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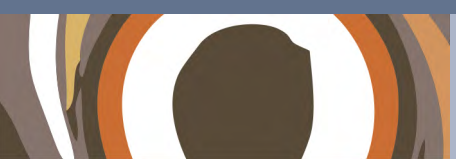

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Editorial

Convenient untruths: Artificial Intelligence and its risks to scientific integrity

Marcel Bursztyn, Carlos Hiroo Saito, Frédéric Mertens e Patrícia Mesquita

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It is not news that fake and science often intersect. The history of science itself is populated by episodes of absurdity, such as the belief that the world was flat, but this is more a reflection of ignorance than distorted knowledge.

There are also moments of folly, such as in the theories of racial eugenics, which represented a manipulation of experiments for racist political ends. Scientists in Nazi Germany were involved in barbaric experiments with torture, human manipulation, and mutilation to demonstrate the unprovable, even though some new knowledge may have been generated under condemnable ethical procedures. Current Research Ethics Committees also aim to prevent interest-oriented research from overriding the values that society cultivates and values.

Individual cases of plagiarism are not new but have become more frequent with the speed and publicity provided by the internet and social networks. The web facilitates plagiarism but also its exposure. A German minister was removed from office after it became public that his doctoral thesis contained plagiarism.

Manipulating data and research results to gain academic visibility or benefit economic and political interests, such as climate change negationism or advocating for the introduction of invasive exotic species, is a phenomenon in our daily lives.

In 2005, the prestigious journal Science "unpublished" an article by South Korean Woo-Suk Hwang on human cloning, published the previous year, after discovering that the study was based on falsified data[1]. Nevertheless, the work still received subsequent citations (van der Heyden, 2009). In another instance, the Kansas Geological Survey, a research and service division of the University of Kansas, identified plagiarism in the work of one of its technical staff members at the time[2,3]. Scientific arguments based on research not validated by consistent peer review may also serve religious proselytism by validating dogmas or beliefs. The acceleration of academic production, with a corresponding race for productivity measured in publications (publish or perish), a phenomenon of recent decades, is accompanied by the exponential growth in the number of journals aligned with various specialities and readers. However, as a side effect, it opens space for errors and malicious conduct.

Not surprisingly, article retractions in scientific journals continue to rise. Data published in the journal Nature indicate that in the year 2023 alone, over 10,000 articles were retracted[4]. In such cases, even if the damage is halted, its effects are not fully reversed, as they may fuel a chain of misinformation that feeds political, cultural, and religious interest groups, which only need some validated citation (even if subsequently retracted) to deceive unsuspecting audiences. Social networks can quickly replicate, under a news format, facts and data extracted from snippets of scientific (or pseudoscientific) works once made public. The formal retraction of articles does not prevent them from being cited or referenced.

The practice of peer-reviewing, which is ancient and important, is not infallible. It acts as a filter but lets flaws pass through. The responsibility of the checks and balances of journals is increasingly challenging. The authors are responsible for ethical protocols, presentation of methodological procedures, and

clarification of data sources and information. Verifying such practices is the responsibility of reviewers. Furthermore, critical analysis is also a prerogative of those who read published articles.

Information science is evolving rapidly. Artificial Intelligence (AI) is already capable of producing texts that appear real but are susceptible to containing false content, manipulations, and plagiarism. In this sense, science faces serious risks that must be adequately addressed.

In 1972, Jacob Bronowski - a physicist who participated in the Manhattan Project, which produced the first atomic bombs - warned scientists about the inherent risks of (mis)using the knowledge they produce. He referred to the artefacts dropped on Hiroshima and Nagasaki. In his view, it had become imperative for science to be regulated by mechanisms established by science itself. He was one of the first scientists to warn that humanity had reached a point where it would be capable of directly influencing the future of its own existence as if man had usurped the role of God. Since then, the debate about the responsibility of knowledge creators has continued to grow. Scientists cannot succumb to the temptation to act like sorcerers' apprentices who do not care about the consequences of their creations and can foresee and undo any potentially harmful effects they may cause.

Fake science has several ways to flourish: falsified data, misleading methods and tools, and conclusions without a basis in proven scientific evidence. In his warning work about the risks of ecological disasters, Al Gore pointed out a series of Inconvenient Truth (2006)[5] about climate change. It is time to be vigilant about the various expressions of fake science. Many articles related to COVID-19 have also been retracted, and due to the recurrence and quantity of these situations, a platform to monitor and publicise retracted works has emerged.

The arrival of AI in the scientific realm, while simultaneously enabling remarkable advances, also opens up ample space for the emergence of convenient untruths for groups of interest that are not always well-intentioned. In addition to the product-related component, the associated cognitive and formative process must also be analysed. With the copy & paste tool, text editing softwares have sped up writing and editing. However, they have also caused damage to the practice of prior reflection and planning of the textual structure, which requires long periods of reflection before starting to write a sentence. Manuscript writing and data analysis require a long training period, with abundant reading of other works and reflection on their contents during and after these readings before forming ideas and opinions that guide their communication. This formative and reflective period can be lost or undervalued, potentially conveying a misguided view of power and wisdom the researcher may not possess but deludes themselves into, supported by AI.

Therefore, there are several aspects to consider in this debate: 1) there is a context that encourages the publication of works, even if they have dubious foundations, which is the productivity measure based on the number of publications and needs to be rethought; 2) the fragmentation of knowledge in science, which goes hand in hand with the productivity logic that disconnects the scientist from ethical reflection, needs to be reversed; 3) it is necessary to question the consequences on the formation of new generations of researchers and the illusion that AI can sell about the reflective capacity of these individuals, and think of strategies that ensure the development of critical thinking and the ability to develop a logical chain of relationships between facts and causalities.

In sustainability, which is essentially multi-, inter-, and transdisciplinary, these three aspects are particularly relevant and crucial for developing an ethical and responsible science.

Given the processes and facts narrated above, SiD enters the debate on the responsibility of scientific journals and the community of authors, reviewers, and readers in its field of interest.

In its first issue of 2024 (issue 1, volume 15), SiD publishes 9 articles in the Varia section.

Firstly, Fagundes and Schreiber discuss the main sources of greenhouse gas emissions (GHG) in the footwear industries in a study involving four companies in the South of Brazil. Following this, Meurer and van Bellen present an analysis of how different countries disclose their Environmental-economic accounting for water through the use of the SEEA-Water methodology, while Barbosa and Ribeiro present an analysis of the conflicts and governance structure of water in the Paraguay River Basin (South America). Monteiro *et al.* then provide an overview of Science and Technology in the Amazon, discussing the role of various institutions and addressing the challenges of mobilising them for sustainable territorial development. Oliveira-Monteiro *et al.* present an evaluation of the environmental perception, pro-ecological behaviours, and quality of life of the caiçara community of Praia do Perequê, located in the city of Guarujá (SP). Lastly, Brites analyses the different environmental urban problems in the city of Posadas (Argentina), seeking to understand and describe the actions or omissions of legislation and/or environmental policies regarding different urban areas.

Ronquim *et al.* discuss the main factors favouring the regeneration of native vegetation in two regions of the state of São Paulo within a period of 30 years, while Budiyoko *et al.* investigate sustainable livelihood strategies of communities in the Monte Slamet region in the Central Java Province, Indonesia. Finally, Menke and Menke discuss traditional taboos in Suriname in the context of the recent convergence of various groups in the capital, Paramaribo, and surrounding areas.

We hope you enjoy the reading of this issue.

NOTES

1| https://revistapesquisa.fapesp.br/era-tudo-mentira/ (access in 6/4/2024)

2| https://link.springer.com/article/10.1007/s10040-014-1215-0

3| https://news.ku.edu/news/article/2013/12/11/public-censure

4| https://www.nature.com/articles/d41586-023-03974-8 (access in 6.4.2024)

5| Al Gore. An Inconvenient Truth, 2006. Oscar-winning film for best documentary film.

REFERENCES

BRONOWSKI, Jacob. **Science and Human Values**. New York, Harper & Row, 1972.

VAN DER HEYDEN M.A.; VAN DE VEN T., OPTHOF T. Fraud and misconduct in science: the stem cell seduction: Implications for the peer-review process. **Neth Heart J.** 2009 Jan;17(1):25-9

Editorial

Inverdades convenientes: a Inteligência Artificial e os riscos à integridade científica

Marcel Bursztyn, Carlos Hiroo Saito, Frédéric Mertens e Patrícia Mesquita

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Não é novidade que o *fake* a e ciência se tangenciem. A própria história da ciência é povoada por episódios de absurdo, como a visão de que o mundo era plano, mas isso faz parte da ignorância, mais do que do conhecimento distorcido.

Há também momentos de estupidez, como nas teorias sobre eugenia de raça, que expressavam uma manipulação de experimentos com fins de política racista. Cientistas da Alemanha nazista protagonizaram experimentos bárbaros, envolvendo tortura, manipulação humana e mutilações, para demonstrar o indemonstrável, ainda que algum conhecimento novo tenha sido gerado, sob procedimentos éticos condenáveis. Os Comitês de Ética em Pesquisa atuais têm também por missão evitar que pesquisas orientadas por interesses se sobreponham aos valores que a sociedade cultiva e preza.

Casos individuais de plágio são antigos, mas se tornaram mais frequentes com a rapidez e publicização proporcionadas pela internet e pelas redes sociais. A web facilita o plágio, mas também facilita o seu desmascaramento. Um ministro alemão foi destituído após se tornar público que sua tese de doutorado continha plágio.

A manipulação de dados e resultados de pesquisa, para conquistar visibilidade acadêmica de cientistas, ou para benefício de interesses econômicos e políticos, como o negacionismo das mudanças climáticas, ou a defesa da introdução de espécies exóticas invasoras, é um fenômeno presente no nosso dia a dia.

Em 2005 a prestigiosa revista *Science* "despublicou" um artigo do sul-coreano Woo-Suk Hwang, sobre clonagem humana, que havia sido publicado no ano anterior, após constatar que o estudo estava baseado em dados falsos[1]. Mesmo assim, o trabalho ainda recebeu citações posteriores (van der Heyden, 2009). Em outra situação, a Kansas Geological Survey, uma divisão de pesquisa e serviços da University of Kansas, apontou a ocorrência de plágios em trabalhos de um membro de seu quadro técnico na época[2,3]. Argumentos científicos baseados em pesquisas não avalizadas por julgamento consistente por pares podem também servir para fins de proselitismo religioso, na medida em que validem dogmas ou alimentem crenças. A aceleração da produção acadêmica, com a correspondente corrida pela produtividade medida em publicações (*publish or perish*), fenômeno característico das últimas décadas, é acompanhada pelo crescimento exponencial do número de periódicos, que atendem a uma infinidade de especialidades e públicos. Mas, como efeito colateral, abre espaço para erros e para condutas mal-intencionadas.

Não por acaso, a incidência de retratação de artigos em periódicos científicos não para de crescer. Dados publicados no periódico *Nature* indicam que, apenas no ano 2023, mais de 10 mil artigos foram objeto de retratação[4]. Nesse caso, mesmo que o dano seja interrompido, seus efeitos não são totalmente revertidos, já que podem alimentar uma cadeia de desinformação que nutre grupos de interesse políticos, culturais e religiosos, que só precisam de alguma citação avalizada (mesmo que posteriormente retratada), para iludir audiências desavisadas. As redes sociais têm uma imensa capacidade de replicar, na forma de notícias, fatos e dados extraídos em recortes de trabalhos científicos

(ou pseudocientíficos), uma vez tornados públicos. A retratação formal de artigos não impede que estes sejam citados ou referenciados.

A prática de *peer-reviewing*, que é antiga e importante, não é infalível. É filtro, mas deixa passar impurezas. A responsabilidade dos *checks and balances* dos periódicos é cada vez mais desafiadora. Protocolos éticos, apresentação dos procedimentos metodológicos e explicitação das fontes de dados e informações são responsabilidade de autores. Verificação de tais práticas é responsabilidade de revisores. E a análise crítica é também uma prerrogativa de quem lê artigos publicados.

A ciência da informação está evoluindo a passos acelerados. A Inteligência Artificial (IA) já é capaz de produzir textos com aparência de real, mas suscetíveis de apresentar conteúdos falsos, manipulações e plágio. Nesse sentido, a ciência está diante de graves riscos, que devem ser devidamente enfrentados.

Em 1972, Jacob Bronowski – físico que participou do Projeto Manhattan, que produziu as primeiras bombas atômicas – advertiu os cientistas sobre o risco inerente ao (mau) uso dos conhecimentos que produzem. Ele se referia aos artefatos lançados sobre Hiroshima e Nagasaki. Em sua visão, tornara-se imperativo que a ciência seja regulada por mecanismos estabelecidos pela própria ciência. Foi um dos primeiros cientistas a advertir que a humanidade chegara a um ponto tal que, doravante, seria capaz de influir diretamente no futuro da própria existência humana, como se o homem tivesse usurpado o papel de Deus. Desde então, o debate sobre a responsabilidade de quem cria conhecimentos não cessa de crescer. Cientistas não podem sucumbir à tentação de agir como aprendizes de feiticeiro, que não se preocupam com as consequências de suas criações e são capazes de prever e desfazer os eventuais efeitos deletérios que possam causar.

Inverdades científicas podem ser alicerçadas de diferentes modos: dados falsos, métodos e ferramentas capciosos, além de conclusões sem base em evidências científicas comprovadas. Al Gore, em sua obra de advertência sobre os riscos de desastres ecológicos, apontou uma série de Verdades Inconvenientes (2006)[5] sobre as mudanças climáticas. É hora de ficarmos atentos às diversas expressões da *fake science*. Um conjunto grande de artigos relacionados à Covid-19 também foi objeto de retratação e, devido à recorrência e quantidade de situações, levou ao surgimento de uma plataforma para monitorar e publicizar os trabalhos retratados.

A chegada da IA ao universo da ciência, ao mesmo tempo que potencializa avanços notáveis, abre também um amplo espaço ao aparecimento de inverdades convenientes a grupos de interesse nem sempre bem-intencionados. Além do componente relacionado ao produto, há que se analisar também o processo cognitivo e formativo associado. Os aplicativos de edição de texto, com a ferramenta do *copy & paste*, deram agilidade à escrita e à revisão de redação, mas provocaram também danos à prática da prévia reflexão e planejamento da estrutura textual, que exigia longos períodos de reflexão antes de iniciar a escrita da frase. A redação de manuscritos e a análise de dados exigem um longo período de formação, com abundantes leituras de outros trabalhos e reflexão sobre seus conteúdos durante e após essas leituras, antes de formar ideias e opiniões que orientam a sua comunicação. Esse período formativo e reflexivo pode se perder ou ser menos valorizado, inclusive vindo a transmitir uma visão equivocada de poder e sapiência que o pesquisador pode não ter, mas se ilude, apoiado pela IA.

Portanto, há alguns aspectos a se considerar nesse debate: 1) há um contexto que estimula a publicação de trabalhos, mesmo que de embasamento duvidoso, que é a medida de produtividade baseada em quantidade de publicações, e que precisa ser repensada; 2) a fragmentação do conhecimento na ciência que anda de mãos dadas com a lógica produtivista que torna o(a) cientista desconectado da reflexão ética precisa ser revertida; 3) é preciso se interrogar sobre as consequências na formação das novas gerações de pesquisadores(as) e a ilusão de que a IA pode vender sobre a capacidade reflexiva dessas pessoas, e pensar estratégias que assegurem o desenvolvimento do pensar crítico e da capacidade de desenvolver uma cadeia lógica de relações entre fatos e causalidades.

Na área da sustentabilidade, essencialmente multi- inter- e transdisciplinar, esses três aspectos são particularmente relevantes e cruciais para que se possa desenvolver uma ciência ética e responsável.

Em vista dos processos e fatos acima narrados, a SiD se junta ao debate sobre a responsabilidade dos periódicos científicos e da comunidade de autores, revisores e leitores de seu campo de interesse.

Em seu primeiro número de 2024 (número 1, volume 15) SiD publica 9 artigos na seção *Varia*.

Primeiramente, Fagundes e Schreiber debatem sobre as principais fontes de emissões de gases de efeito estufa (GEE) nas indústrias de calçados, em um estudo com quatro empresas situadas no Sul do Brasil. Na sequência, Meurer e van Bellen apresentam uma análise de como diferentes países evidenciam suas contas econômicas ambientais de água, por meio do uso da metodologia SEEA-*Water*, enquanto Barbosa e Ribeiro apresentam uma análise dos conflitos e da estrutura de governança da água na Bacia do Rio Paraguai (América do Sul). Já Monteiro *et al.* apresentam um panorama da Ciência e Tecnologia na Amazônia, discutindo o papel de diversas instituições e discorrendo sobre os desafios para a mobilização destas para o desenvolvimento territorial sustentável. Oliveira-Monteiro *et al.* apresentam uma avaliação da percepção ambiental, dos comportamentos pró-ecológicos e da qualidade de vida da comunidade de caiçaras da Praia do Perequê, situada na cidade de Guarujá (SP). E, Brites analisa os diferentes problemas urbanos ambientais na cidade de Posadas (Argentina), onde foi procurado entender e descrever as ações ou omissões da legislação e/ou políticas ambientais em relação às diferentes áreas urbanas.

Ronquim *et al.* discorrem sobre os principais fatores que favorecem a regeneração da vegetação nativa em duas regiões do estado de São Paulo dentro de um período de 30 anos, enquanto Budiyoko *et al.* investigam estratégias de subsistência sustentável de comunidades residentes na região do Monte Slamet, na Província de Java Central, Indonésia. E, por fim, Menke e Menke discorrem sobre os tabus tradicionais presentes no Suriname, em um contexto de recente confluência de diversos grupos na capital Paramaribo e redondezas.

Desejamos a todos(as) uma boa leitura.

NOTAS

1| https://revistapesquisa.fapesp.br/era-tudo-mentira/ (acesso em 6/4/2024)

2| https://link.springer.com/article/10.1007/s10040-014-1215-0

3| https://news.ku.edu/news/article/2013/12/11/public-censure

4| https://www.nature.com/articles/d41586-023-03974-8 (acesso em 6.4.2024)

5| Al Gore. *An Inconvenient Truth*, 2006. Filme laureado com o Oscar de melhor filme documentário.

REFERÊNCIAS

BRONOWSKI, J. **Science and Human Values**. New York, Harper & Row, 1972.

VAN DER HEYDEN M. A.; VAN DE VEN T.; OPTHOF, T. Fraud and misconduct in science: the stem cell seduction. Implications for the peer-review process. **Neth Heart J.**, 2009 Jan, v. 17, n. 1, p. 25-9. DOI: 10.1007/BF03086211.

Strategies for a sustainable future in the footwear industry in the face of greenhouse gas emissions (GHG)

Estratégias para um futuro sustentável na indústria calçadista diante das emissões de gases de efeito estufa (GEE)

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ARTICLE – VARIA

ABSTRACT

In spite of the efforts of the footwear and textile industries to understand their greenhouse gas (GHG) emissions and develop reduction strategies, knowledge on the subject is still incipient. Given this scenario, this paper aims to identify, quantify, and present the main sources of GHG in this economic sector, followed by proposing solutions aimed at more efficient management. A qualitative and quantitative study was conducted with four companies in southern Brazil to achieve this purpose. Among the main sources of emissions are fuel and energy consumption. The main reduction alternatives include searching for alternative fuels and considering energy generation through clean sources. It is clear that implementing initiatives aimed at reducing emissions is not a simple task. However, the research highlighted the technical feasibility of new forms of production with a reduced environmental impact.

Keywords: Footwear Industry. Greenhouse Gases. Brazil GHG Protocol Program. Strategy. Sustainable Future.

RESUMO

Apesar dos esforços das indústrias de calçados e têxtil para compreenderem suas emissões de gases de efeito estufa (GEE) e desenvolverem estratégias de redução, o conhecimento sobre o tema ainda é incipiente. Diante desse cenário, o objetivo deste artigo é mapear, quantificar e apresentar as principais fontes de GEE desse setor econômico, seguido pela proposição de soluções visando uma gestão mais eficiente. Para alcançar esse propósito, realizou-se um estudo qualitativo e quantitativo com quatro empresas situadas no Sul do Brasil. Entre as principais fontes de emissões destacam-se o consumo de combustível e energia. As principais alternativas de redução incluem a busca por

combustíveis alternativos e a consideração da geração de energia através de fontes limpas. Percebe-se que a implementação de iniciativas voltadas para a redução de emissões não é uma tarefa simples. No entanto, a pesquisa evidenciou a viabilidade técnica de novas formas de produção com um impacto ambiental reduzido.

Palavras-chave: *Indústria Calçadista. Gases de Efeito Estufa. Programa Brasileiro GHG Protocol. Estratégia. Futuro Sustentável.*

1 INTRODUCTION

Climate change has emerged as one of the greatest challenges faced by humanity in the 21st century. The increase in greenhouse gas (GHG) emissions resulting from human activities contributes significantly to changes in the global climate. The Earth is witnessing unprecedented climate change, evidenced by extreme events such as more intense hurricanes, prolonged droughts, and rising sea levels. These phenomena threaten biodiversity and ecosystems and directly affect global economic and social stability (IPCC, 2023; Lima *et al.*, 2020).

In the period from 2011 to 2020, the global temperature recorded an average increase of 1.1ºC compared to the period from 1850 to 1900, with this increase attributed to GHG emissions. Each year, there is a progressive increase in the emission of these gases (Adedeji *et al.*, 219). In 2018, emissions reached the mark of 48.9 gigatons of carbon dioxide equivalent ($CO_{2\text{-eq}}$), and in 2022, this number reached 50 $GtCO_{2\text{-eq}}$ (Ghimouz *et al.*, 2023; IPCC, 2023).

This outcome is intrinsically linked to the significant growth in energy generation from fossil sources, changes in land use, and the uncontrolled deforestation that occurs in several parts of the world, especially in Brazil. These intensive human activities have played a crucial role in the escalation of climate change, highlighting the pressing need to transition to more sustainable practices and reduce GHG emissions (IPCC, 2023). In response to the urgency of climate change, organisations are increasingly pressured to adopt more sustainable practices and minimise their GHG emissions. Notably, the consumer goods and fashion goods industries, such as the footwear and textile industries, present a linear production mode, representing this sector's dominant paradigm (Ghimouz *et al.*, 2023). In this context, the search for innovative and responsible strategies becomes an environmental necessity and an opportunity for companies to lead the way towards a low-carbon future (Gallego-Alvarez *et al.*, 2015).

In this context, this paper aims to map and quantify GHG emissions from footwear industries located in the southern region of Brazil and then identify possibilities for reducing emissions. Accurate measurement of GHG emissions is essential for understanding and controlling the environmental impact of industrial operations. To achieve the established objective, a multiple case study was conducted involving quantitative and qualitative approaches in four footwear industries located in the mentioned region during the period from August to December 2023. In the qualitative phase, the premise of data triangulation was employed through semi-structured interviews, documentary research and non-participant observation, following the guidelines proposed by Yin (2015).

For the quantitative stage of the research, the methodology of the Brazil GHG Protocol Program (BGHGPP) was used for the meticulous quantification of GHG emissions associated with the operations of the companies involved for subsequent identification of reduction opportunities. According to Caldeira *et al.* (2022), this is Brazil's most widely used methodology, developed by the Getulio Vargas Foundation.

