mean P in Nahuelbuta is 1300 in the table and 1400 on page 11, line 316

3. Comments on manuscript

Introduction

- In our opinion, the introduction seems too long and weakly structured. We guess not all the information is directly relevant for the specific topic of the article.

- p. 4, line 100-103: The research questions could be formulated more clearly. Maybe use 2-3 sentences to make it clearer. As we understand the question (1): "Is weathering increasing from north to south along the EarthShape precipitation gradient? We want to investigate the differences, although (or precisely because. . .?), there are similarities concerning mineral supply, dissolution kinetics of solids due to erosion rate and lithology."

- p. 4, line 103-104: Why are the research questions already answered in the introduction? We think this belongs to different text bodies with some links to these questions here.

- p. 4, line 104-106: In our opinion, this should be an outcome of the results, discussion and to conclude at the end. If you were able to identify something else than planned from the beginning, why not add or adjust the research question?

Study area and previous results

p.4, line 108: "Previous results" in the title is not clear for us. Is this meant as results from previous studies? If yes, we would recommend to put citations or the few relevant points for this continuative study. This could be the main part of the introduction.

Sampling

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- We can't find any explanations why there were different amounts of samples (bedrock and regolith) taken depending on the locations. e.g. there are less samples for Nahuelbuta

- Descriptions of the sites, sampling and why at some sites specific samples could not be taken could be written in the method part and not later in the text (e.g. discussion) e.g. p.18, line 544: Santa Gracia - the absence of a litter layer

Results and discussion

- p.10, line 304: "Bio-availability of most elements in soil, bar a few exceptions, increase from Pan de Azúcar to La Campana and is lowest in Nahuelbuta." - We are not sure if you can generalize this like that, there are a lot of exceptions: Ca/ Na is rather decreasing, Mg is lower in La Campana, Si is the same for Pan Azucar and Santa Gracia and Sr the same for Santa Garcia and La Campana. The only nutrients which increase are Al, Mn, P and kind of Fe, but there the value for Pan de Azucar is missing

- p.10, line 310: "Average elemental concentrations in bulk plants decrease from Pan de Azúcar towards Nahuelbuta." → We think there are a lot of exceptions too: There are higher values in Santa Gracia (17'800) than in Pan Azucar (15'200) for Ca, higher values in La Campana for Fe,Sr, K and higher values in Nahuelbuta for Mn and Mg

- p.11, line 315: "The nutrient-uptake fluxes of the two most important rock-derived mineral nutrients to plants, P and K, increase steadily from north to south. . ." - we wondered if "steadily" is the right word since there is an exception for Nahuelbuta (1400) which is lower than for La Campana (2900) for K

- p.13, line 377: "As an evaluation of the hypothesis that the nutrient reservoir sets plant stoichiometry ..." → We would recommend that you formulate your hypotheses already in the introduction and not only in the discussion part (like on p.1, line 30)

- p.16, line 480: Why do you introduce the turnover time differences in the discussion part and not in the results part? You might want to consider introducing this term as

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well because you use the term a lot in the discussion part.

- p.17, line 513: “We speculate that the effect of vegetation might even compensate for a potential increase in weathering that would be caused by the increase in MAP, essentially damping the geogenic pathway.” - Would it not be better to include this part in the conclusion?

Conclusion

- We found that you did not clearly answered the research questions from the introduction

- Missing structure: The first two sentences are well understandable but the thoughts or statements are not properly formulated. To separate the sentences might help.

- p. 19, line 573-574: why still “geogenic nutrient pathway” and “organic nutrient cycle” in quotation marks?

- It seems that the functions of the pathways are one main outcome. Better links to the results, discussion and research questions would be desirable.

Figures and Tables

- We would suggest not to use red and green in the same figure for a gradient/ symbols because of color-blind people (e.g figure 1, 6)

- For us, an illustration summarizing the results would help the understanding of the paper (maybe like figure 1)

- Figure 1: The soil profiles are very nicely designed. We would suggest to rather cut out the “EarthShape study area” labeling and scale up the soil profiles for better visibility

- You refer a lot to tables in other papers which is very confusing (e.g p. 13, line 378) - You might put the most important ones in the appendix.

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- For a better visual understanding, it would be nice if you take the same symbols for the same nutrients e.g. Figure 6 orange triangle for Mn, Figure A1 orange circles for Mn

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