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INVESTIGATING THE POSSIBLE SOCIO-ENVIRONMENTAL IMPACTS ARISING FROM THE HABITS OF RIVERSIDE STUDENTS IN THE CONTEXT OF THE BRAZILIAN AMAZON: A LOOK AT PLANETARY HEALTH

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ABSTRACT

Objective: This study aims to investigate potential socio-environmental impacts arising from riverside students' habits in Brazilian Amazon reality. It is important to know the environmental effects that permeate the largest tropical forest on the Earth, in order to take more effective actions to minimize environmental damage, protecting human and environmental health at the same time.

Method: The targeted audience of this investigation was 108 elementary school students from a riverside school in southern Amazonas. Data were collected using a structured questionnaire with 17 closed questions, administered over a 30-minute period. For data analysis, descriptive statistics were used, divided into four axes: social, food, transport and energy, and environment.

Results and conclusion: The results enable reflections on local socio-environmental impacts. The students' perception about the investigated topics revealed inequality and inequity; dietary patterns that compromise health; energy from polluting sources; water from community wells and burning of waste. The research endorses the need to (re)think about the educational praxis experienced in schools, considering planetary health themes, with riverside students as a fundamental part to disseminate information involving local environmental subjects and their relationship with health.

Implications of the research: Presents socio-environmental issues faced by students living along the rivers in the Amazon, with the potential for dialogue between local issues and the dissemination of information to the general society.

Originality/value: The research adds value to the concept of Planetary Health, enabling dialogues between environmental impacts experienced in the Amazon and the need to (re)think educational practices in schools. This is so that students can understand their role in the face of the significant environmental crisis affecting humanity.

Keywords: Amazon Region, Rural Education, Planetary Health.

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INVESTIGANDO OS POSSÍVEIS IMPACTOS SOCIOAMBIENTAIS DECORRENTES DOS HÁBITOS DOS ESTUDANTES RIBEIRINHOS NO CONTEXTO DA AMAZÔNIA BRASILEIRA: UM OLHAR PARA A SAÚDE PLANETÁRIA

RESUMO

Objetivo: Este estudo tem como objetivo investigar potenciais impactos socioambientais decorrentes dos hábitos dos estudantes ribeirinhos na realidade da Amazônia brasileira. É importante conhecer os efeitos ambientais que permeiam a maior floresta tropical da Terra, para tomarmos ações mais eficazes para minimizar os danos ambientais, protegendo ao mesmo tempo a saúde humana e ambiental.

Método: O público-alvo desta investigação foram 108 alunos do ensino fundamental de uma escola ribeirinha do sul do Amazonas. Os dados foram coletados por meio de questionário estruturado com 17 questões fechadas, aplicado em um período de 30 minutos. Para análise dos dados foi utilizada estatística descritiva, dividida em quatro eixos: social, alimentação, transporte e energia, e meio ambiente.

Resultados e conclusão: Os resultados permitem reflexões sobre os impactos socioambientais locais. A percepção dos estudantes sobre os temas investigados revelou desigualdade e iniquidade; padrões alimentares que comprometem a saúde; energia proveniente de fontes poluentes; água de poços comunitários e queima de resíduos. A pesquisa endossa a necessidade de (re)pensar a práxis educativa vivenciada nas escolas, considerando temas de saúde planetária, tendo os estudantes ribeirinhos como peça fundamental para disseminar informações envolvendo questões ambientais locais e sua relação com a saúde.

Implicações da pesquisa: Apresenta questões socioambientais enfrentadas por estudantes que vivem às margens dos rios na Amazônia, com potencial de diálogo entre questões locais e disseminação de informações para a sociedade em geral.

Originalidade/valor: A pesquisa agrega valor ao conceito de Saúde Planetária, possibilitando diálogos entre os impactos ambientais vivenciados na Amazônia e a necessidade de (re)pensar as práticas educativas nas escolas. Isso é para que os alunos possam compreender o seu papel diante da significativa crise ambiental que afeta a humanidade.

Palavras-chave: Região Amazônica, Educação do Campo, Saúde Planetária.