Efforts to curb greenhouse gas (GHG) emissions necessitate an accurate and consistent compilation of GHG emissions inventories across various economic sectors. These inventories serve as crucial

documentation of GHG emissions stemming from diverse economic activities over specific timeframes (Aguiar *et al.*, 2016; Chandrakumar *et al.*, 2019; Ding *et al.*, 2019). The findings derived from these inventories play a pivotal role in informing national policies and strategies related to climate action, underpinned by established methodologies (Abreu *et al.*, 2014; Singh et al., 2014).

It is worth mentioning that, from the total greenhouse gas emissions in 2022 (50 $GtCO_{2-eq}$), approximately 1.7 $GtCO_{2-eq}$ correspond to the contribution of the textile and footwear industry on a global scale, representing 8.5% of the total. Furthermore, it is estimated that this specific industry will emit 2.7 $GtCO_{2-eq}$ in 2030, reflecting a significant increase of 63% from previous levels (Ghimouz *et al.*, 2023).

In this regard, this research seeks to foster the creation of more sustainable and efficient strategies, in line with the dedication to reduce environmental footprints and encourage more responsible practices within the footwear market in the area. The growing desire from consumers for sustainable products is increasingly apparent (Kumar; Carolin, 2020; Pimenta *et al.*, 2023). Furthermore, the numbers presented by Abicalçados (2023) and Pimenta *et al.* (2023) highlight that, in 2022, Brazil produced 840 million pairs of shoes, exporting 143 million to 170 different destinations, responsible for 266,000 formal jobs generated in 5.4 thousand companies all over the country. This significant volume resulting in revenues exceeding R$ 25.2 billion, consolidating the country as the 5th largest footwear producer in the world. This data highlights the importance of the sector for the Brazilian economy, while this study aims to guide the industry to adopt more sustainable practices, contributing to a more responsible and balanced future. For this reason, this paper aims to identify, quantify and present the main sources of GHG in this economic sector, followed by proposing solutions aimed at more efficient management.

2 THEORETICAL FOUNDATION

2.1 CLIMATE CHANGE

Climate change represents one of the greatest contemporary threats to the stability of our planet. Caused primarily by excessive greenhouse gas emissions resulting from human activities such as burning fossil fuels and deforestation, these emissions significantly impact ecosystems, climate, and communities worldwide (IPCC, 2023).

Greenhouse gases are substances present in the atmosphere that have the ability to absorb and re-emit thermal radiation originating from the Earth's surface. This capacity creates an effect similar to what occurs in a greenhouse, allowing part of the solar heat to be retained in the atmosphere and contributing to the planet's warming (IPCC, 2023). Although this natural phenomenon is essential to keep the Earth's temperature at levels suitable for life, human activities have intensified the concentration of some of these gases, worsening the greenhouse effect and causing significant climate change.

The main greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrogen oxides (NO_x), tropospheric ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6) (Serweta *et al.*, 2019). In order to make the impact of these gases on climate change more understandable, the amount emitted by them is quantified by the equivalent of carbon dioxide (CO_{2e}), measured in tons (tCO_{2e}) or kilograms ($kgCO_{2e}$) (BGHGPP, 2023; IPCC, 2023; Serweta *et al.*, 2019). This equivalence makes it possible to compare GHG emissions using a common rating scale. However, it is important to note that different gases contribute to global warming to different degrees, measured through an indicator called "global warming potential", or better known by the acronym GWP (BGHGPP, 2023; IPCC, 2023; Serweta *et al.*, 2019).

According to the IPCC (2023), the value of GHG emissions reached 50 $GtCO_{e-eq}$ in 2022. Within this panorama, the energy sector is linked to 34% of emissions (20 $GtCO_{2-eq}$), followed by industry with 24%

(14 $GtCO_{2-eq}$), Afolu (Agriculture, Forestry and Land Use) with 22% (13 $GtCO_{2-eq}$), transport with 15% (8.7 $GtCO_{2-eq}$) and civil construction with 6% (3. 3 $GtCO_{2-eq}$) (IPCC, 2023). In this context, it is crucial to highlight that the United States and China jointly represent around 40% of total emissions, with energy generation being the main source of GHG emissions in both countries. Both have intensive production and consumption of goods, including manufacturing and industrial processing, directly contributing to GHG emissions (IPCC, 2023).

When specifically analysing data from Brazil, it is observed that the changes in land use and forestry are responsible for 1.1 $GtCO_{2-eq}$, followed by agriculture with 617 megatons of carbon dioxide equivalent ($MtCO_{2-eq}$), energy with 412 megatons of carbon dioxide equivalent ($MtCO_{2-eq}$), waste with 91 $MtCO_{2-eq}$ and industrial processes with 65 $MtCO_{2-eq}$ (Seeg, 2023).

Regardless of the country or sector of activity, the high level of greenhouse gas emissions increases global average temperatures. According to the IPCC (2023) report, the global average surface temperature was approximately 1.1°C higher than the period 1850 to 1900 during the years 2011 to 2020. Furthermore, it is noteworthy that the global average surface temperature has increased more rapidly since 1970 than in any other period in the last 2000 years, at least (IPCC, 2023).

The average increase in temperature results in several global risks for humanity, covering crucial areas such as health, livelihoods, food security, water supply, human security and economic growth. These risks highlight the urgency of effective actions to mitigate climate change and preserve the sustainability of our planet (Adger, 2014; Diffenbaugh; Field, 2013; IPCC, 2023; Rosenzweig; Neofotis, 2013).

2.2 GREENHOUSE GAS EMISSIONS IN BRAZILIAN COMPANIES

Finding studies related to climate change is a simple task to do. In a quick search on Science Direct in December 2023, when entering the keyword “climate change”, more than 850 thousand results are obtained. However, when combining this search with the keyword “footwear industry”, the results decrease to just over one thousand (Science Direct, 2023).

Going deeper into the investigations, it is noted that most studies are focused on quantifying GHG emissions related to specific products throughout their life cycle. For example, a specific footwear category is analysed to evaluate its carbon footprint, from the extraction of raw materials to disposal by the end consumer. This covers the phases of transporting raw materials to the factory, the production process, and the delivery of finished products to consumers.

In two studies conducted in China, Cheah *et al.* (2013) and De Ponte *et al.* (2023) found that most emissions in Chinese industries are concentrated in the footwear production phase, covering energy consumption, the use of fossil fuels and the generation of waste. In a total emission of 14 $kgCO_{2-eq}$ to produce a pair of shoes, 9 $kgCO_{2-eq}$ are associated with the manufacturing stage (Cheah *et al.*, 2013; De Ponte *et al.*, 2023). It is important to note that China predominantly depends on coal as its main energy source, which directly influences this result. The other 5 $kgCO_{2-eq}$ are distributed in raw materials for manufacturing the product, transporting it to the customer, final disposal, and usability. In another study conducted in Europe, similar results were also found by Gajewski *et al.* (2014).

Unlike carbon footprint studies, there are GHG inventories, in which the analysis covers not just one line of products but all those produced by a given company (PBGHG, 2023). In Brazil, it is common to observe companies allocating resources to projects aimed at the comprehensive assessment of their emissions, not limited to a specific product. According to BGHGPP (2023), in 2008, less than 100 companies carried out and made public their GHG inventories, while in 2022, this number reached 434 in Brazil alone.

Still in Brazil, among these companies that release their inventories, 55% are distributed across different sectors, 28% in the manufacturing industry, 10% in the transport, storage and mail sector, 9% in the electricity and gas segments, and 8% in financial activities, insurance and related services. The remaining 45% cover sectors such as professional, scientific, and technical activities; extractive industries; trade and repair of motor vehicles and motorcycles; agriculture, livestock, forestry production, fishing, and aquaculture, among others (BGHGPP, 2023). It is worth mentioning that the BGHGPP (2023) does not provide specific data for the footwear industry.

Regarding the GHG emissions profile of Brazilian organisations, the highlights are emissions from energy consumption, stationary combustion (emissions from burning fuel to produce energy) and industrial processes (emissions from the chemical or physical transformation of any material), as well as fugitive emissions (unintentional release during the production, processing, transmission, storage, or use of the gas). These categories are considered sources owned or controlled directly by the organisation (BGHGPP, 2023).

It is worth mentioning that compared to other electric power systems, the GHG emission factor of the Brazilian electrical grid is notably low. This can be attributed to the composition of the grid, where a significant portion (67.6%) of the energy is generated from hydroelectric sources. Additionally, wind power (8.9%), biomass (8.3%), and other renewable sources contribute to the grid, further reducing its carbon footprint. Non-renewable sources such as oil (2.9%) and gas (7.9%) play a smaller role, with minimal contributions from solar (1.1%) and nuclear (1.2%) energy. This data underscores the relatively clean nature of the Brazilian electrical grid (Caldeira *et al.*, 2022).

Conversely, that is, indirect emissions that occur along the organisation's value chain, categories considered "administrative", such as business travel, waste generated in the organisation's operations, upstream transport, and distribution (emissions from transport and distribution of products purchased) and employee transportation are highlights (BGHGPP, 2023; Caldeira *et al.*, 2022). Measuring emissions without direct control by the organisation presents a more significant challenge. The complexity in measurement arises from the fact that many data are subject to the control of the supply chain and/or intermediate or final consumers of products or services.

On the other hand, Brazilian companies, although they report on a smaller scale, also present records of emissions originating from mobile combustion (resulting from the burning of fuels to generate movement), categories associated with agricultural activities, changes in land use, waste, effluents, and downstream transport (emissions related to the transport and distribution of commercialised products) (BGHGPP, 2023).

3 METHODOLOGY

As mentioned in the introduction of this study, qualitative and quantitative research was conducted to carry out a survey and quantification of greenhouse gas emissions from footwear industries in the southern region of Brazil. A detailed description of each of these steps is presented below.

3.1 QUALITATIVE AND QUANTITATIVE STAGE

In the qualitative stage of this study, which is characterised by the opportunity to carry out interpretations and attributions of meanings, a multiple case study was conducted according to Yin's (2015) guidelines. This method involves data triangulation through semi-structured interviews, non-participant observation and documentary research. This step proved crucial for researchers to obtain in-depth knowledge of the companies involved in the research and to consolidate the process of mapping the sources of greenhouse gas emissions for later requesting data to be used to quantify

emissions. Furthermore, through the semi-structured interview, it was also possible to understand the maturity of the companies in terms of their emissions and what strategies they had already adopted or planned to adopt in the coming years to reduce them.

The four organisations selected to take part in the study were designated as Alpha, Beta, Gamma and Delta companies. The companies agreed to this nomenclature to preserve their identity and guarantee confidentiality. The decision to maintain confidentiality in disclosing the names of the organisations played a fundamental role in obtaining more concrete and truthful answers, following the guidelines of Yin (2015). Both the sector and the footwear industries chosen to be part of the study were chosen non-probabilistically, intentionally and for convenience. Even so, there was concern that they all had similar characteristics that would allow comparison of the data obtained, such as: located in the south of Brazil; large companies; operations in the footwear sector, both nationally and internationally; and having annual revenues exceeding R$ 300 million.

The choice to limit the sample to 4 companies was based on the theoretical saturation criterion, as described by Fontanella *et al.* (2008). The authors considered the information already obtained to date sufficient for the proposed analysis, understanding that including new participants would contribute minimally to the material already collected. All empirical data were subjected to content analysis following the recommendations of Bardin (2011). This entire process lasted 4 months (August-November/ 2023).

In the GHG emissions quantification phase, the emission factors previously established by BGHGPP (2023) were used based on previously specified sources of emissions. From this enumeration, requesting consumption data from organisations was feasible, multiplying the values by the respective emission factors. The calculation process lasted one month, during December 2023.

4 RESULTS

In order to ensure the efficient structuring of the results and discussion phase, it was decided to start the process by providing a succinct characterisation of the companies studied. Subsequently, the sources of emissions associated with these organisations are addressed. Finally, quantitative results are presented, thus outlining possible alternatives for reducing emissions for the companies analysed.

This sequential approach aims to provide a clear and comprehensive understanding of information related to companies' environmental impact, facilitating analysis and discussion.

4.1 CHARACTERISTICS OF COMPANIES

The four companies involved in the research are established in the southern region of Brazil, serving both the national and international markets. The southern region of Brazil is recognised as the birthplace of the footwear industry in the country, standing out for its significant contribution to the development and consolidation of this industrial sector over time.

Alfa operates with two units, Beta operates in three units, while Gama and Delta maintain four units each. These companies are key players in the industry, each contributing uniquely to the sector's dynamics and overall performance. In Table 1, it is possible to check the characteristics of each company.

Table 1 – Characteristics of companies

Categories/Companies	*Number of operation units*	*Employees*	*Millions of pairs/ Year*	*Target audience*
Alfa	2	1.035	2	Infant
Beta	3	2.500	8,5	Women
Gama	4	6.000	18	Women
Delta	4	3.000	9,1	Women

Source: Authors (2023).

All of these companies play a fundamental role in developing the region where they are located, providing a significant economic, social and environmental impact. Not only do they generate more than 10,000 direct jobs, but they also manufacture more than 30 million pairs annually. This large-scale production not only enhances the economic strength of local communities but also indirectly impacts an entire value chain, encompassing manufacturers of raw materials and component manufacturers that are interconnected with it.

Each of the companies was asked about carrying out a similar study, that is, whether they had already mapped and quantified their emissions. Two of them stated it was the first time, while two others mentioned it was the second time. When asked why the process is not yet fully developed within the organisations, they all mentioned the complexity of the supply chain, which often involves multiple suppliers and subcontractors, making it difficult to track and quantify emissions throughout the production process. Additionally, the lack of consistent standards and methodologies for measuring sector-specific emissions hinders comparison and monitoring over time. Another challenge is the limited availability of data and information on production practices and energy consumption at different stages of the footwear manufacturing process. Although they acknowledge the difficulty of quantifying their greenhouse gas emissions, all of them have shown interest in improving their understanding of the subject.

4.2 GHG SOURCES

Although they belong to the same sector of activity, each of the companies has distinct characteristics that directly influence the results of their GHG emissions. An in-depth understanding of these nuances is essential for a precise and personalised analysis of emissions mitigation strategies, allowing for more effective approaches adapted to the uniqueness of each company, as well as the data presented by the IPCC (2023) and Seeg (2023), in which highlights the particularities of each country in the emissions scenario, with one strategy not always applicable to another.

In Table 2, it is feasible to observe the sources of emissions directly controlled by the company and the electricity consumption identified in all organisations. This table provides a comprehensive view of the sources of emissions directly managed by companies.

Table 2 – Sources of GHGs controlled by companies

Categories/Companies	*Alfa*	*Beta*	*Gama*	*Delta*
Stationary Combustion	Generator, Welder, Kitchen Stove, Brushcutter.	Generator and Kitchen Stove.	Boiler, Generator, Kitchen Stove and Brushcutter.	Generator and Kitchen Stove.
Mobile Combustion	Forklifts	Own Vehicle Fleet	Rented Fleet of Vehicles and Forklifts	Rented Fleet of Vehicles and Forklifts
Fugitive Emissions	CO_2 Fire Extinguishers, Air Conditioning, Refrigerators, Shaping Machines, Chiller.	CO_2 Fire Extinguisher, Air Conditioning, Refrigerator, Drinking Fountain and Shaping Machines	Shaping Machines, Air Conditioners, Drinking Fountains, CO_2 Fire Extinguishers, Refrigerators, Air Dryers and Cold Stabilizers.	CO_2 Fire Extinguisher, Air Conditioning, Drinking Fountain, Refrigerators and Shaping Machines.

Source: Authors (2023).

As seen in Table 2, in the stationary combustion category, all companies have generators and kitchen stoves. Specifically, Alfa also uses welders, characterising particularities in its operations. When we asked about the use of this equipment, all companies indicated the use of generators only in situations of lack of electricity, and kitchen stoves are intended for the culinary environment, an installation present in all companies.

As for the brushcutters, present in the companies Alfa and Gama, due to their location in open spaces with abundant vegetation, these companies have them to maintain the area, ensuring the cleanliness and organisation of the space. This care demonstrates companies' attention to issues related to emissions and the physical environment around them.

In relation to the mobile combustion category, which involves the burning of fuels in equipment to generate movement (BGHGPP, 2023), unlike stationary combustion, some particularities are observed. Two companies, Gama and Delta, maintain a rented fleet of vehicles, while Beta has its own fleet. On the other hand, the company Alfa does not have a fleet of vehicles, whether rented or owned. When asking the managers of the companies Beta, Gama and Delta about the use of their vehicle fleets, information was obtained that travel occurs primarily between the company's various units and during visits to customers. It is worth mentioning that although the manufacturing units are in the south of Brazil, these companies provide services to customers throughout the national territory.

In a complementary way, Gama and Delta were asked why the fleet was rented and not owned. In this case, the manager explained that this practice provides the advantage of constantly updating the fleet, eliminating the need to make significant investments in vehicles. permanent property, but not mentioning anything regarding GHG emissions.

On the other hand, when we questioned the company Alfa about the lack of its own fleet, the manager clarified that the necessary investment was not considered advantageous. In situations requiring travel, employees are encouraged to use their own vehicles, with the possibility of later reimbursement of fuel costs or travel through transport apps.

Regarding fugitive emissions, all companies present unintentional emissions from fire extinguishers, air conditioning systems, refrigerators, pre-shaping and shaping machines. In particular, the Alfa company has a chiller. When questioning the manager about the function of this device, he clarified that it was a machine used for cooling, operating as an air conditioning system with cooling based on water and refrigerant. In other words, it is a large piece of equipment. It is relevant to highlight that all companies were surprised to realise that equipment like these emitted greenhouse gases, initially perceiving that only burning fossil fuels was the main source of these emissions.

The company's indirect emissions, that is, those under the control of its value chain, are presented in detail in Table 3. The same surprise occurred when the scope 3 categories were listed for the companies. At that moment, the organisations were unaware they were co-responsible for so many aspects.

Table 3 – Sources of GHGs not controlled by the company

Categories/Companies	*Alfa*	*Beta*	*Gama*	*Delta*
Purchased Assets and Services	x	x	x	x
Capital goods	x	x	x	x
Activities related to fuel and energy not included in Scopes 1 and 2	-	-	-	-
Upstream Transport and Distribution	x	x	x	x
Downstream Transport and Distribution	x	x	x	x
Waste	x	x	x	x
Business Travel	x	x	x	x
Home-Work Commuting	x	x	x	x
Leased assets (the organisation as lessee)	-	-	-	-
Leased assets (the organisation as lessor)	-	-	-	-
Processing of sold products	x	x	x	x
Use of goods and services sold	x	x	x	x
End-of-life treatment of products sold	x	x	x	x
Franchises	x	x	-	X
Investments	x	x	x	x

Source: Authors (2023).

As shown in Table 3, several categories in which companies do not have direct control over emissions were identified. Only three categories were not identified in all companies, namely "Leased Assets" and "Activities related to fuels and energy not included in Scopes 1 and 2". Furthermore, only one company does not have franchises, with this category being present only in the other companies participating in the study. Even so, categories such as business travel, waste generated in the organisation's operations, upstream transport and distribution (emissions from transport and distribution of purchased products) and employee commuting are highlights.

4.3 GHGS EMISSIONS

After thoroughly identifying the sources of emissions in companies, we moved on to the phase of quantifying these emissions. Table 4 provides a clear view of the quantified categories, presenting the corresponding values in tons of carbon dioxide equivalent in each company.

Table 4 – GHG emissions (tCO2-eq)

Categories/Companies	*Alfa*	*Beta*	*Gama*	*Delta*	*Total*
Stationary Combustion	14,93	19,77	48,8	44,78	125,28
Mobile Combustion	0,05	440,24	164,2	132,99	737,48
Fugitive Emissions	126,47	6,91	77,21	87,27	297,86
Energy	195,01	474,15	1.047,57	378,36	2.095,09
Home-Work Commuting	121,47	190,87	589,55	552,4	1.454,29
Upstream Transport and Distribution	1.070,35	-	-	-	1.070,35
Downstream Transport and Distribution	-	166,28	-	328,65	494,93
Business Travel	107,81	11,88	177,66	65,25	362,60
Total	**1.636,09**	**1.310,1**	**2.104,99**	**1.589,7**	**6.640,88**

Source: Authors (2023).

When examining Table 4, it is possible to see that not all categories were quantified, especially those not under the organisations' direct control. Each of the companies analysed faced challenges in presenting related data. When asked about the reason for this difficulty, all managers pointed to their recent concern with monitoring their own emissions, indicating that they have not yet asked their business partners to provide the same data. Furthermore, they explained that in some categories, there is a lack of knowledge about the specific type of data that should be monitored, contributing to the complexity of disclosing this information. To overcome the difficulties, all companies emphasised the need to train their employees regarding this subject. However, they also consider the possibility of hiring external consultancy to deal with this difficulty initially.

Among the mapped categories, Table 4 shows a significant prevalence in emissions associated with energy consumption, employees' commuting and upstream transport and distribution. Regarding energy consumption, all companies are dependent on this essential resource for the proper functioning of their machines and operational processes, justifying its predominance. When there is a power outage, that is, in situations of supply interruption, the generators are activated, resulting in the use of fossil fuel, as mentioned earlier.

However, it is worth highlighting that all managers commented that companies consume energy from the Free Contracting Environment (ACL), better known as the Free Energy Market. When questioning companies about why they opt for this type of consumption, they all highlighted the economic advantages associated with long-term contracts. Furthermore, they reinforced that consumption through this environment makes purchasing energy generated through clean and renewable sources such as wind and solar power possible. Although managers highlight the economic gains as a differentiator for being in this market, the companies also mentioned issues associated with environmental impacts, meeting the demand of some customers concerned about these issues.

Although all the companies analysed acquired 100% of their energy from this market, managers' concern with reducing energy consumption became evident throughout the interviews. With this understanding, all companies have set goals to reduce consumption by 2030. When asked about how they plan to achieve these goals, several actions were mentioned, such as raising employee awareness, replacing equipment to increase efficiency in energy consumption, exchanging common light bulbs for new and more efficient ones, installing solar panels, implementing presence sensors, among other measures.

For organisational activities to occur, all companies rely on a robust team of employees. As a result, emissions associated with employees commuting from their homes to the workplace came in second place. When asking managers about employee travel, they all stated that control is carried out using buses chartered by the companies, only accounting for production/operational personnel, which represents approximately 80% of the workforce. Employees from other sectors, such as administrative sectors, generally travel in private vehicles, which makes access to relevant data even more difficult. However, the companies mentioned the need to also understand the impact of employees who travel in their own vehicles, suggesting the possibility of implementing a questionnaire to gather data from this group.

The upstream transportation and distribution category concerns the movement category of all raw materials and inputs acquired by the company. This is different from the downstream category, which involves the distribution of the final product to the consumer. Both categories had low adherence by organisations. When questioning managers about this difficulty, he mentioned that transport companies still do not record the information necessary to quantify emissions, which makes access to this data challenging. However, two companies (Beta and Delta) complemented the information, highlighting that, in the last two years, they have conducted outreach workshops with carriers, aiming to make them aware of the importance of starting the process of controlling this information.

Finally, the category of business trips is considered by managers as easy to measure since only listing the number of flights to and from the destination is necessary, as well as listing trips made by car or bus by employees. Generally, this data is held by the administrative department responsible for controlling ticket acquisition. The category of upstream transport and distribution, as well as employees' home-to-work journeys and business trips, are widely highlighted in reports, as indicated by BGHGPP (2023), despite the data not being under the direct control of organisations.

