

The study aims to assess the importance of redistribution of phosphorus between seasonally flooded and upland (terra-firma) within Amazonian sub-basins by animals (herbivore and detritivore). Different theoretical sub-basins (characterized by different soil water content for upland and different P input from flooding) are studied. The final question is to understand if such process can contribute to prevent Amazonian ecosystems to fall within terminal steady-state.

The horizontal redistribution of nutrient - P here- by animals is a relevant research question (and, I have to admit, new for me) and I encourage publication. The theoretical framework used to answer to the question is interesting. Both the introduction and discussion are well written. However some clarifications in the Methods section as well as additional description/analysis in the Results section are required. That is why I recommend major revisions before any publication.

Major comments

1) I found that the Results section is too short, not totally clear and deserves deeper analysis. More details are given below:

- one of the key process (animal consumption leads to both decrease and increase losses – respectively through redistribution towards terra-firma with lower leaching and towards dissolved P pool prone to higher leaching) quoted p12,L16-17 should be illustrated and more strongly demonstrated: e.g. by using following plots: dissolved/total P ratio as function of the consumption rate, leaching from available P as function of the consumption rate, total leaching of the sub-basin as function of the consumption rate, etc.

- there is no combination humid x poor (see methods and Fig 4 and 5) while it is mentioned on p12,L9 and while continuous values of soil water content for Varzea are used in Fig. 7 left panels. In Methods, only two values are used for soil water content of terra-firma (0.35 and 0.6 given on p11,L14) while a range is given in Table 3.

- the redistribution sensitivity to the transfer from land to river by piscivores is described in two separate paragraphs: p12,L13 and p12,L32. They should be put together.

- p12,L15: the meaning of “optimal” is not clear: do the authors mean *maximum* of biomass in vegetation? for terra-firma or whole sub-basin?

- p12,L19-30: not clear. E.g. the maximum biomass on terra-firma for rate of 0.2% mentioned L19 applies only to Caqueta-Japura? What explains the “difference of 1%” (L20) is not clear. The role of gradient between flooded and terra-firma and the role of the leaching is mentioned but not demonstrated (see above). The authors should refer to the Fig.7 in this section (this figure underlines the role played by soil water content). “ In contrast” (L25) does not make sense because previous sentence focuses on whole sub-basin while the following sentence focuses on terra-firma. Why “redistribution causes more losses than gains” (L26) ? What explains one major finding (for dry x poor combination, terra firma has larger P than flooded area) is not clear.

- Fig.4: what is the default value used for detritivore consumption rate? Fig.5: what is the default value used for herbivore consumption rate? This has to be given in the Method section.

- Fig.4 and 5: the authors should show on the same plot the P in vegetation for seasonally flooded and terra-firma. This will show more clearly that terra-firma > flooded area on Cerrado sub-basin.

- Figs.4 and 5: remind “dry”, “humid”, “rich”, “poor” on the different line/column titles to help the reader

- Fig.6: the fact that fig 6 focuses on P in vegetation of terra-firma (as explained on p13,L2) is missing in the caption.

- the interpretation/reading of some Figures are not straightforward: E.g.: p13,L4: “in dry climates (Cerrado) herbivory alone is more effective in enhancing P in vegetation in terra firme ecosystems.”. I cannot read these results from Fig.6: for a given detritivore consumption rate, increasing the herbivore consumption rate (go from left to right on a horizontal line) does not increase P in vegetation (even slight decrease).

2) Error or lack of clarity in the equation describing the redistribution of total herbivore/detritivore consumptions between ecosystems (flooded and terra-firma)

p6,L26: “ (...) herbivores consume (...), whereas detritivores consume (...). These fluxes are then returned to the available P and detritus P compartments in the seasonally flooded (F) and terra-firme ecosystems (U). Each ecosystem receives a fraction of the total consumption equal to its fractional area (A_F and A_U , respectively).”

I totally agree with this sentence: the fraction of total (from both flooded and terra-firma) herbivore consumption that returns to a given ecosystem (flooded or terra-firma) has to be equal to the ratio between this ecosystem area and the total sub-basin area (either A_F or A_U). However, this does not appear in the equations given in the Method section.

Basically, AI_{vdE} should be equal to $A_E \cdot k_{HM} \cdot k_H \cdot (A_U \cdot P_{vU} + A_F \cdot P_{vF})$ (and not $k_{HM} \cdot k_H \cdot (A_U \cdot P_{vU} + A_F \cdot P_{vF})$). The term $k_{HM} \cdot k_H \cdot (A_U \cdot P_{vU} + A_F \cdot P_{vF})$ should be equal to $AI_{vdU} + AI_{vdF}$.

This perhaps arises from a confusion between equations given in the text [some of them, such as $k_H \cdot (A_U \cdot P_{vU} + A_F \cdot P_{vF})$, are multiplied by an area (unitless)] and fluxes described in Fig.3 and Table 1 (e.g. $AO_{vU} = k_H \cdot P_{vU}$). Overall, I found the section p6,L20-30 difficult to follow because of the huge numbers of variables introduced, which are not totally consistent with Fig.3.