1 INTRODUCTION

The Anthropocene is a Geological Era marked by the environmental impacts that humans exert on natural ecosystems, compromising the environmental balance on local and global scale [Crutzen, 2016; Steffen et al., 2015; Rockström et al., 2009). Impacts on the biosphere destabilizing natural ecosystems (Dias, 2015), the effects of environmental imbalance compromise the population health and well-being; therefore, it is crucial to understand the dependence between human health and natural environmental systems (Whitmee et al., 2015).

The Planetary Health Alliance (PHA) points out that the environmental effects caused by human beings have never been so significant, surpassing the availability of resources on the only known habitable planet. The main topics pointed out by the PHA are: population growth; consumption of fossil fuels; overfishing in marine environments; use of freshwater; installation of dams; deforestation of tropical and temperate forests. All these issues have had significant impacts with the increase of carbon dioxide in the atmosphere; air pollution; high temperatures

on land and oceans; disappearance of pollinators; sharp loss of biodiversity; extreme events; increase in infectious and cardiovascular diseases; malnutrition and the consequences of disasters on mental health (PHA, 2023).

Thinking about the mentioned environmental impacts and their relationship with health, a scientific field called Planetary Health (PH) could emerge. This new field aims to understand how environmental effects of anthropogenic actions affect the dynamic balance of the planet, seeking solutions to safeguard nature and humanity (Whitmee et al., 2015).

Considering the connections between natural ecosystems and human health, this investigation was developed in a small portion of the Amazon biome, which faces major challenges. One of the richest ecosystems on our planet, known worldwide for its climatic characteristics; exuberant biodiversity; watershed and cultural heterogeneity. It means a true living laboratory, mainly due to the diversity of existing species, many endemic and still unknown to science (Ceballos, Ehrlich & Raven, 2020). Indigenous and traditional peoples who depend on the Amazon biome for their survival also stand out (Zaman, 2022).

The centrality of the Amazon is indisputable, as it plays a fundamental role in maintaining local and global ecosystem services. However, the future of this forest has been taking different directions due to human pressures and influences. This carbon sink is close to its "breaking point", "turning point" - a point of no return, a limit to convert the climate changes -, with the risk of transforming the largest tropical forest in the world into a savanna by the end of the 21st century (Lovejoy & Nobre, 2018; Sampaio et al., 2019; de Wit & Mourato, 2022). This represents a devastating and irreversible theme that compromises planetary survival.

Research involving PH in the Amazon reality is extremely important in all fields of activity. Among many, works in Basic School Education stand out, since these educational spaces can foster the development and become a potential articulator of comprehensive and complex themes with children and adolescents. In fact, this public reveals itself as promising voices for the discussion of these subjects, with the potential to contribute to this scientific field [de Melo et al., 2022; Tilleczek et al., 2023). These future generations are an integral part of the movement for change, and may influence changes in policies and legislation aimed at PH (Faiesall et al., 2023).

Formal education is inseparable in the process of change and engagement in actions aimed at environmental sustainability (Gottieb et al., 2012), and it is essential that schools include environmental issues and their impacts in educational curricula. It means a way of creating and strengthening relationships between people and the environment (UNESCO, 1997). Educating about current environmental issues and climate change is an important factor for conscious measures to reduce negative effects of current environmental impacts (Ghanbari et al., 2023; Kabir et al., 2016; Christensen & Knezek, 2015). Schools have the potential to collaborate with sustainability based on the students' local context (Ghanbari et al., 2023).

The goal 4.7 of the "2030 Agenda" reinforces the understanding that it is essential to guarantee knowledge and skills to promote sustainable development through education for sustainable development and sustainable lifestyles; human rights; gender equality; promotion of a culture of peace and non- violence; global citizenship and appreciation of cultural diversity and the contribution of culture to sustainable development (AGENDA 2030).

A tool that stands out when it is thought about sustainability is the ecological footprint. This is an approach made official in 1996 by Rees and Wackernagel in the book "Ecological Footprint: reducing the impact of human beings on Earth". This is a way of counting, in global hectares, the extent to which human beings individually/collectively use natural resources to sustain lifestyles (Rees, 1992; Wackernagel, M., & Rees, 1992; WWF, 2023; Wackernagel et al., 2006). This tool is based on different categories of human activities, including energy consumption, waste emissions and resources (Gottieb et al., 2012).

