

## ***Interactive comment on “Stable isotope signatures of soil nitrogen on an environmental-geomorphic gradient within the Congo Basin” by Simon Baumgartner et al.***

### **Anonymous Referee #1**

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General comments The study used  $\delta^{15}\text{N}$  of soil profiles to assess ecosystem-level differences in N cycling in three forest ecotypes within the Congo Basin (tropical lowland forest, tropical montane forest, and subtropical Miombo woodland). Based on the distinct  $\delta^{15}\text{N}$  soil profile observed in each forest, the authors conclude that the montane forest indicate a closed N cycle the lowland forest and Miombo woodland tended to have more open N cycles. The study also examined the effect of surface slope angles on  $\delta^{15}\text{N}$  in the same forests to quantify local differences induced by topography, but they found a contrasting effect. Furthermore, the study did a pan-tropical analysis of soil  $\delta^{15}\text{N}$  to reveal that rainfall, vegetation cover, and topography are the main factors to explain  $\delta^{15}\text{N}$  variability between five different tropical forest sites. I find the submission

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to be well-written and relatively thorough with valuable contribution to the literature on N cycling in tropical forests, for which limited information is available. The subject of the study is suitable for SOIL. However, there are some conceptual and technical problems and manuscript should be revised before it is accepted. General comments Although the study briefly mentioned that soil  $\delta^{15}\text{N}$  values can signal openness of ecosystem N cycle (line 68-69), it lacks explanation on how soil  $\delta^{15}\text{N}$  values are interpreted as integrator of N cycling. Indeed, the interpretation of soil (and plant)  $\delta^{15}\text{N}$  values as indicators of N availability is not straight forward with many contradicting interpretations of observed pattern of soil/plant  $\delta^{15}\text{N}$ , and this need to be highlighted in the study with relevant studies from local to global scales. Many factors (not only N availability) affect soil  $\delta^{15}\text{N}$  values at a given site and across sites. Particularly, I am concerned with the lack of data on plant  $\delta^{15}\text{N}$ . There is no linearity between soil  $\delta^{15}\text{N}$  values and N viability, and this needs to be acknowledged in the manuscript in depth, which is also supported by the data in this study. Another major issues/question is why only five sites are included in the SEM? As a result, the SEM was also overly simplified (few sites and few potential variables). Some relevant studies from the bulk studies in other tropical forests in Africa, SE Asia, and S America should be included in the analysis as well as discussion of the results in this study. Specific comments Line 16: Change ‘stable isotope signature’ to ‘natural abundance of stable  $^{15}\text{N}$  isotope’ Line 23: ‘no influence of topography on soil N cycling’. This is not supported by the study. No effect of topography on soil  $\delta^{15}\text{N}$  does not mean that topography has no effect on soil N cycle, which is broader than soil  $\delta^{15}\text{N}$ . The author needs to be more cautious when using N cycling instead of soil  $\delta^{15}\text{N}$ . Line 24: ‘ $\delta^{15}\text{N}$ ’ needs to be referred to consistently (soil  $\delta^{15}\text{N}$ , soil  $\delta^{15}\text{N}$  signature, stable isotope signature. . . are all used to refer to soil  $\delta^{15}\text{N}$  in the manuscript). Line 35: ‘However’ does not seem necessary Line 44: replace ‘forest’ by ‘forests’ Line 52: Delete ‘activity’ Line 55: Correct ‘intact’ as ‘an intact’ Line 58-62: revise these sentences. Consider this ‘Some studies from geometrically active sites of the tropics (Costa Rica and Taiwan) found lower N availability and more closed N cycle in steeper sloping positions suggesting that erosion has a significant control on

