

Response to Reviews of: **Leaching of inorganic and organic phosphorus and nitrogen in contrasting beech forest soils – seasonal patterns and effects of fertilization**

Review #1

The Ms of Fetzer et al. entitled ‘Leaching of inorganic and organic phosphorus and nitrogen in contrasting beech forest soils – seasonal patterns and effects of fertilization’ quantifies annual organic and inorganic P and N fluxes from organic layers and from the mineral topsoil. For this purpose, zero-tension-lysimeters were used in the three soil horizons that were artificially irrigated to standardize water flow. The authors established a comparative study; two sites under beech with different phosphorous availability and sorption capacity (sandy soil and a soil on basalt) were selected, and both sites were subjected to a full factorial N×P fertilization experiment. During the 18-months monitoring period, the sites were sampled five times.

In the context of increasing nutrient imbalances in trees and the occurrence of more frequent and intense climate extremes, the topic of this manuscript is of great importance to both science and practice. The experimental design is state of the art. I like very much that the authors have established a comparative study. The novelty of the study is that the dissolved inorganic and organic N and P fluxes are compared at different nutrient availability of the soils. I think this is not often done. The manuscript is well structured and very well written. After the presentation of the results, the hypotheses are discussed in detail on the basis of the results found and with reference to other studies. The conclusions are clear and based on the results of this study. I recommend the publication of this study in Biogeosciences with minor revisions.

Thank you very much for this positive feedback.

Specific comments

95-100 Please provide information to the humus type and to the stand characteristics

Comment author: We added the missing information in lines 93, 95, and 100 as following:

“The study was conducted in two mature beech forest stands in Germany with contrasting parent material and P availability. **The stands are dominated by 120-140 year old *Fagus sylvatica* (Lang et al., 2017).** The soil with high P stock (Table 4) is a loamy Cambisol developed on basalt at Bad Brückenau (BBR, 809 m a.s.l., 50.35° N, 9.27° E, referred to “high-P site”) **and a mull-like moder organic forest floor layer (Lang et al., 2017).** The soil with the lower P stock is a sandy Cambisol, featuring a thicker organic layer and initial podzolization at Unterlüss (LUE, 115 m a.s.l., 52.8° N, 10.3° E, referred to “low-P site”) that developed from glacial till. **The organic forest floor layer is a mor-like moder (Lang et al., 2017).”**

120 Zero-tension-lysimeter: Is the setup similar to Makowski et al., 2020 JPNSS? If yes, you may refer to it because this paper provides more detailed information.

Comment author: Correct, the lysimeters we used in the mineral soil (lowest depth) are similar to those used by Makowski et al.. We added the reference to this paper in line 131: “..., having a design similar to those used and described in greater detail by Makowski et al., 2020b.”

Reply to the Reviewers

435 You argue that P leaching reinforces nutrient imbalance between N and P. I am not sure if that can be concluded based on your study. Please explain in more detail your conclusion regarding the contribution of P leaching to nutrient imbalances.

Comment author: We relate the N and P leaching to the atmospheric inputs of the two elements, which shows that P leaching as compared to P deposition is higher than for N. To clarify our argumentation, we rephrased the sentence in the lines 483f as follows:

“Therefore, it seems that the leaching losses relative to atmospheric inputs are greater for P than for N, which likely fosters the nutrient imbalances between N and P (Peñuelas et al., 2013)”.

440 Julich et al. (2017 in Forests) quantifies the P export from a small forested headwater-catchment in the Eastern Ore Mountains; their annual fluxes were between 2 and 4 mg m⁻² and year. These data support your argument.

Comment author: Thank you for pointing out that reference, it indeed supports well our discussion. We added it in line 487ff as follows:

“This is supported by annual export rates of P measured in the runoff of forested catchments in Germany of 2-9 mg P m⁻² yr⁻¹ (Julich et al., 2017; Sohrt et al., 2019).”.

530 Please note that N deposition is significantly underestimated due to canopy exchange processes as discussed by Bobbink et al., 1992 (in Environmental Pollution), Talkner et al. 2010 (in Plant and Soil) and others.

Comment author: Thank you for this comment. Assuming that N depositions are even higher than reported due the mentioned underestimation, would strengthen our argumentation, as the difference between P fluxes relative to reported P deposition and N fluxes relative to reported N depositions would be even larger.

The revised sentence in lines 480ff reads as follows:

“In comparison, N fluxes from the A horizons are only 30% and 28% of atmospheric N depositions that have been measured at the same high-P and the low-P site (Brumme et al., 2021; NW-FVA, 2020), which might even represent an underestimate as atmospheric N inputs are generally not completely captured due to canopy exchange processes (Talkner et al., 2010).”