From the challenging scenario of the Amazon, teaching sustainability subjects based on local environmental impacts and the multiple connections with Planetary Health is remarkable, as it makes it possible to advance both local and global issues. Indeed, the dissemination of emerging topics and proposals for solutions based on local knowledge should encourage children and young people to become leaders in planetary themes, consolidating their role as "guardians of the forest".

The present study is part of a doctoral thesis entitled: "Planetary Health: necessary dialogues for scientific education in a riverside school in the south of Amazonas, Brazil". This article aimed to investigate potential socio-environmental impacts arising from riverside students' habits in Brazilian Amazon reality. The proposal enables dialogues between students' local issues and the possibility of disseminating relevant information to society in general, considering education a strong ally in processes that aspire to environmental sustainability.

2 METHODOLOGY

2.1 Study area

This study was conducted in a Brazilian riverside school, located at Uruapiara Lake, southwest of the Amazonas state (6°20'25"S and 62°1'19"W), 172 km away from the urban area of the municipality of Humaitá/AM (Figure 1).

Figure 1. Study area: Cristo Rei School, Uruapiara Lake/AM.
Source: Organized by authors, 2023.

The Cristo Rei School is located at Lake Uruapiara, created by Ordinance No. 031/96, of October 25th, 1996, to offer basic education for students of Elementary and Junior High School levels in the traditional community of Cristo Rei and other surrounding communities.

This research was previously approved by the Committee for Ethics in Research (CEP) of the Federal University of Rio Grande do Sul (UFRGS/Brazil), under the license CAAE 42320821.6.0000.5347.

2.2 Data Collection and Analysis

In the data collection, structured questionnaires with 17 closed questions were applied, with 108 young students from the 8th and 9th grades of Junior High School. The time used for this application was 30 minutes, with the consent of the school teachers. The questions had focus on the riverside reality based on the adaptation of the *Foot Print Calculator*[7] website's carbon footprint. However, calculations of the greenhouse gases emission for the local riverside context were not measured, which must be taken into consideration as an essential issue in future research.

After applying the questionnaires, the data obtained were distributed into four axes, each grouping a certain number of questions related to it (Chart 1). Relative frequency was used, which was presented in bar graphs.

Axes	Question and Answer Options
Social	Q1 – How many people live in your house? (1) two (2) three (3) four (4) more than five Q2 - What material is your house made of? (1) straw (2) wood (3) bricks (4) steel Q3 - How big is your house? (1) one room (2) two rooms (3) three rooms (4) more than four rooms Q4 - How often does your family buy clothes and shoes? (1) when we need it (2) once a year (3) twice a year (4) whenever we go to town
Food	Q1 - Do you eat beef? (1) never (2) up to three times a week / one piece (3) every day / one piece (4) more than three times a week / two or more pieces Q2 – Do you eat fish? (1) never (2) twice a week (3) up to three times a week (4) every day Q3 - Do you eat hunting meat? (1) no (2) twice a week (3) up to three times a week (4) every day Q4 - Do you eat canned food? (1) no (2) twice a week (3) up to three times a week (4) every day Q5 - Do you consume milk and dairy products? (1) no (2) twice a week (3) up to three times a week (4) every day Q6 - Do you eat vegetables and fruits? 1) every day (2) on average five times a week (3) on average four times a week (4) never Q7 – How does your family get the food you consume at home? (1) some are picked from the home garden (2) they are bought from my neighbors (3) they are bought at the market (4) they are bought from middlemen

[7] https://www.footprintcalculator.org/home/en

Transport and Energy	Q1 - Where does the energy in your home come from? (1) there is no electricity (2) it comes from community generators (3) it comes from city generators (4) we have our own generators at home Q2 - What means of transportation do you use to go to school? (1) on foot or by boat without motor (2) by bicycle (3) on the school boat (4), boat with motor Q3 - What is the approximate distance from your house to and from the school by boat? (1) I never use boat (2) 1 to 10 km (3) 10 to 20 km (4) more than 20 km
Environment	Q1 - Where does the water that supplies your home come from? (1) the river that passes through the community (2) a waterhole (3) from a well in the community (4) from a private well Q2 - What do you and your family do with the organic waste in your home? (1) we feed the animals (2) we make fertilizer for the plants (3) we throw it in the backyard (4) we put it in plastic bags and throw it in the backyard or in the river Q3 - What do you do with the recyclables items in your house? (1) we separate recyclable, electronic and organic waste (2) we do not separate garbage because there is no collection in my community (3) we burn it (4) we throw it in the river

Chart 1. Summary of the axes, questions and answer options of the questionnaire
Source: Organized by authors, 2023.