All managers signalled the resumption of business travel after the end of the Covid-19 pandemic. This perspective reflects the global nature of these companies' operations and the trend towards normalisation of corporate travel in the post-pandemic scenario. However, this raises a warning about a possible increase in emissions associated with this category.

5 RESULTS DISCUSSION

Often, strategies to reduce GHG emissions are implemented on a global scale. However, when analysing data from Brazil, the United States and China, there is a disparity in the emissions profiles of each country. For example, the approaches applied in Brazil may not be the most appropriate for implementation in China and the United States. This same consideration must be applied at the organisational level, recognising the diversity of contexts and adopting strategies adapted to each specific reality (IPCC, 2023; Seeg, 2023).

The data provided from the analysis of greenhouse gas (GHG) emissions in various companies within the same sector reveals distinct characteristics influencing their emissions profiles. Comprehending these nuances is essential for mitigation strategies, especially in the quest for innovative processes to lead the way towards a low-carbon future (Abreu *et al.*, 2014; Gallego-Alvarez *et al.*, 201; Singh *et al.*, 2014).

In stationary combustion, for instance, as emphasised by BGHGPP (2023), the category of stationary combustion stands out as one of the most frequently reported categories by Brazilian companies. While all companies possess generators and kitchen stoves, Alfa stands out due to the presence of welders, reflecting its unique operational requirements.

Regarding mobile combustion, which involves burning fuels in equipment to generate movement (BGHGPP, 2023), unlike stationary combustion, some particularities are observed. Gama and Delta opt for rented fleets, while Beta maintains its own. In other words, they are responsible for the fuel their fleet burns. In this case, replacing the fuel with a biofuel or even planning the route to avoid unnecessary travel can be reconsidered. Notably, Alfa lacks a fleet, encouraging employee-owned vehicle use. It is worth mentioning that this type of emission becomes indirect for the organisation, no longer under its direct control (BGHGPP, 2023).

Fugitive emissions are present in all companies, with Alfa having additional equipment like a chiller. This variance highlights the diverse approaches to fleet management among the companies. Concerning the GHG emissions profile of Brazilian organisations, particularly those regarded as sources directly owned or controlled by the organisation, the key emissions highlights include those from energy consumption, stationary combustion, industrial processes, and fugitive emissions (BGHGPP, 2023).

In GHG emissions quantification, energy consumption dominates across all companies, reflecting dependency on this resource for operations as well as Cheah *et al.* (2013), De Ponte *et al.* (2023) and Gajewski *et al.* (2014) results. Since Brazil already has an advanced energy matrix, characterised by renewable and clean sources, which differentiates it from many other countries, reducing emissions requires a specific focus on other areas, making the challenge even more complex. This emphasis on renewable energy procurement demonstrates a commitment to reducing carbon footprints and transitioning towards sustainable practices in response to customer demand for environmentally friendly companies. This finding corroborates with Kumar and Carolin (2020) and Pimenta *et al.* (2023).

Companies face challenges quantifying indirect emissions, highlighting the complexity of data collection and partnerships with third parties. Challenges arise in quantifying emissions associated with upstream transportation and distribution, indicating gaps in data collection from transport partners. These results are also evidenced by BGHGPP (2023) and Caldeira *et al.* (2022). Efforts to engage carriers in emission tracking are underway.

Nevertheless, to reduce these emissions, it is imperative to implement measures in logistics planning, considering sustainable fuel options, such as ethanol. By optimising logistics planning, it is possible to reduce the distance covered by vehicles, thus minimising fuel consumption and CO_2 emissions. The search for transport companies that use NGV (Natural Gas Vehicle) or electric vehicles is also an option, as these technologies have a lower environmental impact compared to traditional fossil fuels.

Renewing the fleet with more efficient and low-emission vehicles is also a strategy. Investing in renewing the vehicle fleet replacing older models with vehicles with cleaner and more efficient technologies, can also provide significant benefits. Modern vehicles generally have more advanced emission reduction systems, releasing less polluting gas.

Business travel presents a relatively straightforward measurement but signifies a potential future increase in emissions post-Covid-19, reflecting a global trend towards business travel resumption. Significant emissions stem from employee commuting, emphasising the importance of transportation-related emissions. Promoting more sustainable travel practices, such as adopting public transport by employees, sharing trips between them and using video conferences for remote meetings, can be a viable alternative. Furthermore, it is necessary to raise awareness among employees about the impacts of GHG emissions during travel. To this end, it is recommended that training sessions be held.

6 FINAL CONSIDERATIONS

This study aimed to map and quantify GHG emissions from footwear industries located in the southern region of Brazil, with the aim of subsequently proposing reduction strategies. A qualitative and quantitative approach was used to achieve this purpose.

Often, strategies to reduce GHG emissions are implemented on a global scale. However, when analysing data from Brazil, the United States and China, there is a disparity in the emissions profiles of each country. For example, the approaches applied in Brazil may not be the most appropriate for implementation in China and the United States. This same consideration must be applied at the organisational level, recognising the diversity of contexts and adopting strategies adapted to each reality.

Since Brazil already has an advanced energy matrix, characterised by renewable and clean sources, which differentiates it from many other countries, reducing emissions requires a specific focus on other areas, making the challenge even more complex. When analysing the results of this study, it is clear that the category with the highest energy emissions is the burning of fossil fuels to generate movement, whether through the transport and distribution of raw materials or through the commuting of employees.

Among the study's limitations, it is necessary to highlight the difficulty in accessing data for the categories in which organisations do not have direct control, which restricts companies' comprehensive analysis of emissions. However, it is important to understand that emissions are still incipient for many companies in Brazil, and the difficulty in accessing data is acceptable. It is recognised that awareness and implementation of emission measurement and control practices are in the early stages, which may impact the availability of detailed information.

Another limitation observed was that, at the national level, emissions data do not allow for an individual analysis of the footwear sector, a gap also highlighted in the BGHGPP (2023) report, which does not devote specific attention to this sector. The lack of particular emphasis on the footwear industry restricts a detailed understanding of its specific contributions to Brazilian and global emissions.

Even without official data on greenhouse gas emissions from the footwear industry in Brazil, multiplying the value of 840 million pairs by 14 kilograms of carbon dioxide equivalent, based on data provided by China, results in a total of 11.760 billion kilograms of carbon dioxide equivalent or 11.760 megatonnes of CO_{2eq}.

Given the aforementioned gaps, it is possible to develop recommendations that aim to fill this lack of emphasis in the sector, such as: research with the sector to seek an understanding of emissions and the development of workshops, courses and training to increase awareness of the issue by encouraging everyone to prepare an inventory to fully understand the sector's emissions.

Despite the limitations mentioned, it is crucial to highlight that they do not disqualify the relevance of this study. On the contrary, it plays a fundamental role in providing insights into GHG emissions in the footwear industry and identifying areas that require further development for a more comprehensive understanding of the topic. In this sense, the study offers an updated view of the scenario and points to the gaps to be filled, contributing to continued progress in understanding and tackling emissions in the footwear industry.

REFERENCES

ABREU, M. C. S. De.; ALBUQUERQUE, A. M.; FREITAS, A. R. P. De. Strategic positioning in response to regulatory constraints on greenhouse gas emissions. **Revista de Administração**, v. 49, n. 3, p. 578–590, 2014. DOI: 10.5700/rausp1169.

ADEDEJI, A. R.; ZAINI, F.; MATHEW, S.; DAGAR, L.; PETRA, M. I.; DE SILVA, L. C. Sustainable energy towards air pollution and climate change mitigation. **Journal of Environmental Management**, v. 260, 2019.

ADGER, W. N. *et al.* Human adaptation to climate change: a review of three historical cases and some general perspectives. **Environmental Science and Policy**, 27, p. 1–13, 2014. DOI: 10.1016/j.envsci.2012.02.008.

AGUIAR, L. V.; FORTES, J. D. N.; MARTINS, E. Carbon compensatory neutralisation – case study: mechanic metal industry, Rio de Janeiro (RJ), Brazil. **Engenharia Sanitária e Ambiental**, v. 21, n. 1, p. 197–205, 2016. DOI: 10.1590/S1413-41520201600100116414.

ASSOCIAÇÃO BRASILEIRA DAS INDÚSTRIAS DE CALÇADOS (ABICALÇADOS). Available from: https://www.abicalcados.com.br/. Acesed in: 2 dez. 2023.

BARDIN, L. **Análise de conteúdo**. São Paulo: Edições 70, 1977.

BRAZILIAN GHG PROTOCOL PROGRAM (PBPGHG). Available from: https://eaesp.fgv.br/centros/centro-estudos-sustentabilidade/projetos/programa-brasileiro-ghg-protocol/. Accessed in: 12 nov. 2023.

CALDEIRA, R. da S. *et al.* Opportunities for GHG Emission Reductions in the Brazilian Graphic Industry Through a Mitigation Plan. **Ambiente e Sociedade**, v. 25, 2022. DOI:10.1590/1809-4422asoc20200210r2vu2022L3OA

CHANDRAKUMAR, C.; MCLAREN, S. J.; MALIK, A.; RAMILAN, T.; LENZEN, M. Understanding New Zealand's consumption-based greenhouse gas emissions: an application of multi-regional input-output analysis. **International Journal of Life Cycle Assessment**, 2019. DOI: 10.1007/s11367-019-01673-z.

CHEAH, L.; CICERE, N. D.; OLIVETTI, E.; MATSUMURA, S.; FORTERRE, D.; ROTH, R.; KIRCHAIN, R. Manufacturing-focused emissions reductions in footwear production. **Journal of Cleaner Production**, v. 44, 2013.

DE PONTE, C. State of the art on the Nexus between sustainability, fashion industry and sustainable business model. **Sustainable Chemistry and Pharmacy**, 2023.

DIFFENBAUGH, N. S.; FIELD, C. B. Changes in Ecologically Critical Terrestrial Climate Conditions. **Science**, v. 341, n. 6145, p. 486–492. DOI: 10.1126/science.1237123.

DING, N.; LIU, J.; KONG, Z.; YAN, L.; YANG, J. X. Life cycle greenhouse gas emissions of Chinese urban household consumption based on process life cycle assessment: exploring the critical influencing factors. **Journal of Cleaner Production**, v. 210, p. 898–906, 2019. DOI: 10.1016/j.jclepro.2018.10.242.

FONTANELLA, B. J. B.; RICAS, J.; TURATO, E. R. Amostragem por saturação em pesquisas qualitativas em saúde: contribuições teóricas. **Cadernos de Saúde Pública**, Rio de Janeiro, v. 24, n. 1, p. 17-27, 2008.

GAJEWSKI, R.; FERRER, J.; MARTINEZ, M. A.; ZAPATERO, A.; CUESTA, N.; GAJEWSKI, A. Foot-wear carbon footprint in footwear industry (CO2Shoe). *In*: CHOCHÓŁ, A.; SZAKIEL, J. (ed.). **Achievements and challenges of commodity science in the age of globalisation**. Kraków: Polish Society of Commodity Science, Cracow University of Economics, 2014.

GALLEGO-ÁLVAREZ, I.; SEGURA, L.; MARTÍNEZ-FERRERO, J. Carbon emission reduction: the impact on the financial and operational performance of international companies. **Journal of Cleaner Production**, v. 103, n. 1, p. 149-159, 2015.

GHIMOUZ, C.; PIERRE, K. J.; HOF, L. A. On sustainable design and manufacturing for the footwear industry – Towards circular manufacturing. **Materials and Design**, v. 233, 2023.

GREENHOUSE GAS EMISSION AND REMOVALS ESTIMATION SYSTEM (SEEG). Available in: https://seeg.eco.br/. Acessed in: 8 dez. 2023.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC). **Climate Change 2023 Synthesis Report**. Available in: https://www.ipcc.ch/report/ar6/syr/. Accessed in: 22 dez. 2023.

KUMAR, P. S.; CAROLIN, C. F. Certifications for Sustainability in Footwear and Leather Sectors. *In*: **Leather and Footwear Sustainability**: manufacturing, supply chain, and product level issues, 2020.

LIMA, M. A.; MENDESB, L. F. R.; MOTHÉA, G. A.; LINHARESA, F. G.; CASTROA, M. P. P.; SILVAA, M. G.; STHELA, M. S. Renewable energy in reducing greenhouse gas emissions: reaching the goals of the Paris agreement in Brazil. **Environmental Development**, v. 33, 2020.

PIMENTA, A. A.; SINDELAR, F. C. W.; PÉRICO, E. Brazilian Footwear Industry: an analysis of the sustainable practices of certified companies by the sustainable origin seal. **Revista de Gestão Social e Ambiental**, v. 16, n. 3, 2023.

ROSENZWEIG, C.; NEOFOTIS, P. G. Detection and Attribution of Anthropogenic Climate Change Impacts. **Wiley Interdisciplinary Reviews: climate change**, p. 4, n. 2, p. 121–150. 2013. DOI: 10.1002/wcc.211.

SCIENCE DIRECT. Available from: https://www.sciencedirect.com/. Acessed in: 8 nov. 2023.

SERWETA, W.; GAJEWSKI, R.; OLSZEWSKI, P.; ZAPATERO, A.; ŁAWIŃSKA, K. Carbon Footprint of Different Kinds of Footwear – a Comparative Study. **Fibres and Textiles in Eastern Europe**, v. 27, n. 5, p. 94-99, 2019.

SINGH, N.; DAMASSA, T.; ALARCÓN-DÍAZ, S.; SOTOS, M. **Exploring Linkages Between National and Corporate / Facility Greenhouse Gas Inventories**. World Resources Institute, 2014.

YIN, R. K. **Case Study Research**: design and methods. Thousand Oaks, CA: Sage Publications, 2015.

Estratégias para um futuro sustentável na indústria calçadista diante das emissões de gases de efeito estufa (GEE)

Strategies for a sustainable future in the footwear industry in the face of greenhouse gas emissions (GHG)

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ARTICLE-VARIA

RESUMO

Apesar dos esforços das indústrias de calçados e têxtil para compreenderem suas emissões de gases de efeito estufa (GEE) e desenvolverem estratégias de redução, o conhecimento sobre o tema ainda é incipiente. Diante desse cenário, o objetivo deste artigo é mapear, quantificar e apresentar as principais fontes de GEE desse setor econômico, seguido pela proposição de soluções visando uma gestão mais eficiente. Para alcançar esse propósito, realizou-se um estudo qualitativo e quantitativo com quatro empresas situadas no Sul do Brasil. Entre as principais fontes de emissões destacam-se o consumo de combustível e energia. As principais alternativas de redução incluem a busca por combustíveis alternativos e a consideração da geração de energia através de fontes limpas. Percebe-se que a implementação de iniciativas voltadas para a redução de emissões não é uma tarefa simples. No entanto, a pesquisa evidenciou a viabilidade técnica de novas formas de produção com um impacto ambiental reduzido.

Palavras-chave: Indústria Calçadista. Gases de Efeito Estufa. Programa Brasileiro GHG Protocol. Estratégia. Futuro Sustentável.

ABSTRACT

In spite of the efforts of the footwear and textile industries to understand their greenhouse gas (GHG) emissions and develop reduction strategies, knowledge on the subject is still incipient. Given this scenario, this paper aims to identify, quantify, and present the main sources of GHG in this economic sector, followed by proposing solutions aimed at more efficient management. A qualitative and quantitative study was conducted with four companies in southern Brazil to achieve this purpose. Among the

main sources of emissions are fuel and energy consumption. The main reduction alternatives include searching for alternative fuels and considering energy generation through clean sources. It is clear that implementing initiatives aimed at reducing emissions is not a simple task. However, the research highlighted the technical feasibility of new forms of production with a reduced environmental impact.

Keywords: *Footwear Industry. Greenhouse Gases. Brazil GHG Protocol Program. Strategy. Sustainable Future.*

1 INTRODUÇÃO

A mudança climática surgiu como um dos maiores desafios enfrentados pela humanidade no século XXI. O aumento das emissões de gases de efeito estufa (GEE) resultante das atividades humanas contribui significativamente para as mudanças no clima global. A Terra está testemunhando uma mudança climática sem precedentes, evidenciada por eventos extremos, como furacões mais intensos, secas prolongadas e aumento do nível do mar. Esses fenômenos não apenas representam uma ameaça para a biodiversidade e os ecossistemas, mas também têm implicações diretas para a estabilidade econômica e social global (IPCC, 2023; Lima *et al.*, 2020).

No período de 2011 a 2020, a temperatura global registrou um aumento médio de 1,1ºC em comparação com o período de 1850 a 1900, sendo esse aumento atribuído às emissões de GEE. A cada ano, há um aumento progressivo na emissão desses gases (Adedeji et al., 219). Em 2018, as emissões atingiram a marca de 48,9 gigatoneladas de dióxido de carbono equivalente ($CO_{2\text{-eq}}$), e, em 2022, esse número alcançou 50 $GtCO_{2\text{-eq}}$ (Ghimouz *et al.*, 2023; IPCC, 2023).

Esse resultado está intrinsecamente ligado ao significativo crescimento na geração de energia a partir de fontes fósseis, mudanças no uso da terra, bem como ao desmatamento descontrolado que ocorre em várias partes do mundo, mas especialmente no Brasil. Essas atividades humanas intensivas desempenharam um papel crucial na escalada das mudanças climáticas, destacando a necessidade premente de transição para práticas mais sustentáveis e redução das emissões de GEE (IPCC, 2023). Em resposta à urgência das mudanças climáticas, há uma pressão crescente para que as organizações adotem práticas mais sustentáveis e minimizem suas emissões de GEE. Notavelmente, as indústrias de bens de consumo e moda, como as indústrias de calçados e têxteis, apresentam um modelo de produção linear, que representa o paradigma dominante nesse setor (Ghimouz *et al*., 2023). Nesse contexto, a busca por estratégias inovadoras e responsáveis se torna não apenas uma necessidade ambiental, mas também uma oportunidade para as empresas liderarem o caminho em direção a um futuro com baixas emissões de carbono (Gallego-Alvarez *et al.,* 2015).

Diante desse cenário, o propósito deste trabalho é mapear e quantificar as emissões de GEE das indústrias de calçados localizadas na Região Sul do Brasil e, em seguida, identificar possibilidades para reduzir essas emissões. A medição precisa das emissões de GEE é essencial para compreender e controlar o impacto ambiental das operações industriais. Para alcançar o objetivo estabelecido, foi realizado um estudo de caso múltiplo, envolvendo abordagens quantitativas e qualitativas em quatro indústrias de calçados localizadas na região mencionada, durante o período de agosto a dezembro de 2023. Na fase qualitativa, foi empregada a premissa da triangulação de dados, por meio de entrevistas semiestruturadas, pesquisa documental e observação não participante, seguindo as diretrizes propostas por Yin (2015).

Para a etapa quantitativa da pesquisa, foi utilizada a metodologia do Programa Brasileiro GHG Protocol (PBGHGP), para a meticulosa quantificação das emissões de GEE associadas às operações das empresas envolvidas, visando à identificação posterior de oportunidades de redução. De acordo com Caldeira *et al.* (2022), essa é a metodologia mais amplamente utilizada no Brasil, desenvolvida pela Fundação Getúlio Vargas.

Os esforços voltados para reduzir as emissões de gases de efeito estufa (GEE) exigem a compilação precisa e consistente de inventários de emissões de GEE em diversos setores econômicos. Esses inventários servem como documentação crucial das emissões de GEE decorrentes de diversas atividades econômicas ao longo de períodos específicos (Aguiar *et al*., 2016; Chandrakumar *et al.*, 2019; Ding *et al.*, 2019). As descobertas derivadas desses inventários desempenham um papel fundamental na informação de políticas e estratégias nacionais relacionadas à ação climática, fundamentadas em metodologias estabelecidas (Abreu *et al.*, 2014; Singh *et al*., 2014).

Vale ressaltar que, das emissões totais de gases de efeito estufa em 2022 (50 $GtCO_{2-eq}$), aproximadamente 1,7 $GtCO_{2-eq}$ corresponde à contribuição da indústria têxtil e de calçados em escala global, representando 8,5% do total. Além disso, estima-se que essa indústria específica emitirá 2,7 $GtCO_{2-eq}$ em 2030, refletindo um aumento significativo de 63% em relação aos níveis anteriores (Ghimouz *et al.*, 2023).

Nesse sentido, esta pesquisa busca promover a criação de estratégias mais sustentáveis e eficientes, alinhadas ao compromisso de reduzir pegadas ambientais e incentivar práticas mais responsáveis dentro do mercado de calçados na região.

O crescente desejo dos consumidores por produtos sustentáveis é cada vez mais evidente (Kumar; Carolin, 2020; Pimenta *et al.*, 2023). Além disso, os números apresentados pela Abicalçados (2023) e por Pimenta *et al.* (2023) destacam que, em 2022, o Brasil produziu 840 milhões de pares de sapatos, exportando 143 milhões para 170 destinos diferentes, responsáveis pela geração de 266 mil empregos formais em 5,4 mil empresas em todo o país. Esse volume significativo resultou em receitas que excedem R$ 25,2 bilhões, consolidando o país como o 5º maior produtor de calçados do mundo. Esses dados destacam a importância do setor para a economia brasileira, enquanto este estudo visa orientar a indústria a adotar práticas mais sustentáveis, contribuindo para um futuro mais responsável e equilibrado. Por essa razão, o objetivo deste trabalho é identificar, quantificar e apresentar as principais fontes de GEE nesse setor econômico, seguido pela proposição de soluções destinadas a uma gestão mais eficiente.

2 FUNDAMENTAÇÃO TEÓRICA

2.1 MUDANÇAS CLIMÁTICAS

As mudanças climáticas representam uma das maiores ameaças contemporâneas à estabilidade de nosso planeta. Causadas principalmente pelas emissões excessivas de gases de efeito estufa resultantes de atividades humanas, como a queima de combustíveis fósseis e o desmatamento, essas emissões têm impactos significativos nos ecossistemas, no clima e nas comunidades ao redor do mundo (IPCC, 2023).

Os gases de efeito estufa são substâncias presentes na atmosfera que têm a capacidade de absorver e reemitir radiação térmica originária da superfície da Terra. Essa capacidade cria um efeito semelhante ao que ocorre em uma estufa, permitindo que parte do calor solar seja retido na atmosfera e contribuindo para o aquecimento do planeta (IPCC, 2023). Embora esse fenômeno natural seja essencial para manter a temperatura da Terra em níveis adequados para a vida, as atividades humanas intensificaram a concentração de alguns desses gases, agravando o efeito estufa e causando mudanças climáticas significativas.

Os principais gases de efeito estufa incluem dióxido de carbono (CO_2), metano (CH_4), óxidos de nitrogênio (NO_x), ozônio troposférico (O_3), hidrofluorocarbonetos (HFCs), perfluorocarbonetos (PFCs) e hexafluoreto de enxofre (SF_6) (Serweta *et al.*, 2019). Para tornar o impacto desses gases nas mudanças climáticas mais compreensível, a quantidade emitida por eles é quantificada pelo equivalente de dióxido de carbono (CO_{2e}), medido em toneladas (tCO_{2e}) ou quilogramas ($kgCO_{2e}$) (IPCC, 2023; PBGHGP, 2023; Serweta *et al.*,

2019). Essa equivalência torna possível comparar as emissões de GEE usando uma escala de avaliação comum. No entanto, é importante observar que diferentes gases contribuem para o aquecimento global em graus diferentes, medidos por meio de um indicador chamado "potencial de aquecimento global" ou mais conhecido pela sigla GWP (IPCC, 2023; PBGHGP, 2023; Serweta *et al.*, 2019).

