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## Reply on RC2

Alan Gomes Mendonça et al.

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Author comment on "Influence of land use and occupation on the water quality of a microbasin in the southwestern Amazon" by Alan Gomes Mendonça et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2020-485-AC2>, 2021

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**The manuscript presents data on water quality parameters of a watershed in the Brazilian Amazon. These data are rare and extremely important for the knowledge of Amazonian aquatic systems. However, these are presented and discussed in a regional view and can be valuable for local monitoring. I suggest reconsidering after major revisions or rejected.**

Abstract

**The abstract has a very regional view of the data and conclusions. I suggest rewriting it to demonstrate how the findings of this study in the Igarapé Nazaré basin can be extrapolated to other streams around the world (or at least in tropical/equatorial systems).**

Introduction

**Like the abstract, the introduction is also very local. It discusses the problem of water quality and its management in Brazil. I suggest thinking how that occurs worldwide. For example, I put some questions bellow that can be thought of to enrich the introduction:**

**- Are there National Policies in other countries? Brazil has the PNRH (line 34), and other countries have similar programs. This could be mentioned in the introduction, giving a more global aspect to the study.**

*Countries such as South Africa (Koppen and Schreiner, 2013), Australia (Byrnes et al. 2006), Malaysia (Afroz et al., 2016), China (Shuzhong et al., 2017), United Arab Emirates (Paleologos et al. ., 2018) and others, present policies for the conservation, management, equal distribution of water resources. Although Brazil has a well-intentioned National Water Resource Policy (PNRH in the Portuguese acronym), specifying various instruments for management of watersheds, these instruments have proved hard to implement in the majority of cases.*

**- The implementation of water quality monitoring is cited (line 41). Is there effective monitoring anywhere in the world? Why? Why hasn't in Brazil?**

*Therefore, more information is necessary to hasten progress in water management. This can be promoted by the use of 40 geoprocessing tools (Flauzino et al., 2010), implementation of effective water quality monitoring, como é realizado em outros países (Ighalo and Adeniyi, 2018; Chen and Han, 2018; Wilson et al., 2018; Altenburger et al., 2019; Li et al., 2020) , and production of information to support policymakers' decisions regarding sustainable water use and ecological restoration of watersheds (Avila, 2016; Vigiak, 2016; Britto, 2018).*

**- The aim is very regional and fits well in a local journal. With these findings in Nazaré, is it possible to understand other streams in the Amazon or in the tropical/equatorial biomes?**

*Looking toward the establishment of these initiatives in the country's North region, our objective in this study was to diagnose the influence of land use and occupation on the water quality of the Igarapé Nazaré microbasin.*

*Our research promotes a better understanding of the impacts of changes in land use in microbasins in the Amazon region, as well as for several tropical biomes*

*The information cited in the previous responses will be present in the text of the article.*

Material and Methods

**In lines 49-51, the manuscript says that there are rainy and dry seasons. In lines 72-73, the manuscript says that water sampling occurred in high-water and low-water seasons. Are these same stations? Are these aquatic systems subject to the flood-pulse of the main river? Is there water fluctuation in sampling points due to the season? This is not described in the Study area section.**

*The term used as flood periods represents the wettest seasons. The ebb period represents the transition period from the rainy to the dry period, where there is a decrease in the flow of this stream. The sampling took place in 4 periods, being in the rainy and dry seasons (popularly called winter and Amazonian summer, respectively), and in the transition periods between one and the other. There is a variation in water fluctuation in all periods.*

**The methods can be briefly described. Example:**

**- lines 73-76: Are these places of discharge accounted for? When they were seen, did the water collection take place upstream or downstream from discharge points?**

*The most relevant point sources, such as industries and sanitary sewage, were counted as shown in figure 2. Diffuse sources were not counted due to the difficulty of measuring these sources. The collections were carried out both upstream and downstream of the discharge points mentioned in the article, since the observed sources of pollution observed maintain a constant discharge flow.*

**- lines 83-85: These methods can be briefly described.**

*Samples were also taken to the laboratory under refrigeration for other analyses, as described by the Standard Methods for the Examination of Water and Wastewater (APHA, 2015) and the National Guide for Collection and Preservation of Samples (2011). The*

turbidity was measured with a portable turbidimeter (Hach model 2100P). The dissolved oxygen (DO) was measured according to the Winkler method (APHA, 2015) and the transparency was determined in the field using a Secchi disk. The concentrations of dissolved nutrients, ammonia, nitrite, nitrate, total phosphorus and dissolved phosphorus were ascertained by spectrophotometry, according to the analytic methods described in APHA (2015).