3 RESULTS AND DISCUSSION

3.1 Social Axis

Considering housing aspects first, it was found that approximately 90% of the students live with more than five people at home, as revealed by Q1. In addition, Q2 points out that, predominantly, the houses are built of wood (82%) and most of them are composed of three rooms (80%). Regarding the consumption habits, such as buying clothes and/or shoes, about half (48%) of the students shop only when they need them, while 45% shop more frequently when they go to town.

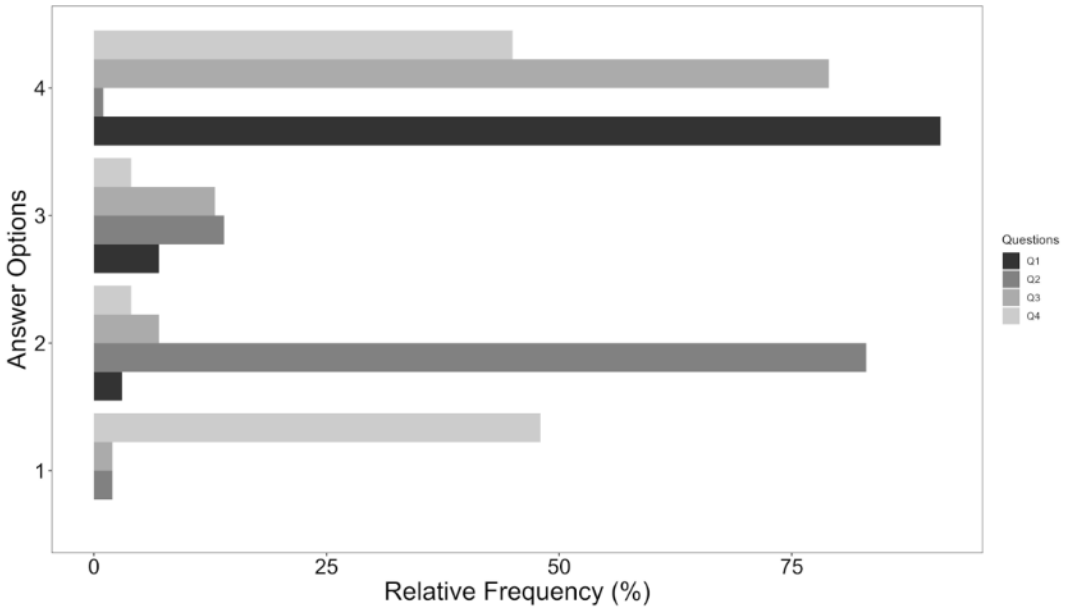

Figure 2. Distribution of relative frequencies by answers given to the Social Axis questions.
Source: Organized by authors, 2023.

Globally, the environmental impacts from anthropogenic actions come from large urban centers, even though the consequences of these impacts can be felt in different ways by different populations. The more vulnerable the population, the more it suffers from the effects on health and the environment. Populations in low- and middle-income regions tend to undergo more effectively from environmental damages; although, they are the ones that contribute the least with them (Watts et al., 2018; Guzmán et al., 2021).

The students' social subjects make it possible to reflect on how inequality and inequity are part of the local/global context in the countryside. In terms of Planetary Health, issues of inequality and lack of equity are extremely relevant, as the effects of the impacts of environmental changes are disproportionately felt by these populations, considering geographic and temporal scales, socio-economic factors, political and cultural contexts (Stone, Myers, & Golden, 2018).

The climate crisis is a good example of how unfair climate changes are. In fact, the negative effects of climate change are disproportionately distributed on riverside populations, *quilombolas* (black people settlements), women, children, among others, as they are considered the most vulnerable populations and, therefore, it is essential to protect all forms of life (Robinson, 2021; Rasmussen, 2023). This more human look at these populations takes place through the movement called "climate justice". For Amazonian peoples, vulnerability is accentuated by dependence on the forest for survival (Fearnside, 2008). Thus, it becomes vital to align adaptive strategies for regions with greater vulnerability, such as this one in Amazon (Smith et al., 2014).