3) For a given sub-basin, the authors restrict their sensitivity analysis to the animal consumption rates and animal input from rivers (Fig.4 and 5) while it would be worth assessing the potential role played by other variables. The theoretical framework built by the authors is particularly appropriate to this. In particular, it would be interesting to study the P redistribution sensitivity to:

- the fraction of the sub-basin covered by each ecosystem (A_U , A_F) (fixed values of 70 and 30% in the current study)
- a difference in k_H between flooded and terra-firma (e.g. to describe difference in population densities or in vegetation biomass between the two ecosystems)
- a difference in soil properties between the two ecosystems that could modulate occlusion or leaching rates. It is true that difference in leaching rate is already taken into account through its sensitivity to the soil water content but what the effect of a difference in soil properties could be?
- the magnitude of I_f (for a given sub-basin) to described some variation in flood pulses, flood duration, etc. E.g. some plot showing the redistribution efficiency vs. I_f would be interesting.

4) Many parameters are uncertain (see section 2.2 and Table 2) and it would be particularly interesting to understand how this uncertainty propagates to the final P redistribution within the sub-basin. In particular, could some processes considered as negligible right now be underestimated?

5) The abstract does not reflect properly the findings of the study:

- please, remove “between sub-basins” (L5) and “fish migrations” (L9) because they do not correspond to the focus of this study (e.g. p18,L14: “Although this is not included in our model, fish migration”)
- develop the key-results (e.g. summarize findings given p15,L8-16)

6) The final question is to understand if animals P re-distribution can contribute to prevent Amazonian ecosystems to fall within terminal steady-state. This is mentioned in the discussion (p19,L23). However, more analysis is required in the Results section: e.g. do the simulations without animal redistribution (the ones at the left-bottom corner of Fig.6) reach this terminal steady-state?

Minor comments and type-setting

- p15,L11: meaning of “saturation”?
- the authors should remind to the reader how the leaching is computed given its role to explain the difference between dry and humid sub-basins
- the authors should justify that the Results focus on P in vegetation (because of the final question about the terminal steady-state?)
- the redistribution of nutrient has also been studied between cropland and forest in temperate ecosystems (see e.g. (Abbas *et al.*, 2012)) and could be quoted in the discussion?

p1,L9: “interweaved” cannot be understood at that stage (but only after reading p17)

p3,L2: “how they could be reaching” → “how they could reach”?

Fig.1: meaning of dashed vs. solid arrows?

p3,L5: not clear how this “contradicts”?

p3,L27: “Overall, for the terrestrial ecosystems of the Amazon basin the atmosphere could even act as P sink, rather than a net P source.”: not clear from what is explained before in the paragraph.

p4,L15: “typically against the gradients of physical flow processes.”: not clear

p4,L22: the status of the piscivory is not clear in the introduction: “piscivory” is quoted besides “herbivory” and “detritivory” then not mentioned at all in the introduction.

p6,L20: “As consider in this model” → “Two ... processes are considered in this model:”

p6,L23: food web → food webs

p6,L22: say explicitly here that the subscript E corresponds to either F or U. It appears only on p8 (also in caption of Table1)

p9,L2: “and occlusion F_{dCE} ”? Occlusion corresponds to O_{oU} in Fig.3.

Equation 3: subscript E is missing in Pd, Id, Iw, etc.

p10,L18: missing “as” before “the Rio Negro sub-basin”

p11,L12: “We run the model for terra firme ecosystems (U) using yearly averaged relative soil water content of 0.35 for the Cerrado (Runyan and D’Odorico, 2012), and 0.6 for the terra firme part of the Caquetá-Japurá and Rio Negro sub-basins.” → “We run the model for terra firme ecosystems (U) using yearly averaged relative soil water content of 0.35 for the Cerrado (Runyan and D’Odorico, 2012), and 0.6 for the Caquetá-Japurá and Rio Negro sub-basins.”

p11,L31: not clear how the upper limit for input from river to lands by animals (242gP/ha/a) is chosen.

Table3: “variable to 1957”, “variable to 250”: does it mean that the value given in the column “value” is the lowest boundary? Or default value?

p12,L6: “(4 vs. 5)” → “(Fig.4 vs. Fig.5)”

Fig.4 and 5: remind the name of the variables used in the plots (k_H , k_D , I_{aF})

p12,L9: “than their associated to várzea ecosystems” → “than terra-firma associated to varza ecosystems”?

p12,L13: the authors should mention “piscivores”

P13,L3: “we”?; “on on”

Table 1: missing “of” in column “description” for line “animal fluxes”

Ref:

Abbas F, Merlet J, Morellet N *et al.* (2012) Roe deer may markedly alter forest nitrogen and phosphorus budgets across Europe. *Oikos*, **121**, 1271–1278.