The analyzes of the dissolved nutrients were performed with water samples previously filtered through glass microfiber filters, 0.45  $\mu\text{m}$  porosity (Whatman AP – 20). Only the analysis of total phosphorus was performed on unfiltered samples. All nutrient analyzes were preceded by a calibration curve with standard solutions. After adding specific solutions for each analysis, absorbances were measured on a spectrophotometer (Kasuki, IL-226-NM). For the analysis of ammonia, samples containing solutions containing phenol, sodium nitroprusside, hypochlorite and sodium hydroxide were added to the samples. Absorbance measurements were performed at 630nm. Nitrite analyzes were performed using 1% sulfanilamide solutions and 0.1% n-naphthyl alcoholic solution. Absorbances were measured at 543 nm. For the nitrate analysis, 1% brucine solution, sulfanilic acid and hydrochloric acid were added to the samples. Absorbance measurements were performed at a wavelength of 410nm. The analysis of dissolved phosphorus was performed by adding the samples ammonium molybdate solution, 15% sulfuric acid solution, ascorbic acid solution and atymone and potassium tartrate solution, followed by the reading of the absorbance at 882 nm. For the analysis of total phosphorus, unfiltered samples were added to supersaturated solution of ascorbic acid, then the samples were autoclaved. After the samples were reaffirmed, the method used for the analysis of dissolved phosphorus was carried out.

#### **- Total nitrogen was not measured in unfiltered water? Why?**

The analyzes of this parameter were not carried out because we do not have all the material devices necessary for it.

#### Results and discussion

#### **- There is a lack of correlation between the parameters evaluated and land use. The data was presented extensively with a temporal perspective, but not a spatial one (and that was the primary objective of the work).**

We emphasize that the data of our research were presented in a spatial perspective. We agree with the Reviewer that the time scale analysis was more emphasized, however the spatial variation of the analyzed variables was also demonstrated and discussed. Below we highlight some parts of the "Results and discussion" that indicate such a placement.

"Points P1, P2 and P3, located in a relatively well preserved rural APP, were the only ones to present concentrations below 0.1 mg.L<sup>-1</sup> in all the periods. The others (P4 to P10) all had levels greater than 0.1 mg.L<sup>-1</sup>, with highlight on P4, which in the low water period had total phosphorus concentration of 27.55 mg.L<sup>-1</sup>. The highest concentrations of total phosphorus were found in the low water period at all the points sampled."

"The lowest concentrations of dissolved phosphorus were also found at points P1, P2 and P3, while the highest concentrations were found at P4 (2.06 mg.L<sup>-1</sup>) and P7 (0.12 mg.L<sup>-1</sup>). These values can reflect the presence of aquatic flora, since this is the main form of phosphate assimilated by aquatic plants (Esteves, 2011)."

"With respect to the dissolved oxygen levels (Figure 5a), only at P2 was the concentration higher than the limit set by CONAMA Resolution 357/2005 (5 mg.L<sup>-1</sup>) in all the periods. Only the points in the microbasin located in rural areas (P1, P2 and P3) had values below

*the regulatory threshold, in periods HW (P1 and P2), HW/LW (P2), LW (P2 and P3) and LW/HW (P1, P2 and P3)."*

*"The sampling points located in the urban area of Ji-Paraná (P4 to P8), in the periods HW, HW/LW and LW, had values below the regulatory limit, with the exception of P7 in the period HW/LW (5.33 mg.L<sup>-1</sup>). In the LW/HW period, there were higher DO concentrations, which can be explained by the strong rainfall on the collection day, contributing to the aeration of the water."*

*"In periods HW and LW, the presence of E. coli was not found at points P2 and P3, and P1 and P3, respectively. The water at all the other points had values above the limits stipulated in CONAMA Resolution 357/2005, of 1,000 coliforms per 100 mL of water. With respect to total coliforms, no point presented values greater than that threshold."*

**- Like the other sections of the paper, I suggest putting in a global perspective. What is the relationship of your results with global parameters observed in anthropized streams?**