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N cycling (Hilton et al., 2013; Weintraub et al., 2015). However, and the magnitude of this effect in more stable landscapes is unknown calling for a consistent study across geomorphic gradients in the tropics. Line 64 : Edits 'The stable isotope composition of N ( $\delta^{15}\text{N}$ )' as 'The natural abundance of stable  $^{15}\text{N}$  isotope ( $\delta^{15}\text{N}$ ) of plant and soil pools' Line 66: should be 'insights into' Line 75-82: A testable hypothesis about the pattern soil  $\delta^{15}\text{N}$  and N availability and openness of N cycle is needed. I would also question the hypothesis that soil  $\delta^{15}\text{N}$  would be lower on steeper slopes because the erosion on steeper slopes removes fresh organic matter input from plants, which would continuously keep  $\delta^{15}\text{N}$  of surface soil low compared to the deeper surface. Line 93: Are both forests used in this study? Line 130: 'Laboratory' is more formal Line 135: provide  $\delta^{15}\text{N}$  of the atmospheric  $\text{N}_2$  Line 146-147: Why only these two sites were chosen? Line 155 (last sentence): Consider putting it at the end of the paragraph Line 157-159: The SEM analysis was very simple with only five sites with only few potential factors that affect soil  $\delta^{15}\text{N}$  being included in the model. What are the variables included in the model? Line 161-165: The values of these variables needs to be directly presented; it is not enthusiastic to many readers to extract the information from the Table (estimates). Line 187: I would not use 'N cycling'. This study did not investigate the many aspects of N cycling. More importantly, the many factors known to affect soil  $\delta^{15}\text{N}$  and which are very important to interpret soil  $\delta^{15}\text{N}$  are not measured. Line 188-89: Eshetu et al., 2004 *Forest Ecology and Management* 187, 139–147 (Ethiopia) and Gerschlueret et al., 2019 *Biogeosciences* 16, 409–424 (Tanzania) are some of the relevant references missing. Line 207-208: This is not necessarily true as lower soil/plant  $\delta^{15}\text{N}$  is not always associated with limited N availability (closed N cycle). Gurmesa et al., 2017 *Biogeosciences*, 14, 2359–2370 (many other studies in SE Asia) have reported ecosystems pools can be strongly  $^{15}\text{N}$ -depleted under N saturated condition. Line 209: how about the effect of  $\delta^{15}\text{N}$  of deposition N? Craine et al., 2015b? Line 214: depleted N-input from where? Only biological N deposition? Do you have data for  $\text{N}_2$ -fixing plant species as well as their mycorrhizal association in the three forests? These are very crucial to interpret soil  $\delta^{15}\text{N}$  values. Line 236: this

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sentence does not help with the logical flow points being discussed in the paragraph Lines 237-238: Line 226-227 repeated? Again, as I mentioned above, low soil  $\delta^{15}\text{N}$  does not necessary indicate closed N cycle. The context needs to be discussed. To say whether N cycle is dominated by organic N, it needs additional measurement. Is there data for soil inorganic N concentration in each forest? Line 239: Edit 'excess of available N' as 'excess N availability'. However, it is not correct to conclude that the forests have excess N availability only based on the values of soil  $\delta^{15}\text{N}$ . Line 240: It is amazing that the author did not provide data on N deposition for any of the sites (including those from literatures). Line 248: change 'soil N' to 'soil  $\delta^{15}\text{N}$ '. the discussion about effects of topography on soil  $\delta^{15}\text{N}$  is interesting, but it did not establish mechanistic relationship of topography with other factors known to strongly affect soil  $\delta^{15}\text{N}$ . The implication in discussion here is that soil  $\delta^{15}\text{N}$  is strongly affected by physical process (erosion) and the factors that control the erosion. Line 289: 'samples' or 'sites'?

Few technical corrections /writing Line 19: delete one of the 'in's Line 65: Should be Craine et al., 2015a. Also check line 209. Figure 2: first letter in y-axis label should be capitalized Figure 3: first letter in x-axis label should capitalized Table 2: Is it important to have all those decimals for fixed effect Estimates? References Clarke et al., 2013 (Line 32) and Vitousek 1985 (line 40) are missing. The superscript in  $^{15}\text{N}$  or  $\delta^{15}\text{N}$  are not correctly written for many reference

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