De acordo com o IPCC (2023), o valor das emissões de GEE alcançou 50 $GtCO_{2e-eq}$ em 2022. Dentro desse panorama, o setor energético está vinculado a 34% das emissões (20 $GtCO_{2-eq}$), seguido pela indústria com 24% (14 $GtCO_{2-eq}$), Afolu (Agricultura, Floresta e Uso da Terra) com 22% (13 $GtCO_{2-eq}$), transporte com 15% (8,7 $GtCO_{2-eq}$) e construção civil com 6% (3,3 $GtCO_{2-eq}$) (IPCC, 2023). Nesse contexto, é crucial destacar que os Estados Unidos e a China representam conjuntamente cerca de 40% das emissões totais, sendo a geração de energia a principal fonte de emissões de GEE em ambos os países. Ambos têm produção e consumo intensivos de bens, incluindo fabricação e processamento industrial, contribuindo diretamente para as emissões de GEE (IPCC, 2023).

Ao analisar especificamente os dados do Brasil, observa-se que as mudanças no uso da terra e na silvicultura são responsáveis por 1,1 $GtCO_{2-eq}$, seguidas pela agricultura com 617 megatoneladas de dióxido de carbono equivalente ($MtCO_{2-eq}$), energia com 412 megatoneladas de dióxido de carbono equivalente ($MtCO_{2-eq}$), resíduos com 91 $MtCO_{2-eq}$ e processos industriais com 65 $MtCO_{2-eq}$ (SEEG, 2023).

Independentemente do país ou setor de atividade, o alto nível de emissões de gases de efeito estufa resulta em um aumento nas temperaturas médias globais. De acordo com o relatório do IPCC (2023), a temperatura média da superfície global estava aproximadamente 1,1°C mais alta do que no período de 1850 a 1900 durante os anos de 2011 a 2020. Além disso, é digno de nota que a temperatura média global da superfície aumentou mais rapidamente desde 1970 do que em qualquer outro período nos últimos 2000 anos, pelo menos (IPCC, 2023).

O aumento médio da temperatura resulta em vários riscos globais para a humanidade, abrangendo áreas cruciais, como saúde, meios de subsistência, segurança alimentar, abastecimento de água, segurança humana e crescimento econômico. Esses riscos destacam a urgência de ações eficazes para mitigar as mudanças climáticas e preservar a sustentabilidade de nosso planeta (Adger, 2014; Diffenbaugh; Field, 2013; IPCC, 2023; Rosenzweig; Neofotis, 2013).

2.2 EMISSÕES DE GASES DE EFEITO ESTUFA NAS EMPRESAS BRASILEIRAS

Encontrar estudos relacionados às mudanças climáticas é uma tarefa simples de fazer. Em uma busca rápida na *Science Direct* em dezembro de 2023, ao inserir a palavra-chave "mudanças climáticas", são obtidos mais de 850 mil resultados. No entanto, ao combinar essa busca com a palavra-chave "indústria de calçados", o número de resultados diminui para pouco mais de mil (Science Direct, 2023).

Aprofundando-se nas investigações, observa-se que a maioria dos estudos está focada na quantificação das emissões de GEE relacionadas a produtos específicos ao longo de seu ciclo de vida. Por exemplo, uma categoria específica de calçados é analisada com o objetivo de avaliar sua pegada de carbono, desde a extração de matérias-primas até o descarte pelo consumidor final. Isso abrange as fases de transporte de matérias-primas para a fábrica, o próprio processo de produção e a entrega dos produtos acabados aos consumidores.

Em dois estudos realizados na China, Cheah *et al.* (2013) e De Ponte *et al.* (2023) descobriram que a maioria das emissões nas indústrias chinesas está concentrada na fase de produção de calçados, abrangendo o consumo de energia, o uso de combustíveis fósseis e a geração de resíduos. Em uma emissão total de 14 $kgCO_{2-eq}$ para produzir um par de sapatos, 9 $kgCO_{2-eq}$ estão associados à etapa de fabricação (Cheah *et al.*, 2013; De Ponte *et al.*, 2023). É importante notar que a China depende predominantemente do carvão como sua principal fonte de energia, influenciando diretamente

esse resultado. Os outros 5 $kgCO_{2-eq}$ estão distribuídos em matérias-primas para fabricar o produto, transporte para o cliente, disposição final e usabilidade. Em outro estudo, realizado na Europa, resultados semelhantes também foram encontrados por Gajewski *et al.* (2014).

Ao contrário dos estudos de pegada de carbono, existem inventários de GEE, nos quais a análise não cobre apenas uma linha de produtos, mas todos aqueles produzidos por uma determinada empresa (PBGHGP, 2023). No Brasil, é comum observar empresas alocando recursos para projetos voltados para a avaliação abrangente de suas emissões, não limitadas a um produto específico. De acordo com o PBGHGP (2023), em 2008, menos de 100 empresas realizaram e divulgaram seus inventários de GEE, enquanto em 2022 esse número alcançou 434 apenas no Brasil.

Ainda no Brasil, entre essas empresas que divulgam seus inventários, 55% estão distribuídas em diferentes setores, 28% na indústria de manufatura, 10% no setor de transporte, armazenamento e correio, 9% nos segmentos de eletricidade e gás, e 8% em atividades financeiras, seguros e serviços relacionados. Os 45% restantes abrangem setores como atividades profissionais, científicas e técnicas; indústrias extrativas; comércio e reparação de veículos automotores e motocicletas; agricultura, pecuária, produção florestal, pesca e aquicultura, entre outros (PBGHGP, 2023). Vale ressaltar que o PBGHGP (2023) não fornece dados específicos para a indústria de calçados.

Em relação ao perfil de emissões de GEE das organizações brasileiras, os destaques são as emissões provenientes do consumo de energia, da combustão estacionária (emissões provenientes da queima de combustível para produzir energia) e dos processos industriais (emissões provenientes da transformação química ou física de qualquer material), bem como as emissões fugitivas (liberação não intencional durante a produção, processamento, transmissão, armazenamento ou uso do gás). Essas categorias são consideradas fontes de propriedade ou controladas diretamente pela organização (PBGHGP, 2023).

Vale ressaltar que, em comparação com outros sistemas de energia elétrica, o fator de emissão de GEE da rede elétrica brasileira é notavelmente baixo. Isso pode ser atribuído à composição da rede, em que uma parte significativa (67,6%) da energia é gerada a partir de fontes hidrelétricas. Além disso, a energia eólica (8,9%), biomassa (8,3%) e outras fontes renováveis contribuem para a rede, reduzindo ainda mais sua pegada de carbono. Fontes não renováveis, como petróleo (2,9%) e gás (7,9%), desempenham um papel menor, com contribuições mínimas de energia solar (1,1%) e nuclear (1,2%). Esses dados destacam a natureza relativamente limpa da rede elétrica brasileira (Caldeira *et al.,* 2022).

Por outro lado, ou seja, emissões indiretas que ocorrem ao longo da cadeia de valor da organização, categorias consideradas "administrativas", como viagens de negócios, resíduos gerados nas operações da organização, transporte e *upstream* e distribuição (emissões do transporte e distribuição de produtos adquiridos), e transporte de funcionários são destaques (Caldeira *et al.*, 2022; PBGHGP, 2023). Medir emissões sem controle direto pela organização apresenta um desafio maior. A complexidade na medição surge do fato de que muitos dados estão sujeitos ao controle da cadeia de suprimentos e/ou de consumidores intermediários ou finais de produtos ou serviços.

Por outro lado, as empresas brasileiras, embora relatem em menor escala, também apresentam registros de emissões originárias da combustão móvel (resultante da queima de combustíveis para gerar movimento), categorias associadas às atividades agrícolas, mudanças no uso da terra, resíduos, efluentes e transporte e *downstream* (emissões relacionadas ao transporte e distribuição de produtos comercializados) (PBGHGP, 2023).

3 METODOLOGIA

Como mencionado na introdução deste estudo, para alcançar o objetivo de realizar um levantamento e a quantificação das emissões de gases de efeito estufa das indústrias de calçados localizadas na Região Sul do Brasil, foram conduzidas pesquisas qualitativas e quantitativas. Uma descrição detalhada de cada uma dessas etapas é apresentada abaixo.

3.1 ETAPA QUALITATIVA E QUANTITATIVA

Na etapa qualitativa deste estudo, que se caracteriza pela oportunidade de realizar interpretações e atribuições de significados, foi conduzido um estudo de caso múltiplo conforme as diretrizes de Yin (2015). Esse método envolve a triangulação de dados por meio de entrevistas semiestruturadas, observação não participante e pesquisa documental. Esta etapa mostrou-se crucial para os pesquisadores obterem conhecimento aprofundado das empresas envolvidas na pesquisa e consolidarem o processo de mapeamento das fontes de emissões de gases de efeito estufa para posterior solicitação de dados a serem utilizados para a quantificação das emissões. Além disso, por meio da entrevista semiestruturada, também foi possível compreender a maturidade das empresas em termos de suas emissões e quais estratégias já haviam adotado ou planejavam adotar nos próximos anos com o objetivo de reduzi-las.

As quatro organizações selecionadas para participar do estudo foram designadas como empresas Alpha, Beta, Gama e Delta. Essa nomenclatura foi acordada com as empresas para preservar sua identidade e garantir a confidencialidade. A decisão de manter a confidencialidade na divulgação dos nomes das organizações desempenhou um papel fundamental na obtenção de respostas mais concretas e verdadeiras, seguindo as diretrizes de Yin (2015). Tanto o setor quanto as indústrias de calçados escolhidas para fazerem parte do estudo foram selecionadas de forma não probabilística, intencional e por conveniência. Mesmo assim, houve preocupação para que todas tivessem características similares que permitissem a comparação dos dados obtidos, tais como: localizadas no Sul do Brasil; grandes empresas; atuação no setor de calçados, tanto nacional quanto internacionalmente; e com receitas anuais superiores a R$ 300 milhões.

A escolha de limitar a amostra a quatro empresas foi baseada no critério de saturação teórica, conforme descrito por Fontanella *et al.*, (2008). Os autores consideraram que as informações já obtidas até o momento eram suficientes para a análise proposta, entendendo que a inclusão de novos participantes contribuiria minimamente para o material já coletado. Todos os dados empíricos foram submetidos à análise de conteúdo, seguindo as recomendações de Bardin (2011). Todo esse processo durou um total de quatro meses (agosto a novembro de 2023).

Na fase de quantificação das emissões de GEE, foram utilizados os fatores de emissão previamente estabelecidos pelo PBGHGP (2023), com base em fontes de emissão previamente especificadas. A partir dessa enumeração, foi viável solicitar dados de consumo das organizações, multiplicando os valores pelos respectivos fatores de emissão. O processo de cálculo durou um mês, durante dezembro de 2023.

4 RESULTADOS

Para garantir a estruturação da fase de resultados e discussão, decidiu-se iniciar o processo fornecendo uma caracterização sucinta das empresas estudadas. Posteriormente, são abordadas as fontes de emissões associadas a essas organizações. Por fim, são apresentados os resultados quantitativos, delineando assim possíveis alternativas para reduzir as emissões para as empresas analisadas.

Essa abordagem sequencial visa fornecer uma compreensão clara e abrangente das informações relacionadas ao impacto ambiental das empresas, facilitando a análise e a discussão.

4.1 CARACTERÍSTICAS DAS EMPRESAS

As quatro empresas envolvidas na pesquisa estão estabelecidas na Região Sul do Brasil, atendendo tanto ao mercado nacional quanto ao internacional. A Região Sul é reconhecida como o berço da indústria de calçados no país, destacando-se por sua significativa contribuição para o desenvolvimento e consolidação desse setor industrial ao longo do tempo.

A Alfa opera com duas unidades, a Beta realiza suas operações em três unidades, enquanto a Gama e a Delta mantêm quatro unidades cada. Essas empresas são players-chave na indústria, cada uma contribuindo de forma única para a dinâmica do setor e desempenho geral. Na Tabela 1, é possível verificar as características de cada empresa.

Tabela 1 – Características das empresas

Categorias/Empresas	*Número de Unidades*	*Colaboradores*	*Milhões de pares/ Ano*	*Mercado-alvo*
Alfa	2	1.035	2	Infantil
Beta	3	2.500	8,5	Feminino
Gama	4	6.000	18	Feminino
Delta	4	3.000	9,1	Feminino

Fonte: Autores (2023).

Todas essas empresas desempenham um papel fundamental no desenvolvimento da região onde estão localizadas, proporcionando um impacto econômico, social e ambiental significativo. Além de gerarem mais de 10.000 empregos diretos, elas também fabricam mais de 30 milhões de pares anualmente. Essa produção em larga escala não apenas fortalece a economia das comunidades locais, mas também impacta indiretamente toda uma cadeia de valor, abrangendo fabricantes de matérias-primas e fabricantes de componentes que estão interconectados com ela.

Cada uma das empresas foi questionada sobre a realização de um estudo semelhante, ou seja, se já haviam mapeado e quantificado suas emissões. Duas delas afirmaram que era a primeira vez, enquanto outras duas mencionaram que era a segunda vez. Quando questionadas sobre por que o processo ainda não está totalmente desenvolvido dentro das organizações, todas mencionaram a complexidade da cadeia de suprimentos, que muitas vezes envolve múltiplos fornecedores e subcontratados, tornando difícil rastrear e quantificar as emissões ao longo do processo de produção. Além disso, a falta de padrões e metodologias consistentes para medir as emissões específicas do setor dificulta a comparação e o monitoramento ao longo do tempo. Outro desafio é a disponibilidade limitada de dados e informações sobre práticas de produção e consumo de energia em diferentes estágios do processo de fabricação de calçados. Apesar de reconhecerem a dificuldade de quantificar suas emissões de gases de efeito estufa, todas mostraram interesse em aprimorar sua compreensão sobre o assunto.

4.2 FONTES DE GEE

Embora pertençam ao mesmo setor de atividade, cada uma das empresas possui características distintas que têm uma influência direta nos resultados de suas emissões de

GEE. Uma compreensão aprofundada dessas nuances é essencial para uma análise precisa e personalizada das estratégias de mitigação de emissões, permitindo abordagens mais eficazes adaptadas à singularidade de cada empresa, bem como aos dados apresentados pelo IPCC (2023) e Seeg (2023), nos quais são destacadas as particularidades de cada país no cenário de emissões, com uma estratégia nem sempre aplicável a outro.

Na Tabela 2, é possível observar as fontes de emissões diretamente controladas pela empresa, juntamente com o consumo de eletricidade identificado em todas as organizações. A tabela fornece uma visão abrangente das fontes de emissões diretamente gerenciadas pelas empresas.

Tabela 2 – Fontes de GEE controladas pelas empresas

Categorias/Empresas	*Alfa*	*Beta*	*Gama*	*Delta*
Combustão Estacionária	Gerador, soldador, fogão de cozinha, roçadeira.	Gerador e fogão de cozinha.	Caldeira, gerador, fogão de cozinha, roçadeira.	Gerador e fogão de cozinha.
Combustão Móvel	Empilhadeiras.	Frota de veículos própria.	Frota alugada de veículos e empilhadeiras.	Frota de veículos alugada e empilhadeiras.
Emissões Fugitivas	Extintores de incêndio de CO_2, ares-condicionados, geladeiras, bebedouros e máquinas pré e conformar.	Extintores de incêndio de CO_2, ares-condicionados, geladeiras, bebedouros, e máquinas pré e conformar.	Máquinas pré e conformar, ares-condicionados, bebedouros, extintores de incêndio de CO_2, geladeiras, secadores de ar e estabilizadores a frio.	Extintores de incêndio de CO_2, ares-condicionados, bebedouros, geladeiras e máquinas pré e conformar.

Fonte: Autores (2023).

Como visto na Tabela 2, na categoria de combustão estacionária, todas as empresas possuem geradores e fogões de cozinha. Especificamente, a empresa Alfa também utiliza soldadores, caracterizando particularidades em suas operações. Quando perguntamos sobre o uso desse equipamento, todas as empresas indicaram o uso de geradores apenas em situações de falta de eletricidade, e os fogões de cozinha são destinados ao ambiente culinário, uma instalação presente em todas as empresas.

No que diz respeito às roçadeiras, presentes nas empresas Alfa e Gama devido à sua localização em espaços abertos com vegetação abundante, essas empresas as possuem para manter a área, garantindo a limpeza e organização do espaço. Esse cuidado demonstra a atenção das empresas não apenas às questões relacionadas às emissões, mas também ao ambiente físico ao seu redor.

Em relação à categoria de combustão móvel, que envolve a queima de combustíveis em equipamentos para gerar movimento (PBGHGP, 2023), ao contrário da combustão estacionária, algumas particularidades são observadas. Duas empresas, Gama e Delta, mantêm uma frota de veículos alugada, enquanto Beta possui sua própria frota. Por outro lado, a empresa Alfa não possui uma frota de veículos, seja alugada ou própria. Ao perguntar aos gerentes das empresas Beta, Gama e Delta sobre o uso de suas frotas de veículos, foram obtidas informações de que as viagens ocorrem principalmente entre as diversas unidades da empresa e durante visitas a clientes. Vale ressaltar que, embora as unidades de fabricação estejam no Sul do Brasil, essas empresas prestam serviços a clientes em todo o território nacional.

De forma complementar, Gama e Delta foram questionadas sobre o motivo de a frota ser alugada e não própria. Nesse caso, o gerente explicou que essa prática proporciona a vantagem de manter a frota

constantemente atualizada, eliminando a necessidade de fazer investimentos significativos em veículos de propriedade permanente, mas não mencionou nada sobre emissões de gases de efeito estufa.

Por outro lado, quando questionamos a empresa Alfa sobre a falta de sua própria frota, o gerente esclareceu que o investimento necessário não foi considerado vantajoso. Em situações que exigem viagens, os funcionários são incentivados a usar seus próprios veículos, com a possibilidade de posterior reembolso dos custos de combustível ou a escolha de viagens por meio de aplicativos de transporte.

Quanto às emissões fugitivas, todas as empresas apresentam emissões não intencionais de extintores de incêndio, sistemas de ar-condicionado, geladeiras, máquinas de pré-conformar e conformar. Em particular, a empresa Alfa possui um resfriador. Ao questionar o gerente sobre a função desse dispositivo, ele esclareceu que era uma máquina usada para resfriamento, operando como um sistema de ar-condicionado com resfriamento à base de água e gás refrigerante. Em outras palavras, é um equipamento robusto. É relevante destacar que todas as empresas ficaram surpresas ao perceber que equipamentos como esses emitiam gases de efeito estufa, percebendo inicialmente que apenas a queima de combustíveis fósseis era a principal fonte dessas emissões.

No que diz respeito às emissões indiretas da empresa, ou seja, aquelas que estão sob o controle de sua cadeia de valor, elas são apresentadas detalhadamente na Tabela 3. Naquele momento, as organizações não estavam cientes de que eram corresponsáveis por tantos aspectos.

Tabela 3 – Fontes de emissões não controladas pela empresa

Categorias/Empresas	*Alfa*	*Beta*	*Gama*	*Delta*
Bens e Serviços Comprados	x	x	x	x
Bens de Capital	x	x	x	x
Atividades relacionadas com combustível e energia não inclusas nos Escopos 1 e 2	-	-	-	-
Transporte e Distribuição Upstream	x	x	x	x
Transporte e Distribuição Downstream	x	x	x	x
Resíduos	x	x	x	x
Viagens a Negócio	x	x	x	x
Deslocamento de Funcionários	x	x	x	x
Bens Arrendados (a organização como arrendatária)	-	-	-	-
Bens Arrendados (a organização como arrendadora)	-	-	-	-
Processamento de Produtos Vendidos	x	x	x	x
Uso de Bens e Serviços Vendidos	x	x	x	x
Tratamento de Fim de Vida dos Produtos Vendidos	x	x	x	x
Franquias	x	x	-	x
Investimentos	x	x	x	x

Fonte: Autores (2023).

Conforme mostrado na Tabela 3, várias categorias, nas quais as empresas não têm controle direto sobre as emissões, foram identificadas. Apenas três categorias não foram identificadas em todas as empresas, a saber, “Bens Arrendados (Arrendatária e Arrendadora)” e “Atividades relacionadas

a combustíveis e energia não incluídas nos Escopos 1 e 2". Além disso, apenas uma empresa não possui franquias, sendo essa categoria presente nas outras empresas participantes do estudo. Mesmo assim, categorias como viagens a negócios, resíduos gerados nas operações da organização, transporte *upstream* e distribuição (emissões do transporte e distribuição de produtos adquiridos) e deslocamento de funcionários são destaques.

4.3 EMISSÕES DE GEE

Após identificar minuciosamente as fontes de emissões nas empresas, avançamos para a fase de quantificação dessas emissões. A Tabela 4 oferece uma visão clara das categorias quantificadas, apresentando os valores correspondentes em toneladas de dióxido de carbono equivalente em cada empresa.

Tabela 4 – Emissões de GEE (tCO2-eq)

Categorias/Empresas	*Alfa*	*Beta*	*Gama*	*Delta*	*Total*
Combustão Estacionária	14,93	19,77	48,8	44,78	125,28
Combustão Móvel	0,05	440,24	164,2	132,99	737,48
Emissões Fugitivas	126,47	6,91	77,21	87,27	297,86
Energia	195,01	474,15	1.047,57	378,36	2.095,09
Deslocamento de Funcionários	121,47	190,87	589,55	552,4	1.454,29
Transporte e Distribuição Upstream	1.070,35	-	-	-	1.070,35
Transporte e Distribuição Downstream	-	166,28	-	328,65	494,93
Viagens a Negócio	107,81	11,88	177,66	65,25	362,60
Total	**1.636,09**	**1.310,1**	**2.104,99**	**1.589,7**	**6.640,88**

Fonte: Autores (2023).

Ao examinar a Tabela 4, é possível observar que nem todas as categorias foram quantificadas, especialmente aquelas que não estão sob o controle direto das organizações. Cada uma das empresas analisadas enfrentou desafios na apresentação dos dados relacionados. Quando questionados sobre o motivo dessa dificuldade, todos os gerentes apontaram para sua preocupação recente com o monitoramento de suas próprias emissões, indicando que ainda não solicitaram aos seus parceiros comerciais que forneçam os mesmos dados. Além disso, explicaram que em algumas categorias há falta de conhecimento sobre o tipo específico de dados que deveriam ser monitorados, o que contribui para a complexidade do processo de divulgação dessas informações. Para superar as dificuldades, todas as empresas enfatizaram a necessidade de treinar seus funcionários sobre esse assunto. No entanto, elas também consideram a possibilidade de contratar consultoria externa para lidar com essa dificuldade inicialmente.