3.2 Food Axis

Regarding beef eating habits, 74% of respondents said they eat a piece of beef up to three times a week, as shown by the results obtained in Q1. As for fish consumption, Q2 reveals that just over 40% of students consume it up to three times a week, and about 35% consume it twice a week. Regarding the consumption of hunting meat, Q3 showed that 43% of respondents consume it up to three times a week (such as White-lipped peccaries - *Tayassu pecari*,

Armadillo - *Oasypus novemcinctus*, Deer - *Mazama americana*, Tapir - *Tapirus terrestris*), as shown in Figure 3.

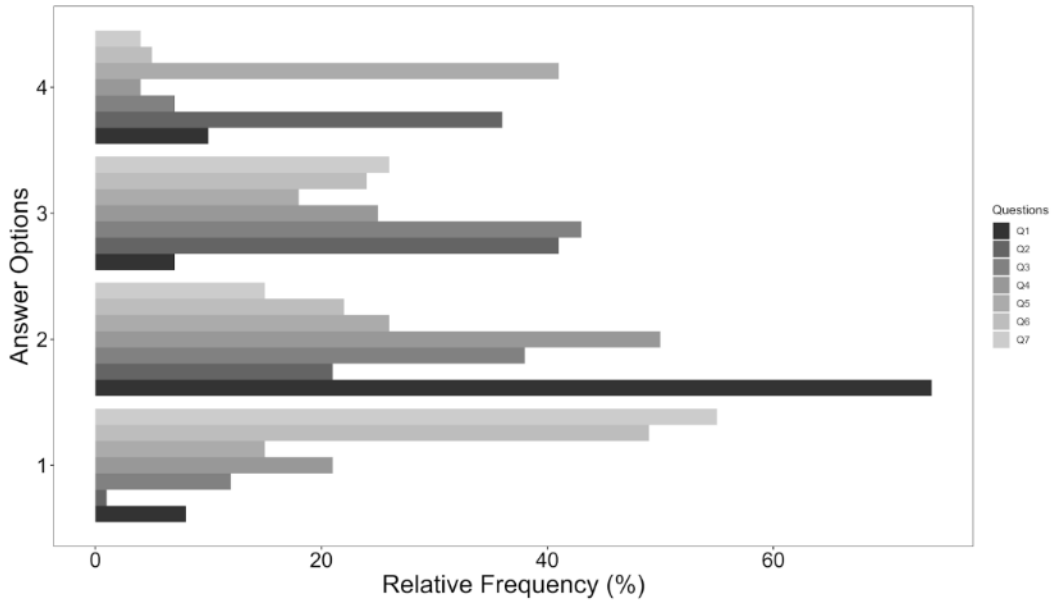

Figure 3. Distribution of relative frequencies by answers given to questions on the Food Axis.
Source: Organized by authors, 2023.

According to Q4, ultra-processed food is consumed twice a week by 50% of students. Based on Q5, it can be seen that the consumption of milk and dairy products is a daily practice for 41% of respondents. In Q6, regarding the consumption of fruits and vegetables, 49% of the students stated that they had this habit of consumption every day. Finally, 55% of the students stated that some of the food they consumed at home was harvested from their home garden (Figure 3).

Based on the students' responses, relevant questions are highlighted, such as the dietary pattern of meat consumption (beef, fish, hunting meat) and canned food. In the presented context, it is essential to point out that food and human health are inextricably linked to the health of our planet (Mueller, 2023; Avesani et al., 2022). Thus, our daily food choices are issues that lead us to think about Planetary Health (Avesani et al., 2022).

Currently, unsustainable food systems are threatening human health and the environment. On a large scale, production, cultivation, trade and disposal of food are factors that corroborate such unsustainability, since they extrapolate the biological rhythms of species, overloading the land and causing ecological imbalances. It is also worth noting that the use of pesticides, which pollute the soil, water and air, cause health problems to countless living beings, loss of biodiversity and climate change (Araújo et al., 2022; El Bilali et al., 2019).