*This suggestion was accepted and a survey on research with similar objectives from different locations on the planet was raised for purposes of comparison with the present work and will be incorporated into the text.*

**- There is a discussion about the parameters listed by CONAMA. Does being within the limits established by CONAMA mean that the water is from a preserved site? And on the contrary? Does being off limits mean that the environment is anthropic or that the water is not fit for human use? Ex: very acidic pH may indicate a black water river, and not that the environment has been modified.**

*Within CONAMA (National Council for the Environment) there is a classification that is called special class, class 1, class 2, class 3 and class 4. These classes define the way in which these waters are used and the degree of quality in which they are used. find. As an example the special class, are waters destined to the preservation of the aquatic environments in integral protection conservation units; preserving the natural balance of aquatic communities. In short, waters that must be protected to maintain their original characteristics. Starting from class 1, these are waters that can be used for public supply, recreation, up to class 4, which has its use only for navigation; and landscape harmony. This classification is used so that the forms of use around this body of water are controlled to prevent the parameters that classified it in this way from maintaining these characteristics. However, there are discussions in the scientific environment in which CONAMA observes this in general, not taking into account the different natural characteristics of water bodies, especially in the Amazon, which has rivers with different characteristics.*

**This discussion should be added to the discussion section since the work gave a lot of emphasis to CONAMA.**

*This information will be added to the discussion session.*

**- Results were compared using ANOVA, but a post hoc test was not done to identify the different group(s) – example: lines198-199.**

*"The nitrate parameter when applied to the Tukey test obtained differences in almost all periods except when comparing the periods LW and LW / HW (HW and HW / LW  $p = 0.001575$ ; LW and HW  $p = 3.90E-06$ ; HW / LW and LW  $p = 2.02E-11$ ; HW and LW / HW  $p = 5.58E-08$ ; HW / LW and LW / HW  $p = 3.87E-13$ ). The ammonia parameter for the same*

test obtained significant differences for the period of HW and LW ( $p = 0.005775$ ); HW / LW and LW / HW ( $p = 0.006708$ ); LW and LW / HW ( $p = 0.008358$ ); showing that the highest concentration of this parameter occurred in the period with the lowest volume of water in the stream."

These were the only nutrient parameters that showed a significant relationship when the Tukey test was applied.

Final considerations

**The authors summarized the findings. It would be more interesting to relate these findings to others in the world. Are such changes commonly seen in anthropic environments? What is the most frequent type of anthropization (e.g., sewage or pasture)?**

As mentioned in previous answers, we performed analyzes of other studies for comparison purposes where we found the following information (briefly):

"The concern with water management on a global scale is growing and current. Several studies similar to this one happen in several locations in an attempt to maintain the quality of the water for its different uses. Authors like Rimoldi (2018); Wei et al. (2020); Buonocore et al. (2021); Lei et al. (2021); Ni et al. (2021); Shehab et al. (2021); Spicer et al. (2021) seek in their work to report the importance of analyzing land uses in different regions of the planet (Argentina; China; Iberian Peninsula; Germany; United States of America; Malaysia; New Zealand) on water quality, having as a similarity in all of them changes in water quality in anthropic environments, whether rural or urban. These studies demonstrate the importance of analyzes such as the one carried out by this article, in regions with little information about their waters and the changes in them caused by anthropic action, in this case, the Amazon region. All of these studies had the objective of paying attention to the planning of water resources management in the studied region and in the adjacent regions. "

DOI of the cited articles:

<https://doi.org/10.1016/j.jclepro.2020.122249>

<https://doi.org/10.1016/j.ecolind.2020.106940>

<https://doi.org/10.1016/j.scitotenv.2021.146034>

<https://doi.org/10.1016/j.catena.2020.105055>

<https://doi.org/10.1016/j.landusepol.2020.105200>

<https://doi.org/10.1016/j.ecolind.2020.107254>

<https://doi.org/10.1016/j.ecolind.2018.01.063>

Regarding the most frequent types of anthropization, in most part we highlight the agricultural areas, where the pasture fits. However, urban areas tend to impact as much as agricultural areas due to the large load of domestic and industrial sewage in bodies of water, as mentioned by the articles cited above.

**Figure 2: It is difficult to see the dots (sewage, food and frigorific industries) in the picture. I suggest increasing them.**

*The change was made as requested.*