Entre as categorias mapeadas, a Tabela 4 mostra uma prevalência significativa em emissões associadas ao consumo de energia, deslocamento dos funcionários e transporte e distribuição *upstream*. Em relação ao consumo de energia, todas as empresas dependem desse recurso essencial para o funcionamento adequado de suas máquinas e processos operacionais, justificando sua predominância. Quando ocorre uma queda de energia, ou seja, em situações de interrupção no fornecimento, os geradores são ativados, resultando no uso de combustíveis fósseis, como mencionado anteriormente.

No entanto, vale ressaltar que todos os gerentes comentaram que as empresas consomem energia do Ambiente de Contratação Livre (ACL), mais conhecido como Mercado Livre de Energia. Ao questionar

as empresas sobre por que optam por esse tipo de consumo, todas destacaram as vantagens econômicas associadas a contratos de longo prazo. Além disso, reforçaram que o consumo por meio desse ambiente possibilita a compra de energia gerada por fontes limpas e renováveis, como energia eólica e solar. Embora os gerentes destaquem os ganhos econômicos como diferencial por estarem nesse mercado, as empresas também mencionaram questões associadas aos impactos ambientais, atendendo à demanda de alguns clientes preocupados com essas questões.

Embora todas as empresas analisadas adquiram 100% de sua energia desse mercado, ao longo das entrevistas ficou evidente a preocupação dos gerentes em reduzir o consumo de energia. Com essa compreensão, todas as empresas estabeleceram metas para reduzir o consumo até 2030. Ao serem questionadas sobre como planejam alcançar essas metas, várias ações foram mencionadas, como conscientização dos funcionários, substituição de equipamentos para aumentar a eficiência no consumo de energia, troca de lâmpadas comuns por novas e mais eficientes, instalação de painéis solares, implementação de sensores de presença, entre outras medidas.

Para que as atividades organizacionais ocorram, todas as empresas dependem de uma equipe robusta de funcionários. Como resultado, as emissões associadas ao deslocamento dos funcionários de suas casas para o local de trabalho ficaram em segundo lugar. Ao questionar os gerentes sobre as viagens dos funcionários, todos afirmaram que o controle é realizado por meio de ônibus fretados pelas empresas, contabilizando apenas o pessoal de produção/operacional, o que representa aproximadamente 80% da força de trabalho. Funcionários de outros setores, como setores administrativos, geralmente viajam em veículos particulares, o que torna o acesso a dados relevantes ainda mais difícil. No entanto, as empresas mencionaram a necessidade de também entender o impacto dos funcionários que viajam em seus próprios veículos, sugerindo a possibilidade de implementar um questionário para reunir dados desse grupo.

A categoria de transporte e distribuição *upstream* diz respeito ao movimento de todas as matérias-primas e insumos adquiridos pela empresa. Diferente da categoria *downstream*, que envolve a distribuição do produto final ao consumidor. Ambas as categorias tiveram baixa adesão pelas organizações. Ao questionar os gerentes sobre essa dificuldade, mencionaram que as empresas de transporte ainda não registram as informações necessárias para quantificar as emissões, o que torna o acesso a esses dados desafiador. No entanto, duas empresas (Beta e Delta) complementaram as informações, destacando que, nos últimos dois anos, realizaram *workshops* de conscientização com transportadoras, com o objetivo de conscientizá-las sobre a importância de iniciar o processo de controle dessas informações.

Por fim, a categoria de viagens a negócios, considerada pelos gerentes como fácil de medir, uma vez que apenas a listagem do número de voos com origem e destino é necessária, bem como a listagem de viagens feitas de carro ou ônibus pelos funcionários. Geralmente, esses dados são mantidos pelo departamento administrativo, responsável pelo controle da aquisição de passagens. A categoria de transporte e distribuição *upstream*, assim como os deslocamentos casa-trabalho dos funcionários e as viagens a negócios, é amplamente destacada nos relatórios, conforme indicado pelo PBGHGP (2023), apesar de os dados não estarem sob o controle direto das organizações.

Todos os gerentes sinalizaram a retomada das viagens a negócios após o fim da pandemia da Covid-19. Essa perspectiva reflete a natureza global das operações dessas empresas e a tendência à normalização das viagens corporativas no cenário pós-pandêmico. No entanto, isso levanta um alerta sobre um possível aumento nas emissões associadas a essa categoria.

5 DISCUSSÃO DE RESULTADOS

Frequentemente, estratégias para reduzir as emissões de gases de efeito estufa são implementadas em escala global. No entanto, ao analisar os dados do Brasil, Estados Unidos e China, há uma disparidade

nos perfis de emissões de cada país. As abordagens aplicadas no Brasil, por exemplo, podem não ser as mais adequadas para implementação na China e nos Estados Unidos. Essa mesma consideração precisa ser aplicada no nível organizacional, reconhecendo a diversidade de contextos e adotando estratégias adaptadas a cada realidade específica (IPCC, 2023; Seeg, 2023).

Os dados fornecidos pela análise das emissões de gases de efeito estufa em várias empresas dentro do mesmo setor revelam características distintas que influenciam seus perfis de emissões. Compreender essas nuances é essencial para as estratégias de mitigação, especialmente na busca por processos inovadores para liderar o caminho rumo a um futuro com baixas emissões de carbono (Abreu *et al.*, 2014; Gallego-Alvarez *et al.*, 2015; Singh *et al.*, 2014).

Na combustão estacionária, por exemplo, como enfatizado por PBGHGP (2023), a categoria de combustão estacionária se destaca como uma das categorias mais frequentemente relatadas pelas empresas brasileiras. Enquanto todas as empresas possuem geradores e fogões de cozinha, a Alfa se destaca pela presença de soldadores, refletindo suas necessidades operacionais únicas.

Quanto à combustão móvel, que envolve a queima de combustíveis em equipamentos para gerar movimento (PBGHGP, 2023), ao contrário da combustão estacionária, algumas particularidades são observadas. Gama e Delta optam por frotas alugadas, enquanto a Beta mantém a sua própria. Em outras palavras, a responsabilidade recai sobre elas pelo combustível queimado por sua frota. Nesse caso, substituir o combustível por um biocombustível ou até mesmo planejar a rota para evitar viagens desnecessárias pode ser reconsiderado. Notavelmente, a Alfa não possui uma frota, incentivando o uso de veículos de propriedade dos funcionários. Vale mencionar que esse tipo de emissão se torna indireto para a organização, não mais sob seu controle direto (PBGHGP, 2023).

Emissões fugitivas estão presentes em todas as empresas, com a Alfa possuindo equipamentos adicionais como um resfriador. Essa variação destaca as diversas abordagens para o gerenciamento de frotas entre as empresas. No que diz respeito ao perfil de emissões de GEE das organizações brasileiras, especialmente aquelas consideradas como fontes diretamente de propriedade ou controladas pela organização, os principais destaques de emissões incluem aquelas provenientes do consumo de energia, combustão estacionária, processos industriais e emissões fugitivas (PBGHGP, 2023).

Na quantificação das emissões de GEE, o consumo de energia domina em todas as empresas, refletindo a dependência desse recurso para as operações, bem como os resultados de Cheah *et al.* (2013), De Ponte *et al.* (2023) e Gajewski *et al.* (2014). Considerando que o Brasil já possui uma matriz energética avançada, caracterizada por fontes renováveis e limpas, o que o diferencia de muitos outros países, a necessidade de reduzir as emissões requer um foco específico em outras áreas, tornando o desafio ainda mais complexo. Esse destaque para a aquisição de energia renovável demonstra um compromisso com a redução das pegadas de carbono e a transição para práticas sustentáveis em resposta à demanda dos clientes por empresas ecologicamente corretas. Esse achado corrobora os estudos de Kumar e Carolin (2020) e Pimenta *et al.* (2023).

As empresas enfrentam desafios na quantificação de emissões indiretas, destacando a complexidade da coleta de dados e as parcerias com terceiros. Desafios surgem na quantificação de emissões associadas ao transporte e distribuição *upstream*, indicando lacunas na coleta de dados com parceiros de transporte. Esses resultados também são evidenciados por Caldeira *et al.* (2022) e PBGHGP (2023). Esforços para envolver transportadoras no rastreamento de emissões estão em andamento.

No entanto, para reduzir essas emissões, é imperativo implementar medidas no planejamento logístico, considerando opções de combustíveis sustentáveis, como o etanol. Ao otimizar o planejamento logístico, é possível reduzir a distância percorrida pelos veículos, minimizando assim o consumo de combustível e as emissões de CO_2. A busca por empresas de transporte que utilizem veículos a Gás

Natural Veicular (GNV) ou veículos elétricos também é uma opção, pois essas tecnologias têm um menor impacto ambiental em comparação com os combustíveis fósseis tradicionais.

Renovar a frota com veículos mais eficientes e de baixa emissão também é uma estratégia. Investir na renovação da frota de veículos, substituindo modelos mais antigos por veículos com tecnologias mais limpas e eficientes, também pode proporcionar benefícios significativos. Os veículos modernos geralmente possuem sistemas de redução de emissões mais avançados, resultando na liberação de gases menos poluentes.

As viagens a negócios apresentam uma medição relativamente simples, mas significam um potencial aumento futuro nas emissões pós-Covid-19, refletindo uma tendência global de retomada das viagens de negócios. Emissões significativas derivam do deslocamento dos funcionários, enfatizando a importância das emissões relacionadas ao transporte. Promover práticas de viagem mais sustentáveis, como a adoção de transporte público pelos funcionários, compartilhamento de viagens entre eles e o uso de videoconferências para reuniões remotas, pode ser uma alternativa viável. Além disso, é necessário conscientizar os funcionários sobre os impactos das emissões de GEE durante as viagens; para isso, recomenda-se a realização de sessões de treinamento.

6 CONSIDERAÇÕES FINAIS

O objetivo deste estudo foi mapear e quantificar as emissões de gases de efeito estufa das indústrias de calçados localizadas na Região Sul do Brasil com o objetivo de posteriormente propor estratégias de redução. Para alcançar esse propósito, foi utilizada uma abordagem qualitativa e quantitativa.

Frequentemente, as estratégias para reduzir as emissões de GEE são implementadas em escala global. No entanto, ao analisar dados do Brasil, Estados Unidos e China, há uma disparidade nos perfis de emissões de cada país. As abordagens aplicadas no Brasil, por exemplo, podem não ser as mais apropriadas para implementação na China e nos Estados Unidos. Essa mesma consideração precisa ser aplicada no nível organizacional, reconhecendo a diversidade de contextos e adotando estratégias adaptadas a cada realidade específica.

Considerando que o Brasil já possui uma matriz energética avançada, caracterizada por fontes renováveis e limpas, o que o diferencia de muitos outros países, a necessidade de reduzir as emissões requer um foco específico em outras áreas, tornando o desafio ainda mais complexo. Ao analisar os resultados deste estudo, fica claro que a categoria com as maiores emissões é a energia e a queima de combustíveis fósseis para gerar movimento, seja através do transporte e distribuição de matérias-primas ou através dos deslocamentos dos funcionários.

Entre as limitações do estudo, é necessário destacar a dificuldade de acesso a dados para as categorias nas quais as organizações não têm controle direto, o que restringiu a análise abrangente das emissões pelas empresas. No entanto, é importante entender que a questão das emissões ainda é incipiente para muitas empresas no Brasil, e a dificuldade de acesso a dados é aceitável. Reconhece-se que a conscientização e implementação de práticas de medição e controle de emissões estão em estágios iniciais, o que pode impactar a disponibilidade de informações detalhadas.

Outra limitação observada foi que, em nível nacional, os dados de emissões não permitem uma análise individual do setor de calçados, uma lacuna também destacada no relatório do PBGHGP (2023), que não dedica atenção específica a esse setor. A falta de ênfase particular na indústria de calçados restringe uma compreensão detalhada de suas contribuições específicas para as emissões brasileiras e globais.

Mesmo sem dados oficiais sobre as emissões de gases de efeito estufa da indústria de calçados no Brasil, multiplicando o valor de 840 milhões de pares por 14 quilogramas de dióxido de carbono equivalente,

com base em dados fornecidos pela China, resulta em um total de 11,760 bilhões de quilogramas de dióxido de carbono equivalente ou 11,760 megatoneladas de CO_{2eq}.

Dadas as lacunas mencionadas, é possível desenvolver recomendações que visem preencher essa falta de ênfase na área de calçados, como pesquisa com o setor, com o objetivo de buscar entendimento sobre as emissões, e o desenvolvimento de *workshops*, cursos e treinamentos visando aumentar a conscientização sobre a questão, incentivando todos a preparar um inventário para entender totalmente as emissões da indústria calçadista.

Apesar das limitações mencionadas, é crucial destacar que elas não desqualificam a relevância deste estudo. Pelo contrário, desempenha um papel fundamental ao fornecer *insights* sobre as emissões de GEE na indústria de calçados, além de identificar áreas que requerem desenvolvimento adicional para uma compreensão mais abrangente do tema. Nesse sentido, o estudo não apenas oferece uma visão atualizada do cenário, mas também aponta as lacunas a serem preenchidas, contribuindo para o progresso contínuo na compreensão e combate às emissões na indústria de calçados.

REFERÊNCIAS

ABREU, M. C. S. De.; ALBUQUERQUE, A. M.; FREITAS, A. R. P. De. Strategic positioning in response to regulatory constraints on greenhouse gas emissions. **Revista de Administração**, v. 49, n. 3, p. 578–590, 2014. DOI: 10.5700/rausp1169.

ADEDEJI, A. R.; ZAINI, F.; MATHEW, S.; DAGAR, L.; PETRA, M. I.; DE SILVA, L. C. Sustainable energy towards air pollution and climate change mitigation. **Journal of Environmental Management**, v. 260, 2019.

ADGER, W. N. *et al.* Human adaptation to climate change: a review of three historical cases and some general perspectives. **Environmental Science and Policy**, 27, p. 1–13, 2014. DOI: 10.1016/j.envsci.2012.02.008.

AGUIAR, L. V.; FORTES, J. D. N.; MARTINS, E. Carbon compensatory neutralization – case study: mechanic metal industry, Rio de Janeiro (RJ), Brazil. **Engenharia Sanitária e Ambiental**, v. 21, n. 1, p. 197–205, 2016. DOI: 10.1590/S1413-41520201600100116414.

ASSOCIAÇÃO BRASILEIRA DAS INDÚSTRIAS DE CALÇADOS (ABICALÇADOS). Disponível em: https://www.abicalcados.com.br/. Acesso em: 2 dez. 2023.

BARDIN, L. **Análise de conteúdo**. São Paulo: Edições 70, 1977.

BRAZILIAN GHG PROTOCOL PROGRAM (PBGHGP). Disponível em: https://eaesp.fgv.br/centros/centro-estudos-sustentabilidade/projetos/programa-brasileiro-ghg-protocol/. Accesso em: 12 nov. 2023.

CALDEIRA, R. da S.; SOUZA, S. L. Q. de; MARTINS, E. M.; CORRÊA, S. M. Opportunities for GHG Emission Reductions in the Brazilian Graphic Industry Through a Mitigation Plan. **Ambiente e Sociedade**, v. 25, 2022. DOI:10.1590/1809-4422asoc20200210r2vu2022L3OA

CHANDRAKUMAR, C.; MCLAREN, S. J.; MALIK, A.; RAMILAN, T.; LENZEN, M. Understanding New Zealand's consumption-based greenhouse gas emissions: an application of multi-regional input-output analysis. **International Journal of Life Cycle Assessment**, 2019. DOI: 10.1007/s11367-019-01673-z.

CHEAH, L.; CICERE, N. D.; OLIVETTI, E.; MATSUMURA, S.; FORTERRE, D.; ROTH, R.; KIRCHAIN, R. Manufacturing-focused emissions reductions in footwear production. **Journal of Cleaner Production**, v. 44, 2013.

DE PONTE, C. State of the art on the Nexus between sustainability, fashion industry and sustainable business model. **Sustainable Chemistry and Pharmacy**, 2023.

DIFFENBAUGH, N. S.; FIELD, C. B. Changes in Ecologically Critical Terrestrial Climate Conditions. **Science**, v. 341, n. 6145, p. 486–492. DOI: 10.1126/science.1237123.

DING, N.; LIU, J.; KONG, Z.; YAN, L.; YANG, J. X. Life cycle greenhouse gas emissions of Chinese urban household consumption based on process life cycle assessment: exploring the critical influencing factors. **Journal of Cleaner Production**, v. 210, p. 898–906, 2019. DOI: 10.1016/j.jclepro.2018.10.242.

FONTANELLA, B. J. B.; RICAS, J.; TURATO, E. R. Amostragem por saturação em pesquisas qualitativas em saúde: contribuições teóricas. **Cadernos de Saúde Pública,** Rio de Janeiro, v. 24, n. 1, p. 17-27, 2008.

GAJEWSKI, R.; FERRER, J.; MARTINEZ, M. A.; ZAPATERO, A.; CUESTA, N.; GAJEWSKI, A. Foot-wear carbon footprint in footwear industry (CO2Shoe). *In*: CHOCHÓŁ, A.; SZAKIEL, J. (ed.). **Achievements and challenges of commodity science in the age of globalization**. Kraków: Polish Society of Commodity Science, Cracow University of Economics, 2014.

GALLEGO-ÁLVAREZ, I.; SEGURA, L.; MARTÍNEZ-FERRERO, J. Carbon emission reduction: the impact on the financial and operational performance of international companies. **Journal of Cleaner Production**, v. 103, n. 1, p. 149-159, 2015.

GHIMOUZ, C.; PIERRE, K. J.; HOF, L. A. On sustainable design and manufacturing for the footwear industry – Towards circular manufacturing. **Materials and Design**, v. 233, 2023.

GREENHOUSE GAS EMISSION AND REMOVALS ESTIMATION SYSTEM (SEEG). Disponível em: https://seeg.eco.br/. Acesso em: 8 dez. 2023.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC). **Climate Change 2023 Synthesis Report.** Disponível em: https://www.ipcc.ch/report/ar6/syr/. Acesso em: 22 dez. 2023.

KUMAR, P. S.; CAROLIN, C. F. Certifications for Sustainability in Footwear and Leather Sectors. *In*: **Leather and Footwear Sustainability:** manufacturing, supply chain, and product level issues, 2020.

LIMA, M. A.; MENDESB, L. F. R.; MOTHÉA, G. A.; LINHARESA, F. G.; CASTROA, M. P. P.; SILVA, M. G.; STHELA, M. S. Renewable energy in reducing greenhouse gas emissions: reaching the goals of the Paris agreement in Brazil. **Environmental Development**, v. 33, 2020.

PIMENTA, A. A.; SINDELAR, F. C. W.; PÉRICO, E. Brazilian Footwear Industry: an analysis of the sustainable practices of certified companies by the sustainable origin seal. **Revista de Gestão Social e Ambiental**, v. 16, n. 3, 2023.

ROSENZWEIG, C.; NEOFOTIS, P. G. Detection and Attribution of Anthropogenic Climate Change Impacts. **Wiley Interdisciplinary Reviews: climate change**, p. 4, n. 2, p. 121–150. 2013. DOI: 10.1002/wcc.211.

SCIENCE DIRECT. Disponível em: https://www.sciencedirect.com/. Acesso em: 8 nov. 2023.

SERWETA, W.; GAJEWSKI, R.; OLSZEWSKI, P.; ZAPATERO, A.; ŁAWIŃSKA, K. Carbon Footprint of Different Kinds of Footwear – a Comparative Study. **Fibres and Textiles in Eastern Europe**, v. 27, n. 5, p. 94-99, 2019.

SINGH, N.; DAMASSA, T.; ALARCÓN-DÍAZ, S.; SOTOS, M. **Exploring Linkages Between National and Corporate / Facility Greenhouse Gas Inventories**. World Resources Institute, 2014.

YIN, R. K. **Case Study Research:** design and methods. Thousand Oaks, CA: Sage Publications, 2015.

Environmental-economic accounting for water: a global comparative analysis

Contas econômicas ambientais da água: uma análise comparativa global

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ABSTRACT

Water accounts emerge to express their physical volume in the environment and the economy, as well as the economic aspect of water supply and use. Therefore, it enables public policymakers to make the most appropriate decisions for its management. So, the research objective is to analyse how different countries disclose their environmental and economic accounts for water. Therefore, a categorical analysis model of 120 categories was developed based on the SEEA-Water framework and analysed in 13 countries. The results highlight the high adherence to the physical water supply and use tables. It is interpreted as a "starting point" for compiling water accounts. Despite this, water emission accounts have not been prioritis**ed, po**ssibly due to data unavailability. Both hybrid and asset accounts are in progress. Concerning the countries, Brazil, Mexico, and Costa Rica achieved the highest adequacy level for the proposed model.

Keywords: Water Accounting. National Accounts. SEEA-Water. Content Analysis.

RESUMO

Contas da água surgem para expressar os seus volumes físicos no ambiente e na economia, bem como os aspectos econômicos do fornecimento e uso da água. Portanto, possibilita que os formadores de políticas públicas tomem decisões mais adequadas para o gerenciamento do recurso. Assim, a pesquisa objetiva analisar como diferentes países evidenciam suas contas econômicas ambientais da água. Para tanto, foi desenvolvido um modelo de análise categorial composto por 120 categorias, embasadas na metodologia SEEA-Water, analisadas em 13 países. Os resultados apontam a elevada aderência das tabelas físicas de fornecimento e uso da água, interpretadas como "ponto de partida" para a compilação das contas da água. Contudo, contas de emissões na água não foram priorizadas, possivelmente pela indisponibilidade de dados. Tratando-se de contas híbridas e contas de ativos hídricos, ambas

se encontram em andamento. Entre os países, Brasil, Costa Rica e México obtiveram maior nível de adequação ao modelo proposto.

Palavras-chave: *Contabilidade da Água. Contas Nacionais. SEEA-Water. Análise de Conteúdo.*

INTRODUCTION

Billions of people still lack safely managed drinking water and sanitation, even though both services are recognised as human rights and common factors that drive development to shape a prosperous future (UN-Water, 2021; United Nations, 2023). This has made water levels and fluctuations in quantity and quality to ensure the sustainability of nations become one of the most pressing global issues of the 21st century, and many countries are greatly concerned about it (Chalmers; Godfrey; Lynch, 2012; Chalmers; Godfrey; Potter, 2012).

Therefore, ensuring the availability and sustainable management of water and sanitation for all is a challenge many economies have adopted to achieve Sustainable Development Goal 6. However, there is a concern about whether the current water resources policies will be sufficient to achieve the ambitious goals proposed by the 2030 Agenda (World Water Forum, 2018) since it is a duty mostly for governments (Ferrer *et al.*, 2022).

Since it is considered a public good, water-related issues involve public responsibility for its use, management, and protection (Signori; Bodino, 2013). Moreover, recognising that data management for decision support is a challenging aspect of any decision-making process, water management is no exception (Torres López; Barrionuevo; Rodríguez-Labajos, 2019).

In this regard, water data are critical to the water management process (Ferrer *et al.*, 2022; Pinto Filho; Rêgo; Lunes, 2019), both to base decisions and to measure the progress of the measures adopted (Dutta *et al.*, 2017). Considering that decision-makers rely on economic accounting methods for urban planning and infrastructure investments (Tapsuwan *et al.*, 2021), it is recommended that a water accounting system be implemented to organise water-related data (Bagheri; Babaeian, 2020). Thus, water accounts provide data on the stock and flow of water in physical, monetary, and qualitative terms and produce indicators that can translate the performance of water resources (Romeiro; Kuwahara, 2004).