Therefore, the consequences of these food habits are syndemic, obesity and malnutrition. On the one hand, populations have been eating insufficiently and, on the other hand, consuming food with low nutritional content (Willett et al., 2019; Salles-Costa et al., 2022; Swinburn et al., 2011). These nutrient-poor diets, with high rates of saturated fats, sugars and refined carbohydrates contribute to the increased prevalence of chronic non-transmissible diseases, such as obesity and type 2 diabetes (Butler & Barrientos, 2020; Springmann et al., 2016).

In contrast, sustainable food systems provide food and nutrition security for populations. These systems take into account natural resources in food production processes, as they play a role in reducing the threat of infectious diseases, promoting nutrition, and building healthy

environments by reducing the carbon footprint (Canavan et al., 2017). Healthy eating is one of the pillars of PH, not only due to the health and quality of life of the populations, but also for all the processes involving food - production; consumption; cultural issues; appreciation of certain foods from a given local biodiversity (here, especially, the Amazon), etc.

It is important to consider that the National School Feeding Program (PNAE) is responsible for the offer of the school meals for the students enrolled in basic education in Brazilian schools. This program aims to contribute to the biopsychosocial growth and development, learning, school performance and the formation of healthy eating habits among students. Nevertheless, the supply demands healthy and quality food, which can come from family farming and from rural family entrepreneurs and their organizations (PNAE, 2009). These advances have profound contributions for the school and for the communities, in view of the socioeconomic, environmental and cultural importance of family farming. However, many schools do not have any quality lunch at all.

Studies carried out in the northern Brazilian Amazon indicate that school meals do not comply with the proposals of the PNAE (da Silva Junior et al., 2021; da Silva Santos, Ximenes & Prado 2021). It is also worth mentioning that these works suggest the execution of work plans that increase purchases from family farming, evaluate and monitor the supply of meals and their preparation, considering the importance for the cognitive development of students (da Silva Junior et al., 2021; da Silva Santos, Ximenes & Prado 2021).

Exaggerated and frequent consumption of red meat and processed/ultra-processed foods have been considered harmful to human health, since they severely increase the risks of developing many types of diseases (Paterniani, 2021; Aune, 2017). In this assumption, it is highlighted that the possibility of having balanced eating habits has a beneficial effect on the health of populations, including the prevention of diseases such as cancer and cardiovascular problems. It is worth considering that riverside students need to be encouraged to consume foods that have a positive effect on their health, such as native fruits and vegetables.

Based on these data and discussed notes, we outline paths for the "Planetary Health Diet", whose priority is to ensure the conservation of ecosystems, the reduction of diseases, and the guarantee of life quality. The main principles of this document are the inclusion of plant foods such as fruits, vegetables, whole grains and legumes; reduction in the consumption of animal protein and the exclusion of processed foods (Willett et al., 2019). In the Amazon, this proposal has a special role, as it is directly associated with preserving biodiversity, improving health and respecting the dietary peculiarities of population cultures.

3.3 Transport and Energy axis

The data of Q1 about the origin of the residences energy showed that 75% of the respondents affirm that the energy in their homes come from city generators in the city (Figure 4).

Regarding the means of transportation they use to go to school, as shown in Q2, 71% said they use the school boat. Regarding the approximate distance of the journey to and from home by motorized boat, as shown in Q3, 28% reported a distance of one to ten kilometers; 25% from ten to 20 kilometers, and, approximately 26% of students needing to travel for more than 20 kilometers to go to and come back from school (Figure 4).

