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Interactive comment on "Base cations in the soil bank. Non-exchangeable pools may sustain centuries of net loss to forestry and leaching" *by* Nicholas P. Rosenstock et al.

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Anonymous Referee #2

In relation to biomass harvest, especially whole tree harvesting, I'm also interested in quantification of sustainable levels of biomass harvesting or soil productivity without nutrient inputs in forest ecosystem. By the subtraction of each extraction of base cations, it is meaningful to demonstrate the sources of base cations or availability for plant uptake. In addition, as the report of the potential size of soil nutrient pools in base

cations is fewer than that in nitrogen, the data of soil base cation concentration from different soil fraction in each horizon are valuable.

However, soil sampling depth was discrete and not continuous from surface soil to lower in each soil pit.

Soil sampling was indeed discrete, but effort was taken to represent each discernable horizon in the soil, and determine an inventory for the entire soil profile. Furthermore sampling depth within each horizon was broad (5-10 cm) to integrate as much as possible. The depth and bulk density of each horizon was taken into account when converting from extraction contents to available pools per unit forest area. We have added to the supplementary methods section to make this more clear. "To calculate the total available nutrient pools on an areal basis, nutrient yields from each extract (mg/kg soil) and each horizon were multiplied by the dry soil mass of that horizon, which is the product of the bulk density and the depth of that horizon, which was measured at the time of sampling."

Moreover, soil bulk density was not shown in each depth.

We thank the reviewer for pointing this out. Bulk density was estimated for each horizon with the pedo-transfer function from Nilsson and Lundin (2006) based on depth and organic carbon content. We have now added bulk density to table 1, and detailed the method used in the supplemental methods section. Actual measurements of bulk density would be preferable, but they were not available at the time of sampling. Given our use of the data, we deem the bulk density values obtained from these pedo-transfer functions to be suitable. This pedo-transfer function was derived from hundreds of Swedish soils, with similar soil types, and the error can be expected to be under 15%. We have now added discussion about the potential variation between the calculated bulk density values and the actual bulk density in the supplemental methods.

Therefore, estimation of all amounts of soil base cation was unsatisfied with the prerequisites of mass-balance method and improper as utilization of mass-balance method;

this estimation was not able to indicate correctly the all amounts of base cations in each soil pit although comparison of the amounts and trends of base cations among the horizons in each soil would be possible from surface soil to lower or from upslope soil to downslope.

While more comprehensive sampling would have improved the precision of our data, we do not think the use of discrete sampling depths and a pedo-transfer function to estimate bulk density stands in the way of our interpolating the discrete observations to estimate the base cation content across the entire soil profile. Therefore we believe that our mass-balance analysis of the soil nutrient pools is valid, with all necessary calculations and assumptions specified. The mass-balance estimates are based on estimated flows into and out of the system, and, as such, are not affected by bulk density or soil depth. (The weathering model also uses bulk density measurements). We examined different extractant-defined nutrient pools and compared their magnitude; these different pools were equally affected by the use of a pedotransfer funtion to estimate bulk density and the use of discretized depths for sampling. The comparison of mass-balances to soil nutrient pools over the course of a year or an entire forest rotation may have been affected by the use of a pedotransfer function to estimate bulk density and the use of discretized depths for sampling, but here our focus was more on how the estimated time periods that different nutrient pools could sustain net ecosystem losses compared to one another, and less on the absolute numbers

Furthermore, if the comparison of uptake fluxes of base cations among the soil pits with the difference of the hydrological gradient, as in the difference of moisture condition of the soil pits, amounts of uptake of base cations by plants should be different among the soil pits, you should examine the uptake by the soil pit.

It was not possible to measure nutrient uptake at each position along the hydrological gradient. What we do have data for is relative growth rate (table 1; site index), and while growth is similar along the gradient, the trees at the lower end of the gradient (downslope groundwater discharge) exhibit the highest growth rates, and those at the highest

end (upslope groundwater recharge) exhibit the lowest growth rates, while those at midslope (groundwater recharge) exhibit intermediate growth rates. The biomass uptake values we have are for the trees at the midslope (site index = 24; table 1). We can thus infer that uptake rates at the downslope location (site index = 25) will be somewhat higher, and those at the upslope position (site index = 23) somewhat lower. Zetterberg et al. (2014) have shown that at this site (Kindla) an increase of site index from 24m to 28m corresponds to an increase in the total biomass from 182 to 193 tonnes ha-1. Hence, increasing the site index by 1m can be expected to affect the biomass by less than 2%. We will add discussion about the potential for this variation in uptake rates to affect our projections of the time period that different nutrient pools can buffer net losses for.

Finally, although this manuscript provides some interesting scientific results, due to misuse of mass balance method and rough estimation mentioned above, it is difficult to accept for publication in Soil in this time, and I suggest to submit to other journals or resubmit to.

We hope that the revisions have presented our methodology more clearly so as to show that we did not “misuse” the mass-balance method. Thus we have hopefully now succeeded in demonstrating that our calculation of pools are not flawed by being based on sampling at discrete depths.

References: Nilsson, T., Lundin, L.: Predictions of bulk density of Swedish forest soils from the organic content and soil depth. Report in Forest Ecology and Forest Soils no 91, Swedish University of Agricultural Sciences, Uppsala. ISSN 0348-3398, 41 pp. (In Swedish, English summary), 2006.

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