According to Kilimani, Van Heerden and Bohlmann (2016), water accounts are vital to providing information to policymakers on the impact of current economic policies and growth patterns on water resources, making it possible to judge whether or not such policies are sustainable. Consequently, water account systems that record and report resource-related data in a relevant, reliable, understandable, and comparable way have gained prominence (Chalmers; Godfrey; Potter, 2012). Its multidisciplinary nature promotes the contribution of several fields beyond accounting, including engineering, hydrology, meteorology, geography, and law (Christ; Burritt, 2018; Russell, 2021).

Thus, while different nations develop and publish their water accounts differently, there is general agreement on the structure and scope of water accounting. This agreement is formalised by the publication of the System of Environmental and Economic Accounting for Water (SEEA-Water) (Berger *et al.*, 2018; United Nations, 2012).

SEEA-Water provides a conceptual framework for organising hydrological and economic information coherently and consistently, using the System of National Accounts (SNA) as a base framework. Therefore, when properly implemented, water accounts may provide a core set of reliable statistics needed in an increasingly fragmented information landscape (Bagstad *et al.*, 2020). Furthermore, it gives a standard for the compilation of economic statistics and the derivation of economic indicators, allowing the comparability of accounts compiled in and between countries (United Nations, 2012).

However, uncertainties and challenges hinder the progress of the structure in some jurisdictions due to insufficient involvement from political decision-makers, data unavailability, and the need to tailor accounts to specific regions (Cavalletti; Corsi, 2022). Thus, recognising the challenges that permeate the advancement of water accounts, this study aims to analyse how different countries disclose their environmental-economic accounts for water. We then analyse the countries that have already compiled their environmental-economic accounts for water based on the SEEA-Water methodology.

Therefore, this research is justified by the benefits of compiling environmental-economic accounts for water recognised by the countries that have already done so. In Botswana, for example, it was noted that implementing environmental-economic accounts for water has become critical to achieving sustainable development and economic growth in the country (Setlhogile; Arntzen; Pule, 2017). In Mexico, through this implementation, the government promoted different programs for more efficient resource use, besides identifying an increase in water productivity from its first compilation to its most recent version. In China, technical and methodological issues in water resources management were overcome with the application of SEEA-Water, as there used to be a fragmentation of agencies responsible for collecting and disclosing water-related data (Gan *et al.*, 2012).

2 WATER ACCOUNTING

The role of accounting is recognised as a social science because its accountability directly affects the qualitative aspects of human and social relationships while also interacting with the quantitative aspects of measurement and mediation (Coliath, 2014). Recognising accounting beyond its focus on wealth and income promotes awareness of opportunities to use accounting knowledge and shape a system based on accountants' contributions and regulatory focus (Chalmers; Godfrey; Lynch, 2012). Additionally, through accounting for natural resources, the accounting approach adds analytical capacity to basic statistics, accurately reflecting the differences in natural resources in different periods and obtaining the effect of their measurement (Yang *et al.*, 2021).

Given that issues related to water access and management are among the most pressing economic, social, and environmental concerns today, the accounting profession increasingly recognises the implications associated with water risk and value (Christ, 2014). Hence, the Water Accounting Standards Board (2014) defines water accounting as a systematic process of identifying, recognising, quantifying, reporting, and assuring information about water, its rights, other claims, and obligations against this resource.

However, according to Christ and Burritt (2018), this aggregate of water-related information gives water accounting strong transdisciplinary features. Its collaboration intersects between, through, and beyond different fields, including engineering, accounting, hydrology, meteorology, geography, and law. According to Russell (2021), because water issues are multidisciplinary in nature, a range of professionals from different fields can work together to develop policies and practices that promote resource preservation.

Consequently, standardised water accounting methodologies are being developed for different geographical and organisational levels, increasing the quality and credibility of the information available to various stakeholders. Thus, water accounting standards at the macroeconomic level can serve the public interest as the quality and credibility of the information available to stakeholders increase. Based on water accounts, decision-makers can make informed choices about the allocation of resources, which can impact economic growth and environmental protection (Chalmers; Godfrey; Lynch, 2012). With the assistance of macroeconomic regulation and market control, water resources can be allocated optimally, promoting its sustainable use and socioeconomic development (Sun et al., 2017).

For this reason, different water accounting frameworks have been proposed to organise hydrological and economic data in an integrated manner to provide a platform for assessing water resource systems

(Bagheri; Babaeian, 2020). However, although the Dutch 'National Accounting Matrix, including Water Accounts' and the 'Australian Water Accounting Standards' are recognised methodologies, physical and economic data on water in many nations are becoming more widely integrated by adopting the SEEA-Water (Bagstad *et al.*, 2020).

2.1 SYSTEM OF ENVIRONMENTAL AND ECONOMIC ACCOUNTING FOR WATER (SEEA-WATER)

Although the SNA is a universal economic statistical system that provides effective economic analysis for decision-makers, it does not cover concepts related to sustainable development. Therefore, in 1993, the United Nations (UN) and the World Bank launched the first System of Environmental and Economic Accounting (SEEA) to complement the SNA (Sun *et al.*, 2017). The SEEA was created by the statistical community in collaboration with ecologists, economists, and other scientists to provide countries with a framework for compiling environmental and natural resources statistics (Esen; Hein, 2020).

While previous developments encompassed a variety of environmental accounts, such as the SEEA – Central Framework, there emerged a need to create a more detailed methodology specifically addressing water resources. Consequently, the SEEA-Water was established between 2004 and 2007. This methodology emerged to standardise water reporting among countries, replacing the previous ad hoc approach (Vardon *et al.*, 2012). Thus, it employs accounting principles for valuing different capital forms and physical terms, generating more coherent environmental data and facilitating their integration with economic information (Obst, 2015). Furthermore, it defines a series of accounting identities to enable consistent comparisons across areas and over time (Vardon *et al.*, 2012).

In 2012, the UN released the latest version of the SEEA-Water, which provides a conceptual framework designed to organise hydrological and economic information coherently and consistently, which facilitates the systematic organisation of water flow from the environment to the economy within the economy and back to the environment compatible with the SNA. Notably, this system of satellite accounts also includes principles for organising data on water stocks or assets, water reuse, and various financial items related to water supply and sanitation (Tello; Hazelton, 2018; United Nations, 2012). More specifically, the tool suggests dividing water accounts into four "water statements" - Physical Water Supply and Use Tables, Water Emissions Accounts, Hybrid Accounts, and Water Asset Accounts.

3 METHODOLOGICAL PROCEDURES

For this research's development, countries that have already compiled their environmental-economic accounts for water using the SEEA-Water were analysed (United Nations, 2012). Thus, the following countries met the established criteria: Armenia, Australia, Botswana, Brazil, Colombia, Costa Rica, Fiji, Netherlands, Mauritius, Mexico, Rwanda, Uganda, and Zambia.

First, to enable the recognition of these 13 countries, the Statistics South Africa's (2017) document and the Waves - *Wealth Accounting and the Valuation of Ecosystem Services*' (2021) electronic address were used. Thus, 29 countries were initially analysed.

Then, data on the environmental-economic accounts for water were collected from these 29 countries using three sources of information: the Waves (2021) electronic address, the electronic addresses of the national statistical agencies responsible for compiling the accounts in each country, and, when not available, emails forwarded to these agencies.

Based on the previous email responses and data collection, of the 29 countries analysed, 13 meet the established criteria and base this research sample. The remaining 16 were excluded for not adopting the

SEEA-Water methodology (adopting only the SEEA-Central Framework or another non-corresponding methodology), not publicising their water accounts, or not making them available via email.

Regarding the time frame, we seek to analyse each case's most recent accounts compilation. Considering that the research was carried out in 2021, we found publications between the periods from 2017 to 2020, although the publications provide retroactive information.

The categorical analysis technique was used as a data analysis technique. According to Bardin (2010, p. 199), this "works through operations of dismembering the text into units, into categories according to analogical regroupings." Gray (2016) emphasises that this is about making inferences about research data and systematically and objectively identifying special characteristics (classes or categories) among them.

Given this, Bardin (2010) highlights some necessary qualities to develop good categories: mutual exclusion, homogeneity, relevance, objectivity and fidelity, and productivity. By adhering to these qualities, a categorical analysis model based on the SEEA-Water (United Nations, 2012) is organised into four major categories: (i) physical water supply and use tables; (ii) water emissions accounts; (iii) hybrid accounts; and (iv) water asset accounts. Table 1 presents the proposed model based on the SEEA-Water (United Nations, 2012), with 120 categories listed. The different colours between the categories aim to organise the analysis in the next section.

Table 1 – Content Analysis Categories

1. Physical water supply and use tables		21	Service economic activities
1.1 Flow from the environment to the economy		**1.2.2 Water received from other economic units**	
01	Abstraction for own use	22	Use of water received from other economic units
02	Abstraction for distribution	23	Reused water from other economic units
03	Abstraction from inland water resources	24	Wastewater to sewerage from other economic units
04	Abstraction from surface water	25	Desalinated water from other economic units
05	Abstraction from groundwater	26	Consumed by economic activities
06	Abstraction from soil water	27	Consumed by households
07	Abstraction from the sea	28	Exportation
08	Collection of precipitation	**1.2.3 Supply of water to other economic units**	
09	Abstraction from other water resources	29	Supply of water to other economic units
10	Total water abstraction to the economy	30	Reused water supplied to other economies
1.1.1 Supplementary items		31	Wastewater sewerage to other economies
11	Abstraction for hydroelectric power generation	32	Desalinated water to other economies
12	Abstraction for irrigation water	33	Supplier economic activities
13	Abstraction for mine water	34	Supplier households
14	Abstraction for urban run-off	35	Importation
15	Abstraction for cooling water	**1.3 Flow from the economy into the environment**	
1.2 Flow within the economy		36	Returns to inland water resources
1.2.1 Breakdown of the economic activities		37	Returns to inland water resources – surface water
16	Agriculture, forestry and fishing	38	Returns to inland water resources – groundwater
17	Mining and quarrying, manufacturing, and construction	39	Returns to inland water resources – soil water
18	Electricity, gas and steam supply	40	Returns to other sources
19	Water collection, treatment and supply	41	Returns to seawater
20	Sewerage	42	Total returns into the environment

1.3.1 Supplementary items		79	Economic activities intermediate consumption
43	Returns from hydroelectric power generation	80	Final consumption by households
44	Returns from irrigation water	81	Final consumption by government
45	Returns from mine water	82	Capital formation
46	Returns from urban run-off	83	Exports
47	Returns from cooling water	**3.2 Physical units**	
48	Returns from treated wastewater	84	Total supply of water
49	Losses in distribution due to leakages	85	Supply of water to other economic units
1.4 Water consumption		86	Supply of wastewater to sewerage
50	Water consumption by the whole economy	87	Total returns
51	Water consumption by economic activities	88	Output of economic activities
52	Water consumption by households	89	Supply by households
53	Losses not due to leakages	90	Imports
2. Water emission accounts		91	Total use of water
2.1 Pollutant emissions by economic units		92	Total abstraction
54	Gross emissions of pollutants	93	Abstraction for own use
55	Emissions by economic activities	94	Use of water received from other economic units
56	Emissions by households	95	Intermediate consumption of economic activities
57	Direct emissions to water	96	Final consumption by households
58	Direct emissions after treatment	97	Exports
59	Direct emissions without treatment	98	Total emission of pollutants
60	Direct emissions to inland water resources	**4. Water asset accounts**	
61	Direct emissions to the sea	99	Opening stocks
62	Emissions to sewerage	100	Increases in stocks
2.2 Pollutant emissions by sewage system		101	Returns
63	Emissions after treatment	102	Precipitation
64	Emissions without treatment	103	Inflows
65	Emissions into water resources	104	Inflows from upstream territories
66	Emissions into the sea	105	Inflows from other resources in the territory
2.3 Supplementary items		106	Decreases in stocks
67	Pollutant content	107	Abstraction
68	Volume of sludge generated by sewerage	108	Evaporation/actual evapotranspiration
69	People with access to improved sanitation	109	Outflows
3. Hybrid accounts		110	Outflows to downstream territories
3.1 Monetary units		111	Outflows to the sea
70	Total water output and supply	112	Outflows to other resources in the territory
71	Natural water output and supply	113	Closing stocks
72	Sewerage services output and supply	114	Surface water
73	Economic activities output	115	Surface water – artificial reservoirs
74	Imports	116	Surface water – lakes
75	Taxes	117	Surface water – rivers
76	Total intermediate consumption and use	118	Surface water – snow, ice, and glaciers
77	Natural water intermediate consumption and use	119	Groundwater
78	Sewerage services intermediate consumption and use	120	Soil water

Source: Prepared by the authors based on the SEEA-Water (United Nations, 2012).

4 RESULTS AND DISCUSSION

In this chapter, to display whether a certain category is disclosed or not in a specific country, the matrices have their corresponding space (water account "x" and country "y") highlighted with green colour for disclosure and red colour for no disclosure. Furthermore, the accounts expressed in the left column are represented by different colours based on their categorisation, which can be found in Table 1 in the previous section. At the right and bottom edges, respectively, immediately after the total value, there is the percentage of the total number of countries that disclose each account (right column) and the total number of accounts disclosed by each country (bottom row). These are presented with colour gradients from red to green to make it easier to visualise the percentage tens representing disclosure. The closer the colour is to red, the lower the disclosure, and the closer it is to green, the higher the disclosure.

4.1 PHYSICAL WATER SUPPLY AND USE TABLES

Physical Water Supply and Use Tables (PWSUT) aim to demonstrate the flow of water from its initial abstraction from the environment by the economy, its supply and use within the economy, and its final discharge back into the environment, with all entries being expressed in quantitative terms (United Nations, 2012). Thus, we decided to separate them into blocks that reflect these flows. Matrix 1 illustrates the observed disclosure findings.

Matrix 1 – Physical Water Supply and Use Tables

	Armenia	*Australia*	*Botswana*	*Brazil*	*Colombia*	*Costa Rica*	*Fiji*	*Netherlands*	*Mauritius*	*Mexico*	*Rwanda*	*Uganda*	*Zambia*	*Total Countries*	*%*
1														10	77%
2														10	77%
3														6	46%
4														13	100%
5														13	100%
6														6	46%
7														8	62%
8														9	69%
9														5	38%
10														11	85%
11														6	46%
12														4	31%
13														3	23%
14														0	0%
15														1	8%
16														12	92%
17														12	92%
18														12	92%
19														13	100%
20														10	77%
21														9	69%

	Armenia	Australia	Botswana	Brazil	Colombia	Costa Rica	Fiji	Netherlands	Mauritius	Mexico	Rwanda	Uganda	Zambia	Total Countries	%
22														11	85%
23														6	46%
24														6	46%
25														1	8%
26														13	100%
27														13	100%
28														7	54%
29														11	85%
30														10	77%
31														11	85%
32														2	15%
33														13	100%
34														13	100%
35														7	54%
36														9	69%
37														10	77%
38														9	69%
39														7	54%
40														6	46%
41														6	46%
42														13	100%
43														5	38%
44														3	23%
45														2	15%
46														0	0%
47														1	8%
48														3	23%
49														7	54%
50														9	69%
51														9	69%
52														11	85%
53														8	62%
Total	**26**	**35**	**35**	**40**	**36**	**36**	**32**	**29**	**29**	**33**	**36**	**30**	**18**	**415**	
%	49%	66%	66%	75%	68%	68%	60%	55%	55%	62%	68%	57%	34%	60%	

Where:

Colours of water accounts (1st column): See categories in Table 1

Matrix "x" (water accounts) by "y" (countries): Undisclosed Disclosed

Percentage colour gradient: 0% 100%

Source: Prepared by the authors (2023).

Initially, to comprehend the flow from the environment to the economy, it is essential to have access to information about the amount of water abstracted from natural resources for distribution. Therefore, it is observed that all the countries analysed have compiled accounts that show the abstraction of both surface water and groundwater (categories 04 and 05) within their respective territories.

Rwanda decided to subdivide the 'abstraction from surface water' account according to the water resources involved. This was done by creating separate accounts for lakes, rivers, and reservoirs. According to the SEEA-Water, PWSUT can be compiled at varying levels of detail, depending on the country's policy concerns and data availability (United Nations, 2012).

After analysing water account reports, we observed discrepancies regarding the importance given to different water resources in different territories. For example, when it comes to groundwater, households in Rwanda abstract more than twice the volume of water compared to what is extracted by water supply agencies from sources such as groundwater since the agencies' supply is limited (Government of Rwanda, 2019). In the Netherlands, groundwater abstractions are limited due to their serious impact, including leading to water stress situations (Statistics Netherlands, 2017). In Costa Rica, problems such as saline intrusion into groundwater have arisen due to the overexploitation of wells, prompting initiatives to desalinate seawater (Banco Central de Costa Rica, 2019).

Regarding the abstraction for hydroelectric power generation (11) account, reported by 46% of countries, these typically reflect their energy profiles. Countries such as Brazil, Costa Rica, and Rwanda note that this abstraction is one of the reasons why the energy sector uses the largest volume of water among economic activities.

Finally, in formulating the categories, the water received by the rest of the world has been classified as "export" and water supplied as "import." For instance, Botswana imports water from South Africa via the Molatedi Dam (Republic of Botswana, 2017).

Regarding the flow from the economy into the environment, the economic unit responsible for discharges (industries, families, and the rest of the world) is considered the "supplier", while the environment is the "destination" of these flows (United Nations, 2012). Through the analysis, we noted that all countries have disclosed at least the total water return to the environment. However, the behaviour changes according to each country's reality when this "headline" account is disaggregated among the resources. For example, considering the returns to seawater (41), four countries that do not disclose it are not located in coastal regions to justify such return — Armenia, Botswana, Uganda, and Zambia.

Concerning the 'returns from cooling water' account (47), this is disclosed only by the Netherlands. Their report noted that despite significant water abstraction for cooling purposes, the flow typically returns to the environment after use (Statistics Netherlands, 2017). This type of flow is known as non-consumptive use, meaning that an economic process utilises water and returns almost entirely to the environment without significant physical or chemical changes (Banco Central de Costa Rica, 2019; IBGE, 2018; Inegi, 2019).

With a slightly higher level of disclosure (54%), the account "losses in distribution due to leakages" (49) was observed in seven countries. Rwanda comments that most of these leaks are due to the old and damaged water supply infrastructure, poor maintenance, and general breakdowns (Government of Rwanda, 2019). On the other hand, "losses not due to leakages" (53) refer to losses that do not return directly to water resources. Among them, we can mention evaporation losses (Mexico), metering errors (Costa Rica), ineffective water bill collection (Botswana), illegal use of water resources (Costa Rica), losses in the purification process (Fiji), and water incorporation into products (Uganda).

4.2 WATER EMISSION ACCOUNTS

Following the PWSUT, the second section of categories addresses water emissions accounts. As seen in Matrix 2, only two countries (15%) provided information about these – Costa Rica and Mexico.

Matrix 2 – Water Emission Accounts

	Armenia	Australia	Botswana	Brazil	Colombia	Costa Rica	Fiji	Netherlands	Mauritius	Mexico	Rwanda	Uganda	Zambia	Total Countries	%
54														1	8%
55														2	15%
56														0	0%
57														1	8%
58														0	0%
59														0	0%
60														0	0%
61														0	0%
62														1	8%
63														1	8%
64														0	0%
65														0	0%
66														0	0%
67														0	0%
68														0	0%
69														1	8%
Total	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**7**	
%	0%	0%	0%	0%	0%	31%	0%	0%	0%	13%	0%	0%	0%	3%	

Where:

Colours of water accounts (1st column): See categories in Table 1

Matrix "x" (water accounts) by "y" (countries): Undisclosed Disclosed

Percentage colour gradient: 0% 100%

Source: Prepared by the authors (2023).

Notably, the only account evidenced by both countries is the "emissions by economic activities" (55). Regarding Mexico, the country mentions in its report that the compilation of this account arose from available data on the emission of tons of biochemical oxygen demand (BOD) from the industry and services sectors.

Regarding this account, Costa Rica has legislation that simplifies the compilation of this data. As per the country's regulations, any entity that discharges wastewater into the sewer system is obligated to submit an operational report to the Ministry of Health, indicating the discharged flow and laboratory analysis parameters (Banco Central de Costa Rica, 2019). Finally, the account "people with access to

adequate sanitation" (69) in Costa Rica indicates that 99.60% of the population had access to adequate sanitation in 2016.

Although the challenges of compiling water emission accounts are acknowledged, a greater number of countries are expected to initiate their development. These accounts are a unique feature of the SEEA-Water, filling a gap left by the SEEA-Central Framework. Thus, emission accounts constitute a useful tool for designing economic instruments, including new regulations aiming to reduce water emissions (United Nations, 2012).

4.3 HYBRID ACCOUNTS

The disclosure of hybrid water accounts is illustrated in Matrix 3. Hybrid accounts provide both monetary information (categories in yellow) and physical information (categories in orange) about the supply and use of water (United Nations, 2012).

Matrix 3 – Hybrid Accounts

	Armenia	*Australia*	*Botswana*	*Brazil*	*Colombia*	*Costa Rica*	*Fiji*	*Netherlands*	*Mauritius*	*Mexico*	*Rwanda*	*Uganda*	*Zambia*	*Total Countries*	*%*
70														6	46%
71														5	38%
72														5	38%
73														4	31%
74														3	23%
75														4	31%
76														6	46%
77														6	46%
78														5	38%
79														6	46%
80														6	46%
81														3	23%
82														4	31%
83														3	23%
84														5	38%
85														3	23%
86														3	23%
87														4	31%
88														4	31%
89														3	23%
90														3	23%
91														5	38%
92														5	38%
93														4	31%
94														3	23%

	Armenia	Australia	Botswana	Brazil	Colombia	Costa Rica	Fiji	Netherlands	Mauritius	Mexico	Rwanda	Uganda	Zambia	Total Countries	%
95														5	38%
96														5	38%
97														3	23%
98														1	8%
Total	**28**	**18**	**0**	**27**	**0**	**13**	**0**	**0**	**0**	**28**	**0**	**0**	**8**	**122**	
%	97%	62%	0%	93%	0%	45%	0%	0%	0%	97%	0%	0%	28%	32%	

Where:

Colours of water accounts (1st column): See categories in Table 1

Matrix "x" (water accounts) by "y" (countries): Undisclosed Disclosed

Percentage colour gradient: 0% 100%

Source: Prepared by the authors (2023).

In relation to the hybrid accounts, evidenced by six countries, Armenia, Brazil, and Mexico disclose them nearly completely. Australia and Costa Rica also presented hybrid accounts, but they are not entirely consistent with the SEEA-Water methodology, which has affected their level of disclosure. On the other hand, Zambia has chosen to disclose only monetary accounts and has left its physical accounts solely in the PWSUT.

Regarding the compilation of suppliers and/or consumers of water-related services, economic activities form hybrid accounts in most countries. Australia is an exception as it lacks the "water production by economic activities" account. However, the government justifies its omission by claiming a lack of reliable data to generate accurate estimates, considering the large number of companies that abstract water for their own use (Australian Bureau of Statistics, 2019).

Households are also included in the hybrid accounts. In Armenia and Mexico, the 'household' account is broken into 'final consumption' and 'government social transfers.' This is because water services are not directly purchased by families but are provided free of charge, or nearly so, by the government and non-profit institutions (Inegi, 2019). Thus, another user agent of water services is the government (81). However, only Armenia, Brazil, and Mexico use this category.