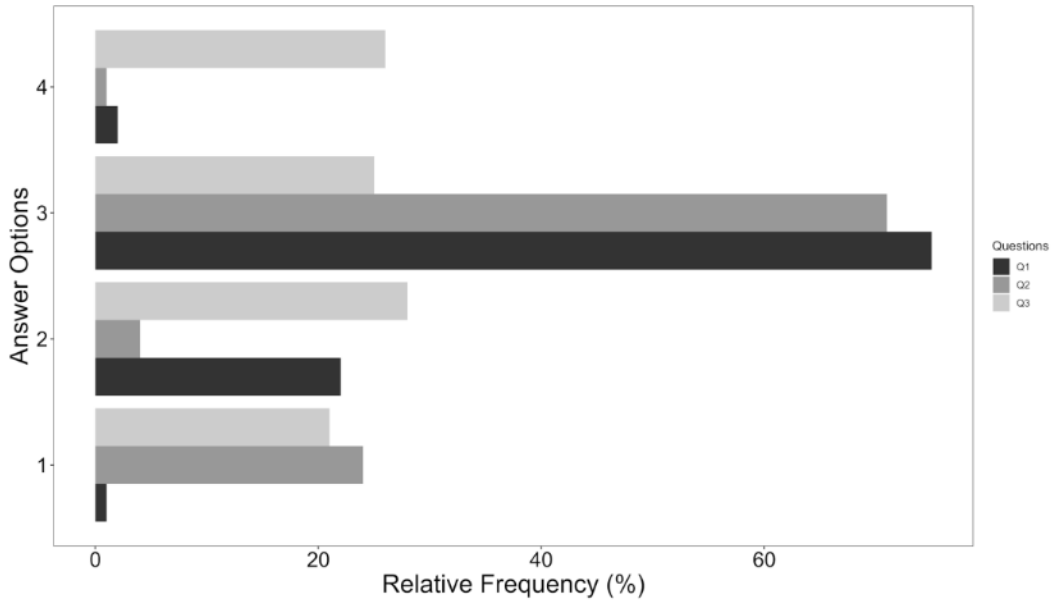

Figure 4. Distribution of relative frequencies by answers given to questions on the Transport and Energy Axis.
Source: Organized by authors, 2023.

The energy sector effectively contributes to the emission of carbon dioxide (CO_2), one of the main gasses that potentiate the increase in the greenhouse effect (GHG) (SEEG, 2023). The research points out that the use of energy comes from thermoelectric generation units with great polluting potential.

For this discussion, it is essential to consider that the municipality of Humaitá/AM is located 200 km from the Brazilian city of Porto Velho, Rondônia (RO) state, where the hydroelectric plant of Santo Antônio is located, on the Madeira River. Hydroelectric power plants are considered sources of "clean energy", because they do not emit pollutant gasses in their operation. Nonetheless, their construction processes involve major socio-environmental impacts, among which deforestation; loss of biodiversity; changes in rainfall; changes in the courses of rivers and the removal of residents from their vicinity. The construction of the Santo Antônio hydroelectric power plant significantly altered the regional biophysical parameters, implying a reduction in the amount of energy (Moura et al., 2019).

It is important to consider that every form of energy generation - including, alternative fonts, such as solar, wind and thermal - has environmental impacts, although other sources of energy generation considered "clean" can also have impacts if the generation is carried out in large poles. In the Planetary Health area, it is much discussed about solar and wind energy, mainly for their use on a lesser scale and in smaller communities, due to the positive impacts on the environment, such as the reduction of GHG emissions (Do et al., 2021; Spiru, 2023).

The use of public transport, reported by most students, is one of the main recommendations when it comes to reducing the carbon footprint, because of this kind of transport can contribute to reducing the increased of fossil fuels and energy use, consequently, reducing socio-environmental impacts and land uses (Ercan, Onat & Tatari, 2016).

3.4 Envirnmental Axis

In Q1, which refers to the origin of the water that supplies the residences, 63% of the students answered that the supply is carried out from a well in the community. Regarding organic waste, as shown in Q2, 46% stated that they use it for animal feeding purposes and 44%

reported that they use it as fertilizer for plants. In Q3, which refers to recyclable waste, almost 90% said that they burn it.