4.4 WATER ASSET ACCOUNTS

Regarding stocks or water asset accounts, Matrix 4 summarises the disclosure. Only five countries (45.45%) have these accounts—Brazil, Costa Rica, the Netherlands, Mauritius, and Rwanda. Among them, it is notable that all adhere to the basic structure of the SEEA-Water or the categories in question. The level of disaggregation of certain information is what modifies the level of disclosure in each country.

Matrix 4 – Water Asset Accounts

	Armenia	Australia	Botswana	Brazil	Colombia	Costa Rica	Fiji	Netherlands	Mauritius	Mexico	Rwanda	Uganda	Zambia	Total Countries	%
99														5	38%
100														5	38%
101														5	38%
102														5	38%
103														2	15%
104														5	38%
105														5	38%
106														5	38%
107														5	38%
108														5	38%
109														2	15%
110														5	38%
111														5	38%
112														5	38%
113														5	38%
114														5	38%
115														3	23%
116														3	23%
117														3	23%
118														0	0%
119														5	38%
120														5	38%
Total	**0**	**0**	**0**	**21**	**0**	**16**	**0**	**18**	**19**	**0**	**19**	**0**	**0**	**93**	
%	0%	0%	0%	95%	0%	73%	0%	82%	86%	0%	86%	0%	0%	33%	

Where:

Colours of water accounts (1st column): See categories in Table 1

Matrix "x" (water accounts) by "y" (countries): Undisclosed Disclosed

Percentage colour gradient: 0% 100%

Source: Prepared by the authors (2023).

For instance, the disaggregation of surface water accounts into artificial reservoirs, lakes, and rivers (115, 116, and 117) underscores the challenge of measuring such water resources separately. Although Rwanda has provided a disaggregation of surface water accounts, the classification boundaries are not always precise, indicating the difficulty of measuring these resources separately.

Alongside the measurement challenge, there may be a lack of disclosure of accounts that do not align with the country's context. This is exemplified by the "surface water - snow, ice, and glaciers" account (118), which is not disclosed by any country in the sample, as most countries considered are characterised by a climate that does not include these resources.

4.5 GENERAL ANALYSIS

This section provides an overview of the levels of disclosure after analysing the specific disclosed categories. For this reason, Figure 1 summarises the percentage of countries that disclosed each of the 120 determined categories. The first quadrant demonstrates the level of disclosure of the 53 categories of the PWSUT; the second quadrant shows the 16 water emission accounts; the third quadrant comprises 29 hybrid accounts; and the fourth quadrant includes 22 water asset accounts. Additionally, each point on the figure represents one of the 120 categories, and the closer the point is to the circumference, the less that category was disclosed. Similarly, the closer the point is to the centre, the better its level of adoption by countries.

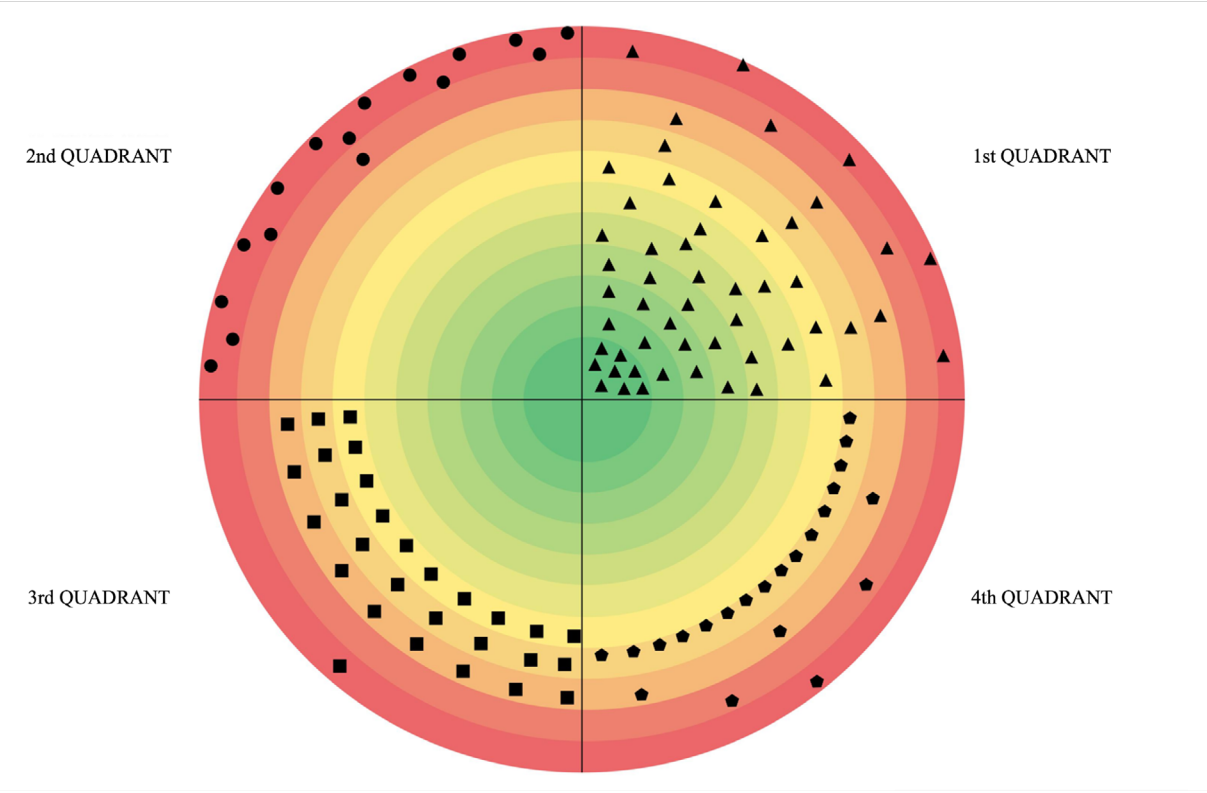

Figure 1 – Disclosure of the Proposed Categories

Source: Prepared by the authors (2023).

Observing the graph, we can see that countries show a higher level of adherence to the PWSUT, with a minimum disclosure rate of 50% for most of their accounts. This category stands out as the only one with a notable level of adherence among countries. Furthermore, we can notice that countries often use these categories as a "starting point" for compiling water accounts.

However, the analysis of water emission accounts reveals a different pattern. With disclosure levels not exceeding 20%, this does not seem to have been prioritised by the countries. Some countries cite the unavailability of necessary data for proper compilation as a justification.

Finally, a similar trend is observed in the disclosure of hybrid and water asset accounts. Both categories are in the early stages of development. Furthermore, these broad categories include some accounts whose information is derived from the PWSUT. This highlights the significance of compiling data from the PWSUT and justifies the increased availability of disclosed data.

Matrix 5 presents another comprehensive analysis to complement the developed categorical analysis, which revisits the disclosure level of each of the four major categories developed while also adding the total disclosure level of the analysed countries.

Matrix 5 – Combined Analysis of the Categories

	Armenia	*Australia*	*Botswana*	*Brazil*	*Colombia*	*Costa Rica*	*Fiji*	*Netherlands*	*Mauritius*	*Mexico*	*Rwanda*	*Uganda*	*Zambia*	*Total*
PWSUT	49%	66%	66%	75%	68%	68%	60%	55%	55%	62%	68%	57%	34%	60%
Emission	0%	0%	0%	0%	0%	31%	0%	0%	0%	13%	0%	0%	0%	3%
Hybrid	97%	62%	0%	93%	0%	45%	0%	0%	0%	97%	0%	0%	28%	32%
Asset	0%	0%	0%	95%	0%	73%	0%	82%	86%	0%	86%	0%	0%	33%
Total	45%	44%	29%	73%	30%	58%	27%	39%	40%	53%	46%	25%	22%	

Where:

PWSUT: Physical Water Supply and Use Tables

Emission: Water Emissions Accounts

Hybrid: Hybrid Accounts

Asset: Water Asset Accounts

Percentage colour gradient: 0% 100%

Source: Prepared by the authors (2023).

Based on this data, it is evident that Brazil is the country that disclosed the most water accounts according to the proposed category model (73%). Despite not compiling water emission accounts, Brazil is recognised for its high level of compliance, particularly in hybrid accounts and water assets. Subsequently, we find Costa Rica (58%) to be another notable country, followed by Mexico (53%).

Costa Rica was the only country to disclose information related to all four major categories of analysis; however, it did not delve deeply into any of them.

Mexico, on the other hand, stood out in the level of disclosure of hybrid accounts, with a 97% alignment. However, water asset accounts were not presented, and only 13% of water emission accounts were disclosed.

Zambia, Uganda, Fiji, Botswana, and Colombia, in that order, were the countries that showed the least engagement with water accounts. Except for Zambia, these were the only ones to disclose information

in just one group of categories – PWSUT. Although it presented some hybrid accounts (monetary only), Zambia had limited engagement with water accounts, with a 22% disclosure rate. However, it should be noted that the country emphasises in its report that this is a preliminary presentation of its water accounts. Thus, future developments should demonstrate greater engagement among these countries and new adherents to the SEEA-Water.

5 FINAL CONSIDERATIONS

The present research analysed how different countries disclose their environmental-economic accounts for water based on the SEEA-Water methodology. Therefore, the study employs a categorical analysis encompassing 120 categories, subdivided into PWSUT, water emission accounts, hybrid accounts, and water asset accounts.

Based on this, we observed that PWSUTs tend to be the primary information highlighted by the countries developing water accounts, given their significant level of adherence. On the other hand, water emission accounts were the least disclosed. The unavailability and difficulty in obtaining data for these accounts are among the justifications cited by those who do not disclose them.

Regarding the level of disclosure of hybrid accounts and water asset accounts, the countries exhibit a similar rate. Approximately half of the countries present some of these accounts, indicating they are in a developmental phase. Some countries' interest in future compilations reflects this trend.

In terms of contributions from this research, we highlight economic, environmental, managerial, and social contributions. Economically, it promotes the recognition of water as natural capital by elucidating its information in both physical and monetary terms. Environmental and social contributions arise from how the research encourages the disclosure of information about water resources. This disclosure fosters more significant engagement with resource management and preservation by developing organised data that drives more informed decision-making. It then catalyses the development of public policies to preserve water, mitigate water stress, and ensure resource quality.

Concerning this research's limitations, it is relevant to acknowledge that certain accounts, reports, and information on water accounts from some countries were unavailable and, therefore, not analysed. It is also worth mentioning that the language barrier in some publications may have hindered the analysis of water account disclosures in some cases, such as those from Armenia.

REFERENCES

AUSTRALIAN BUREAU OF STATISTICS. **Water Account, Australia**. 2019.

BAGHERI, A.; BABAEIAN, F. Assessing water security of Rafsanjan Plain, Iran – Adopting the SEEA framework of water accounting. **Ecological Indicators**, v. 111, p. 105959, 2020. Available at: https://doi.org/10.1016/j.ecolind.2019.105959

BAGSTAD, K. J. *et al.* Integrating physical and economic data into experimental water accounts for the United States: lessons and opportunities. **Ecosystem Services**, v. 45, 2020. Available at: https://doi.org/10.1016/j.ecoser.2020.101182

BANCO CENTRAL DE COSTA RICA. **Cuenta de Agua**. 2019. Available at: https://www.bccr.fi.cr/seccion-cuentas-ambientales/cuentas-ambientales.

BARDIN, L. **Análise de Conteúdo**. 4. ed. Lisboa: Edições 70, 2010.

BERGER, M. *et al.* Enhancing the Water Accounting and Vulnerability Evaluation Model: WAVE+. **Environmental Science & Technology**, v. 52, n. 18, p. 10757–10766, 2018. Available at: https://doi.org/10.1021/acs.est.7b05164

CAVALLETTI, B.; CORSI, M. The system of environmental and economic accounting and the valuation problem: a review of the literature. **Journal of Environmental Planning and Management**, v. 65, n. 11, p. 1999–2028, 2022.

CHALMERS, K.; GODFREY, J. M.; LYNCH, B. Regulatory theory insights into the past, present and future of general purpose water accounting standard setting. **Accounting, Auditing & Accountability Journal**, v. 25, n. 6, p. 1001–1024, 2012.

CHALMERS, K.; GODFREY, J.; POTTER, B. Discipline-Informed Approaches to Water Accounting. **Australian Accounting Review**, v. 22, n. 3, p. 275–285, 2012. Available at: https://doi.org/10.1111/j.1835-2561.2012.00175.x

CHRIST, K. L. Water management accounting and the wine supply chain: empirical evidence from Australia. **British Accounting Review**, v. 46, n. 4, p. 379–396, 2014. Available at: https://doi.org/10.1016/j.bar.2014.10.003

CHRIST, K. L.; BURRITT, R. L. The role for transdisciplinarity in water accounting by business: reflections and opportunities. **Australasian Journal of Environmental Management**, v. 25, n. 3, 2018. Available at: https://doi.org/10.1080/14486563.2018.1460631

COLIATH, G. C. A Contabilidade como Ciência Social e sua contribuição para o Capitalismo. **Revista Eniac Pesquisa**, v. 3, p. 152, 2014. Available at: https://doi.org/10.22567/rep.v3i2.157

DUTTA, D. *et al.* Development and application of a large scale river system model for National Water Accounting in Australia. **Journal of Hydrology**, v. 547, p. 124–142, 2017. Available at: https://doi.org/10.1016/j.jhydrol.2017.01.040

ESEN, S. E.; HEIN, L. Development of SEEA water accounts with a hydrological model. **Science of the Total Environment**, v. 737, p. 140168, 2020. Available at: https://doi.org/10.1016/j.scitotenv.2020.140168

FERRER, L. M. *et al.* Composition of the social urban water shortage vulnerability index (SUWSVI) applied to São José dos Campos, SP, Brazil. **Sustainability in Debate**, v. 13, n. 3, p. 173–188, 2022. Available at: https://doi.org/10.18472/SustDeb.v13n3.2022.4552

GAN, H. *et al.* Development and Application of the System of Environmental –Economic Accounting for Water in China. *In:* **Water Accounting**: international approaches to policy and decision-making. Cheltenham: Edward Elgar, 2012. p. 139–161.

GOVERNMENT OF RWANDA. **Rwanda Natural Capital Accounts - Water**. 2019. Available at: https://www.wavespartnership.org/en/knowledge-center/rwanda-water-accounting-report-2012-2015.

GRAY, D. E. **Pesquisa no mundo real**. 2016.

IBGE. **Contas Econômicas Ambientais da Água no Brasil**. 2018. Available at: https://www.ibge.gov.br/estatisticas/economicas/contas-nacionais/20207-contas-economicas-ambientais-da-agua-brasil.html?=&t=o-que-e.

INEGI. **Memoria de Cálculo de las Cuentas Económico-Ambientales Integradas del Agua**. 2019.

KILIMANI, N.; VAN HEERDEN, J.; BOHLMANN, H. Water resource accounting for Uganda: use and policy relevancy. **Water Policy**, v. 18, n. 1, p. 161–181. 2016. Available at: https://doi.org/10.2166/wp.2015.035

OBST, C. G. Reflections on natural capital accounting at the national level. **Sustainability Accounting, Management and Policy Journal**, v. 6, n. 3, p. 315–339, 2015. Available at: https://doi.org/10.1108/SAMPJ-04-2014-0020

PINTO FILHO, J. L. DE O.; RÊGO, A. T. A. DO; LUNES, A. R. DA S. Management of water resources in semi-arid: assessment of the drinking water supply in rural communities of Chapada do Apodi-RN. **Sustainability in Debate**, v. 10, n. 3, p. 276–319, 2019. Available at: https://doi.org/10.18472/SustDeb.v10n3.2019.24398

REPUBLIC OF BOTSWANA. **Botswana Water Accounting Report**. 2017. Available at: https://www.wavespartnership.org/en/knowledge-center/botswana-water-accounting-report-201516.

ROMEIRO, A. R.; KUWAHARA, M. Y. Avaliação e contabilização de impactos ambientais. **Revista de Economia Mackenzie**, v. 3, n. 3, p. 186–195, 2004.

RUSSELL, S. Water. *In:* **Routledge Handbook of Environmental Accounting**. New York, NY: Routledge, 2021.

SETLHOGILE, T.; ARNTZEN, J.; PULE, O. B. Economic accounting of water: the Botswana experience. **Physics and Chemistry of the Earth**, v. 100, p. 287–295, 2017. Available at: https://doi.org/10.1016/j.pce.2016.10.007

SIGNORI, S.; BODINO, G. A. Water management and accounting: remarks and new insights from an accountability perspective. *In:* **Studies in Managerial and Financial Accounting**. Bingley: Emerald Group, 2013. v. 26, p. 115–161. Available at: https://doi.org/10.1108/S1479-3512(2013)0000026004

STATISTICS NETHERLANDS. **Physical water accounts for the Netherlands**. 2017. Available at: https://www.cbs.nl/en-gb/background/2017/38/physical-water-accounts-for-the-netherlands.

STATISTICS SOUTH AFRICA. **Global Assessment of Environmental-Economic Accounting and Supporting Statistics**. 2017. Available at: https://seea.un.org/sites/seea.un.org/files/area_d_gap_analysis_v3.0.pdf.

SUN, P. *et al.* **Study on Water Assets Accounting under the Concept of Sustainable Development**. Proceedings of the 6th International Conference on Energy, Environment and Sustainable Development. Paris, France: Atlantis Press, 2017. Available at: https://doi.org/10.2991/iceesd-17.2017.91

TAPSUWAN, S. *et al.* Valuing ecosystem services of urban forests and open spaces: application of the SEEA framework in Australia. **Australian Journal of Agricultural and Resource Economics**, v. 65, p. 37–65, 2021. Available at: https://doi.org/10.1111/1467-8489.12416

TELLO, E.; HAZELTON, J. The challenges and opportunities of implementing general purpose groundwater accounting in Australia. **Australasian Journal of Environmental Management**, v. 25, n. 3, p. 285–301, 2018. Available at: https://doi.org/10.1080/14486563.2018.1431157

TORRES LÓPEZ, S.; BARRIONUEVO, M.; RODRÍGUEZ-LABAJOS, B. Water accounts in decision-making processes of urban water management. **Sustainable Cities and Society**, v. 50, 2019. Available at: https://doi.org/10.1016/j.scs.2019.101676

UN-WATER. Summary Progress Update 2021: SDG 6 — Water and sanitation for all. **UN-Water**, p. 1–58, 2021.

UNITED NATIONS. **System of Environmental-Economic Accounting for Water**. 2012. Available at: https://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf.

UNITED NATIONS. **Blueprint for Acceleration**: Sustainable Development Goal 6 Synthesis Report on Water and Sanitation 2023. New York: United Nations, 2023.

VARDON, M. *et al.* The system of environmental-economic accounting for water: development, implementation and use. *In:* **Water Accounting**: international approaches to policy and decision-making. Edward Elgar, 2012. p. 32–57.

WATER ACCOUNTING STANDARDS BOARD. **Water Accounting Conceptual Framework for the Preparation and Presentation of General Purpose Water Accounting Reports**. 2014. Available at: http://www.bom.gov.au/water/standards/wasb/documents/Water-Accounting-Conceptual-Framework-Accessible.pdf.

WEALTH ACCOUNTING AND THE VALUATION OF ECOSYSTEM SERVICES. **Knowledge Center**. 2021. Available at: https://www.wavespartnership.org/en/knowledge-center.

WORLD HEALTH ORGANIZATION. **World Water Day**. 2017.

WORLD WATER FORUM. **Declaração de Sustentabilidade**. 2018. Available at: http://8.worldwaterforum.org/pt-br/documents-0.

YANG, Y. *et al.* Urban natural resource accounting based on the system of environmental economic accounting in Northwest China: a case study of Xi'an. **Ecosystem Services**, v. 47, p. 101233, 2021. Available at: https://doi.org/10.1016/j.ecoser.2020.101233

Contas econômicas ambientais da água: uma análise comparativa global

Environmental-economic accounting for water: a global comparative analysis

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ARTICLE-VARIA

RESUMO

Contas da água surgem para expressar os seus volumes físicos no ambiente e na economia, bem como os aspectos econômicos do fornecimento e uso da água. Portanto, possibilita que os formadores de políticas públicas tomem decisões mais adequadas para o gerenciamento do recurso. Assim, a pesquisa objetiva analisar como diferentes países evidenciam suas contas econômicas ambientais da água. Para tanto, foi desenvolvido um modelo de análise categorial composto por 120 categorias, embasadas na metodologia SEEA-*Water*, analisadas em 13 países. Os resultados apontam a elevada aderência das tabelas físicas de fornecimento e uso da água, interpretadas como "ponto de partida" para a compilação das contas da água. Contudo, contas de emissões na água não foram priorizadas, possivelmente pela indisponibilidade de dados. Tratando-se de contas híbridas e contas de ativos hídricos, ambas se encontram em andamento. Entre os países, Brasil, Costa Rica e México obtiveram maior nível de adequação ao modelo proposto.

Palavras-chave: Contabilidade da Água. Contas Nacionais. SEEA-*Water*. Análise de Conteúdo.

ABSTRACT

Water accounts emerge to express their physical volume in the environment and the economy, as well as the economic aspect of water supply and use. Therefore, it enables public policymakers to make the most appropriate decisions for its management. So, the research objective is to analyse how different countries disclose their environmental and economic accounts for water. Therefore, a categorical analysis model of 120 categories was developed based on the SEEA-Water framework and analysed in 13 countries. The results highlight the high adherence to the physical water supply and use tables. It is interpreted as a "starting point" for compiling water accounts. Despite this, water emission accounts

have not been prioritised, possibly due to data unavailability. Both hybrid and asset accounts are in progress. Concerning the countries, Brazil, Mexico, and Costa Rica achieved the highest adequacy level for the proposed model.

Keywords: *Water Accounting. National Accounts. SEEA-Water. Content Analysis.*

1 INTRODUÇÃO

Bilhões de pessoas ainda vivem sem água potável e saneamento geridos de forma segura, embora ambos os serviços sejam reconhecidos como direitos humanos e denominadores comuns de desenvolvimento para moldar um futuro próspero (UN-Water, 2021; United Nations, 2023). Isso faz com que os níveis e a oscilação de quantidade e qualidade da água para garantir a sustentabilidade das nações sejam as questões globais mais prementes do século XXI, sendo motivo de grande preocupação em muitos países (Chalmers; Godfrey; Lynch, 2012; Chalmers; Godfrey; Potter, 2012).

Desse modo, assegurar a disponibilidade e gestão sustentável de água e saneamento para todos é um desafio que muitas economias já se propuseram a atingir ao adotarem o Objetivo de Desenvolvimento Sustentável 6. Todavia, existe uma preocupação se as atuais políticas de recursos hídricos serão suficientes para alcançar as metas ambiciosas propostas pela Agenda 2030 (World Water Forum, 2018), visto que é um dever principalmente para os governos (Ferrer *et al.*, 2022).

Por ser considerada um bem público, questões relacionadas à água envolvem a responsabilidade pública pelo seu uso, seu gerenciamento e sua proteção (Signori; Bodino, 2013)it gives an overview of Australian Standardised Water Accounting (SWA. E, sabendo que o gerenciamento de dados para suporte à decisão é um aspecto desafiador de qualquer processo de tomada de decisão, a gestão da água não é uma exceção (Torres López; Barrionuevo; Rodríguez-Labajos, 2019).