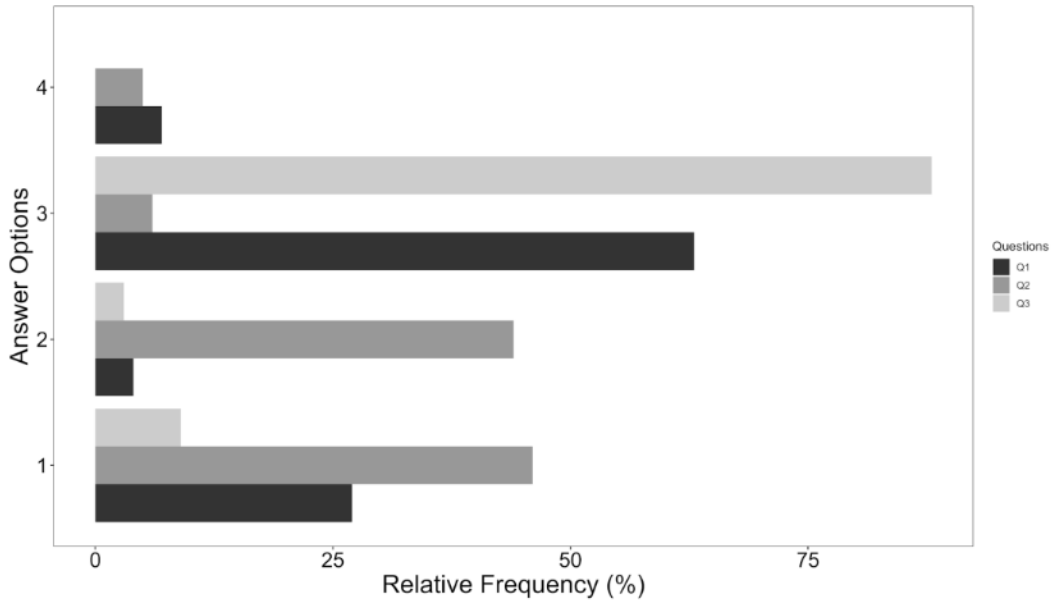

Figure 5. Distribution of relative frequencies by answers given to questions on the Transport and Energy Axis.
Source: Organized by authors, 2023.

Regarding the supply of water from community wells, it is important to carry out studies that assess the quality of water from wells in communities, considering the negative effects of deteriorating water quality in communities, mainly related to the high incidence of water-transmissible diseases and the causes of death associated with these diseases (Birhan et al., 2023).

Water contamination accelerates the increase in waterborne diseases such as amebiasis, hepatitis, schistosomiasis, cholera and typhoid fever, seen that the population groups most affected by them are children and the elderly (Pruss-Ustun, 2008). Data available from the Brazil Sanitation Panel indicate that the north and northeast regions of Brazil had higher expenses with waterborne diseases, totaling more than 84,000 hospitalizations in 2021, resulting in expenses of almost R$ 33 million, which are mainly due to lack of access to treated water and sewage (Brasil & Ministério das Cidades, 2021).

In addition to issues related to contaminated water, residues are also considered important points for this discussion. In their answers, the students stated that they use organic waste for animal feeding or as fertilizer for plants, an extremely relevant fact, considering that the amount of food waste worldwide is high. According to data from the Food and Agriculture Organization (FAO), about 1.300 billion tons of food produced for consumption are lost or wasted. These tons of food would be enough to feed approximately 2 billion people (Benítez, 2019). For example, Brazil is among the ten countries that waste more food on the planet (FAO, 2015).

The data showed that it is possible for a community in the Amazon to make use of these foods for animals or even for plants. With this, there is a reduction in food waste, strengthening sustainability and food systems, in addition to reducing the emission of greenhouse gasses, thus improving human and environmental health (PNUMA, 2021).

Regarding recyclable waste - such as plastic, glass, paper and cans -, they are burned according to the students' statements. The burning of waste is a source of air pollution, consequently, causing several problems for the environment and human health (Pathak et al.,

2023). Therefore, the need for initiatives to be developed in schools and the community is endorsed, such as workshops on sustainable consumption, recycling, and composting, in order to reduce the amount of waste generated in the community. However, it is essential to implement waste management in communities, considering that open burning is one of the ways to deal with local waste issues, especially in places where collection services do not exist or are limited (Ajay et al., 2022).

5 CONCLUSIONS

As discussed in this work, the socio-environmental impacts from the social, food, transport and energy and the environmental axes allowed deep reflections. Among which we highlight the need to (re)think about the educational praxis adopted by schools, so that students understand their role in the face of the great environmental crisis faced by humanity, especially when considering the role of the Amazon in the global/local context.

Didactic proposals on Planetary Health themes in the Amazon countryside schools are extremely relevant for their investigative character. But above all, for allowing students to acquire scientific knowledge allied with their own life experiences and their awakening as a resilient attitude to deal with complex themes of extreme relevance to humanity.

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