À vista disso, os dados sobre a água são base crítica no processo de gestão hídrica (Ferrer *et al.*, 2022; Pinto Filho; Rêgo; Lunes, 2019), tanto para basear as decisões quanto para medir o progresso das medidas adotadas (Dutta *et al.*, 2017). Sabendo que os tomadores de decisão contam com métodos da contabilidade econômica para o planejamento urbano e investimentos em infraestrutura (Tapsuwan *et al.*, 2021), um sistema de contabilidade da água é recomendado para organização dos dados hídricos (Bagheri; Babaeian, 2020). As contas de água fornecem, portanto, dados sobre o estoque e fluxo de água em termos físicos, monetários e qualitativos, além de produzirem indicadores que podem traduzir o desempenho dos recursos hídricos (Romeiro; Kuwahara, 2004).

Segundo Kilimani, Van Heerden e Bohlmann (2016), as contas da água são vitais para fornecer informações aos formuladores de políticas sobre o impacto das atuais políticas econômicas e dos padrões de crescimento sobre os recursos hídricos, tornando possível o julgamento se tais políticas são ou não sustentáveis. Como consequência, os sistemas de contas de água que registram e relatam dados relacionados ao recurso de maneira relevante, confiável, compreensível e comparável ganharam destaque (Chalmers; Godfrey; Potter, 2012). Sua natureza multidisciplinar promove a contribuição de diversas áreas além da contabilidade, incluindo engenharia, hidrologia, meteorologia, geografia e o direito (Christ; Burritt, 2018; Russell, 2021).

Desse modo, embora diferentes nações estejam desenvolvendo e publicando suas contas econômicas ambientais da água de forma diferente, existe um acordo geral sobre a estrutura e o escopo da contabilidade da água. Tal acordo é formalizado pela publicação do *System of Environmental and Economic Accounting for Water* (SEEA-*Water* – Sistema de Contas Econômicas Ambientais da Água) (Berger et al., 2018; United Nations, 2012).

O SEEA-*Water* fornece uma estrutura conceitual para organizar informações hidrológicas e econômicas de maneira coerente e consistente, e utiliza como marco básico o Sistema de Contas Nacionais (SCN). Portanto, quando implementadas de maneira adequada, as contas de água podem fornecer um conjunto básico de estatísticas confiáveis que são necessárias em um cenário de informações cada vez mais fragmentado (Bagstad *et al.*, 2020). Propicia, assim, um padrão para a compilação de estatísticas econômicas e a derivação de indicadores econômicos, permitindo a comparabilidade das contas compiladas nos países e entre eles (United Nations, 2012).

Todavia, incertezas e desafios limitam o avanço da estrutura em algumas jurisdições, resultantes do envolvimento insuficiente de alguns decisores políticos, da indisponibilidade de dados e da necessidade de ajustar as contas às especificidades de cada região (Cavalletti; Corsi, 2022). Posto isso, reconhecendo os desafios que permeiam o avanço das contas de água, o presente estudo objetiva analisar como diferentes países evidenciam suas contas econômicas ambientais da água. Para isso, são analisados os países que já compilaram suas contas econômicas ambientais da água baseadas na metodologia SEEA-*Water*.

A pesquisa se justifica, portanto, pelos benefícios da compilação das contas econômicas ambientais da água, reconhecidos pelos países que já a fizeram. Em Botsuana, por exemplo, observou-se que a implementação das contas econômicas ambientais da água tornou-se crítica para o alcance do desenvolvimento sustentável e crescimento econômico do país (Setlhogile; Arntzen; Pule, 2017) self-providers (mines and the agricultural sector. No México, com essa implementação, o governo promoveu diferentes programas para o uso mais eficiente do recurso, além de identificar um aumento na produtividade da água desde a sua primeira compilação até sua versão mais recente. Na China, ainda, problemas técnicos e metodológicos do gerenciamento dos recursos hídricos foram superados com a aplicação do SEEA-Water, visto que havia uma fragmentação de agências responsáveis pela coleta e evidenciação dos dados (Gan *et al.*, 2012).

2 CONTABILIDADE DA ÁGUA

A contabilidade tem seu papel reconhecido como ciência social por sua prestação de contas afetar diretamente os aspectos qualitativos das relações humanas e sociais, e interagir com os aspectos quantitativos de medição e mediação (Coliath, 2014). Desse modo, reconhecer a contabilidade, além do enfoque de riqueza e renda, promove a conscientização das oportunidades de utilizar os conhecimentos contábeis e moldar um sistema a partir de contribuições e foco regulador dos contadores (Chalmers; Godfrey; Lynch, 2012). Pela contabilidade dos recursos naturais, a abordagem contábil adiciona capacidade analítica às estatísticas básicas, podendo refletir com mais precisão as diferenças dos recursos naturais, em diferentes períodos e obter o efeito de sua medição (Yang *et al.*, 2021).

Sendo as questões relacionadas ao acesso e à gestão da água uma das preocupações econômicas, sociais e ambientais mais enfrentadas atualmente, as implicações associadas ao risco e valor da água tornam-se cada vez mais reconhecidas pela profissão contábil (Christ, 2014). Posto isso, o *Water Accounting Standards Board* (2014) define a contabilidade da água como processo sistemático de identificação, reconhecimento, quantificação, relato e garantia de informações sobre a água, os direitos ou outras reivindicações, além das obrigações contra esse recurso.

Todavia, segundo Christ e Burritt (2018), esse agregado de informações relativas à água faz com que a contabilidade desta apresente fortes características transdisciplinares. Sua colaboração interage entre, por meio e além de diferentes disciplinas, como a engenharia, contabilidade, hidrologia, meteorologia, geografia e o direito. De acordo com Russell (2021), ao refletir a natureza multidisciplinar das questões hídricas, uma série de profissionais de diferentes áreas podem colaborar para o desenvolvimento de políticas e práticas que promovam a preservação do recurso.

Por conseguinte, metodologias padronizadas de contabilidade da água estão sendo desenvolvidas para diferentes níveis geográficos e organizacionais, objetivando aumentar a qualidade e a credibilidade das informações disponíveis para os diversos usuários. Assim, padrões de contabilidade da água em nível macroeconômico podem servir ao interesse público, visto que a qualidade e a credibilidade das informações disponíveis aos *stakeholders* aumentam. A partir das contas da água, as decisões tomadas podem afetar a transferência de recursos, o crescimento econômico e a proteção ambiental (Chalmers; Godfrey; Lynch, 2012). Com a ajuda da regulação macroeconômica e controle da economia de mercado, a alocação ideal de recursos hídricos sob o uso de contas da água promoverá seu uso sustentável e o desenvolvimento sustentável da economia social (Sun *et al.*, 2017).

É por esse motivo que diferentes estruturas de contabilidade da água foram sugeridas para organizar os dados hidrológicos em combinação com os dados econômicos de uma maneira integrada para fornecer uma plataforma para avaliação dos sistemas de recursos hídricos (Bagheri; Babaeian, 2020). Todavia, embora perceba-se a existência de metodologias, como a holandesa *National Accounting Matrix including Water Accounts* e a australiana *Australian Water Accounting Standards*, os dados físicos e econômicos sobre a água em muitas nações estão se tornando mais amplamente integrados por meio da aplicação do SEEA-*Water* (Bagstad et al., 2020).

2.1 SISTEMA DE CONTAS ECONÔMICAS AMBIENTAIS DA ÁGUA (SEEA-*WATER*)

Embora o SCN seja um sistema padrão estatístico econômico universal que fornece uma análise econômica eficaz para os tomadores de decisão, este não englobava conceitos advindos da preocupação com o desenvolvimento sustentável. Desse modo, em 1993, a ONU e o Banco Mundial lançaram o primeiro *System of Environmental and Economic Accounting* (SEEA – Sistema de Contas Econômicas Ambientais) para auxiliar o SCN (Sun et al., 2017). O SEEA foi desenvolvido pela comunidade estatística em colaboração com ecologistas, economistas e outros cientistas para oferecer aos países uma estrutura para compilar estatísticas sobre o meio ambiente e os recursos naturais (Esen; Hein, 2020) water resources are increasingly under pressure. The Water accounting approach of the System of Environmental-Economic Accounting (SEEA.

Embora os desenvolvimentos anteriores englobavam uma variedade de contas de caráter ambiental, como o SEEA – *Central Framework*, surgiu a necessidade de se criar uma metodologia mais detalhada para tratar especialmente dos recursos hídricos. À vista disso, entre 2004 e 2007, o SEEA-Water foi criado. Essa metodologia surge em um esforço para harmonizar o relatório de água de países, que até então haviam se desenvolvido de maneira ad hoc (Vardon *et al.*, 2012). Utilizam-se, portanto, dos princípios contábeis em relação ao valor das formas de capital e em termos físicos, desenvolvendo dados mais coerentes sobre o meio ambiente e facilitando a integração desses com informações econômicas (Obst, 2015). Ainda, define uma série de identidades contábeis para permitir comparações consistentes entre áreas e ao longo do tempo (Vardon *et al.*, 2012).

Em 2012, a ONU publicou a última versão do SEEA-*Water*, a qual fornece uma estrutura conceitual cuja função é organizar informações hidrológicas e econômicas de maneira coerente e consistente, sob a qual o fluxo de água do meio ambiente para a economia, dentro da economia e da economia de volta ao meio ambiente pode ser organizado de uma maneira sistemática compatível com o SCN. Salienta-se que esse sistema de contas satélites também apresenta princípios que permitem organizar dados sobre os estoques ou ativos de água, a reutilização desta e vários itens financeiros relacionados ao abastecimento de água e saneamento (Tello; Hazelton, 2018; United Nations, 2012). Mais especificamente, a ferramenta propõe a subdivisão das contas da água em quatro "demonstrativos hídricos" – Tabelas Físicas de Fornecimento e Uso da Água, Contas de Emissões na Água, Contas Híbridas e Contas de Ativos Hídricos.

3 PROCEDIMENTOS METODOLÓGICOS

Para o desenvolvimento da pesquisa, foram analisados os países que já compilaram suas contas econômicas ambientais da água a partir do SEEA-*Water* (United Nations, 2012). Desse modo, atenderam ao critério estabelecido: Armênia, Austrália, Botsuana, Brasil, Colômbia, Costa Rica, Fiji, Holanda, Ilhas Maurício, México, Ruanda, Uganda e Zâmbia.

Para que o reconhecimento desses 13 países fosse possível, foi utilizado, inicialmente, o documento do *Statistics South Africa* (2017) e o endereço eletrônico do WAVES – *Wealth Accounting and the Valuation of Ecosystem Services* (2021). Totalizam-se, assim, 29 países inicialmente analisados.

A partir disso, foi feita a coleta das contas econômicas ambientais da água desses 29 países, realizada por três fontes de informação: o endereço eletrônico do Waves (2021); os endereços eletrônicos das agências estatísticas nacionais responsáveis pela compilação das contas em cada país; e, quando não encontradas, *e-mails* encaminhados para essas agências.

Com base nas respostas e nos levantamentos previamente realizados dos 29 países analisados, 13 atendem aos critérios estabelecidos e formam a amostra desta pesquisa. Os 16 restantes foram excluídos por não adotarem a metodologia SEEA-*Water* (adotando apenas o SEEA-*Central Framework*, ou outra metodologia não correspondente), ou por não disponibilizarem, publicamente ou por e-mail, suas contas da água.

Quanto ao recorte temporal, para cada caso, buscamos analisar a compilação de contas mais recentes. Considerando que o levantamento foi realizado em 2021, encontramos publicações entre os períodos de 2017 a 2020, embora as publicações remetem informações retroativas.

Como método de análise de dados, foi empregada a técnica de análise categorial. De acordo com Bardin (2010, p. 199), esta "funciona por operações de desmembramento do texto em unidades, em categorias segundo reagrupamentos analógicos". Gray (2016) ressalta que ela trata de fazer inferências sobre os dados da pesquisa, identificando de forma sistemática e objetiva características especiais (classes ou categorias) entre eles.

À vista disso, Bardin (2010) retrata algumas qualidades para garantir que boas categorias sejam desenvolvidas: exclusão mútua; homogeneidade; pertinência; objetividade e fidelidade; e produtividade. Respeitando essas qualidades, é organizado um modelo de análise categorial baseado no SEEA-*Water* (United Nations, 2012) a partir das quatro grandes categorias: (i) tabelas físicas de fornecimento e uso da água; (ii) contas de emissões na água; (iii) contas híbridas; e (iv) contas de ativos hídricos. O Quadro 1 apresenta o modelo proposto embasado no SEEA-*Water* (United Nations, 2012), com 120 categorias elencadas. As diferentes cores entre as contas servem para organizar a análise na próxima seção.

Quadro 1 – Categorias da Análise de Conteúdo

1. Tabelas físicas de abastecimento e uso da água		08	Coleta de água da chuva
1.1 Fluxo do meio ambiente para a economia		09	Retirada de outros recursos hídricos
01	Retirada para atendimento próprio	10	Retirada total de água para a economia
02	Retirada para distribuição	**1.1.1 Itens suplementares**	
03	Retirada de recursos hídricos interiores	11	Retirada para geração de energia hidrelétrica
04	Retirada de águas superficiais	12	Retirada para irrigação
05	Retirada de águas subterrâneas	13	Retirada de água de mina
06	Retirada de água do solo	14	Retirada por escoamento urbano
07	Retirada de água do mar	15	Retirada de água de resfriamento

1.2 Fluxo dentro da economia		54	Emissão bruta de poluentes
1.2.1 Composição das atividades econômicas		55	Emissão de poluentes pelas atividades econômicas
16	Agricultura, silvicultura e pesca	56	Emissão de poluentes liberados pelas famílias
17	Mineração e pedreiras, manufatura e construção	57	Emissões diretas na água
18	Fornecimento de eletricidade, gás e vapor	58	Emissões diretas após tratamento
19	Captação, tratamento e abastecimento de água	59	Emissões diretas antes do tratamento
20	Sistema de esgoto	60	Emissões diretas nos recursos hídricos
21	Atividades econômicas de serviços	61	Emissões diretas no mar
1.2.2 Água recebida de outras unidades econômicas		62	Emissões para o sistema de esgoto
22	Uso de água de outras unidades econômicas	**2.2 Emissões de poluentes pelo sistema de esgoto**	
23	Água reutilizada de outras unidades econômicas	63	Emissões após tratamento
24	Águas residuais de esgoto de outras economias	64	Emissões antes do tratamento
25	Águas dessalinizadas de outras economias	65	Emissões para os recursos hídricos
26	Atividades econômicas consumidoras	66	Emissões para o mar
27	Famílias consumidoras	**2.3 Itens suplementares**	
28	Exportação	67	Conteúdo dos poluentes
1.2.3 Água fornecida para outras unidades econômicas		68	Volume de iodo gerado pelo sistema de esgoto
29	Fornecimento de água para outras economias	69	Pessoas com acesso a saneamento adequado
30	Água reutilizada fornecida para outras economias	**3. Contas híbridas**	
31	Águas residuais de esgoto para outras economias	**3.1 Informações monetárias**	
32	Águas dessalinizadas para outras economias	70	Produção e fornecimento total de água
33	Atividades econômicas fornecedoras	71	Produção e fornecimento de água de distribuição
34	Famílias fornecedoras	72	Produção e fornecimento de serviços de esgoto
35	Importação	73	Produção de água pelas atividades econômicas
1.3 Fluxo da economia para o meio ambiente		74	Importações
36	Retorno para recursos hídricos interiores	75	Impostos
37	Retorno para RHI – águas superficiais	76	Consumo e uso intermediário total
38	Retorno para RHI – águas subterrâneas	77	Consumo e uso interm. de água de distribuição
39	Retorno para RHI – água do solo	78	Consumo e uso intermediário de serviços de esgoto
40	Retorno para outros tipos de recursos	79	Consumo intermediário das atividades econômicas
41	Retorno para água do mar	80	Consumo final pelas famílias
42	Retorno total de água para o meio ambiente	81	Consumo final pelo governo
1.3.1 Itens suplementares		82	Formação de capital
43	Retorno de geração de energia hidrelétrica	83	Exportações
44	Retorno de irrigação	**3.2 Informações físicas**	
45	Retorno de água de mina	84	Fornecimento total de água
46	Retorno de escoamento urbano	85	Fornecimento de água para outras economias
47	Retorno de água de resfriamento	86	Fornecimento de águas residuais para esgoto
48	Retorno de águas residuais tratadas	87	Retornos totais
49	Perdas devido a vazamentos	88	Fornecimento pelas atividades econômicas
1.4 Consumo de água		89	Fornecimento pelas famílias
50	Consumo de água por toda economia	90	Importações
51	Consumo de água pelas atividades econômicas	91	Uso total de água
52	Consumo de água pelas famílias	92	Retirada total
53	Perdas não causadas por vazamentos	93	Retirada para atendimento próprio
2. Contas de emissões na água		94	Uso de água de outras economias
2.1 Emissões de poluentes pelas unidades econômicas		95	Consumo intermediário das atividades econômicas

96	Consumo final pelas famílias	108	Evaporação/evapotranspiração real
97	Exportações	109	Saídas
98	Emissão total de poluentes	110	Saídas para territórios a jusante
4. Contas de ativos hídricos		111	Saídas para o mar
99	Estoque de abertura	112	Saídas para outros recursos no território
100	Aumento no estoque	113	Estoque final
101	Retornos	114	Águas superficiais
102	Precipitação	115	Águas superficiais – reservatórios artificiais
103	Entradas	116	Águas superficiais – lagos
104	Entradas de outros territórios a montante	117	Águas superficiais – rios
105	Entrada de outros recursos no território	118	Águas superficiais – neve, gelo e geleiras
106	Diminuição no estoque	119	Águas subterrâneas
107	Retiradas	120	Água do solo

Fonte: Elaborado pelos autores com base no SEEA-Water (United Nations, 2012).

4 APRESENTAÇÃO E ANÁLISE DOS RESULTADOS

Para expor a evidenciação ou não de determinada categoria, em determinado país, as matrizes apresentadas neste capítulo têm seu espaço correspondente (conta da água "x" e país "y") grifado em verde, para caso haja a evidenciação, e em vermelho, caso não haja evidenciação da categoria. Ademais, as contas expressas na coluna esquerda estão representadas por distintas cores, em conformidade com sua categorização apresentada no Quadro 1, da seção anterior. Nas extremidades direita e inferior, respectivamente, logo após o valor total, existe a porcentagem do total de países que evidenciam cada conta (coluna direita) e o total de contas evidenciadas por cada país (linha inferior). Estas são apresentadas com gradientes de cores do vermelho ao verde para facilitar a visualização das dezenas percentuais que representam a evidenciação. Quanto mais próximo do vermelho, menor evidenciação, e quanto mais próximo do verde, maior evidenciação.

4.1 TABELAS FÍSICAS DE FORNECIMENTO E USO DA ÁGUA

Tabelas físicas de fornecimento e uso da água (TFFUA) pretendem demonstrar o fluxo de água desde sua retirada inicial do meio ambiente pela economia, seu fornecimento e uso dentro da economia, até seu retorno final de volta ao meio ambiente, com todas as entradas sendo expressas em termos quantitativos (United Nations, 2012). Desse modo, optou-se por separá-las em blocos que reflitam esses fluxos. A Matriz 1 ilustra os resultados observados quanto à evidenciação.

Matriz 1 – Tabelas Físicas de Fornecimento e Uso da Água

	Armênia	*Austrália*	*Botsuana*	*Brasil*	*Colômbia*	*Costa Rica*	*Fiji*	*Holanda*	*Ilhas Maurício*	*México*	*Ruanda*	*Uganda*	*Zâmbia*	*Total Países*	*%*
1														10	77%
2														10	77%
3														6	46%
4														13	100%
5														13	100%
6														6	46%

	Armênia	Austrália	Botsuana	Brasil	Colômbia	Costa Rica	Fiji	Holanda	Ilhas Maurício	México	Ruanda	Uganda	Zâmbia	Total Países	%
7														8	62%
8														9	69%
9														5	38%
10														11	85%
11														6	46%
12														4	31%
13														3	23%
14														0	0%
15														1	8%
16														12	92%
17														12	92%
18														12	92%
19														13	100%
20														10	77%
21														9	69%
22														11	85%
23														6	46%
24														6	46%
25														1	8%
26														13	100%
27														13	100%
28														7	54%
29														11	85%
30														10	77%
31														11	85%
32														2	15%
33														13	100%
34														13	100%
35														7	54%
36														9	69%
37														10	77%
38														9	69%
39														7	54%
40														6	46%
41														6	46%
42														13	100%
43														5	38%
44														3	23%
45														2	15%
46														0	0%

	Armênia	Austrália	Botsuana	Brasil	Colômbia	Costa Rica	Fiji	Holanda	Ilhas Maurício	México	Ruanda	Uganda	Zâmbia	Total Países	%
47														1	8%
48														3	23%
49														7	54%
50														9	69%
51														9	69%
52														11	85%
53														8	62%
Total	**26**	**35**	**35**	**40**	**36**	**36**	**32**	**29**	**29**	**33**	**36**	**30**	**18**	**415**	
%	49%	66%	66%	75%	68%	68%	60%	55%	55%	62%	68%	57%	34%	60%	

Legenda:

Cores das contas de água (1ª coluna): Vide categorias no Quadro 1

Matriz "x" (conta da água) por "y" (países): Não evidenciada | Evidenciada

Gradiente de cores das porcentagens: 0% — 100%

Fonte: Elaborada pelos autores (2023).

Inicialmente, para compreender o fluxo do meio ambiente para economia, é essencial que sejam disponibilizadas informações das retiradas realizadas nos recursos hídricos objetivando a distribuição. Desse modo, percebe-se que todos os países analisados compilaram contas que demonstram as retiradas de águas superficiais e águas subterrâneas (04 e 05) no território.

Na conta "retirada de águas superficiais", Ruanda optou por subdividi-la de acordo com os recursos hídricos em questão. Para isso, contas de lagos, rios e reservatórios foram adicionadas. De acordo com o SEEA-*Water*, as TFFUA podem ser compiladas em vários níveis de detalhes, dependendo da preocupação política de um país e da disponibilidade de dados (United Nations, 2012).

A partir de uma análise dos relatórios das contas de água, discrepâncias a respeito da importância atribuída a cada recurso hídrico em territórios distintos foram observadas. Um exemplo é relacionado às águas subterrâneas. Em Ruanda, as famílias retiram mais de duas vezes o volume captado por agências de abastecimento de água, de fontes como águas subterrâneas, visto que o fornecimento pelas agências é limitado (Government of Rwanda, 2019). Já na Holanda as retiradas de águas subterrâneas são limitadas no país, visto que seu impacto é considerado grave, inclusive levando a situações de estresse hídrico (Statistics Netherlands, 2017). Na Costa Rica, devido a uma superexploração dos poços, há problemas como a intrusão salina nas águas subterrâneas, fazendo com que surgissem iniciativas para dessalinizar a água do mar (Banco Central de Costa Rica, 2019).

Quanto às contas de retirada de água para a geração de energia hidrelétrica (11), evidenciada por 46% dos países, estas costumam refletir suas realidades energéticas. Países como o Brasil, a Costa Rica e Ruanda comentam sobre essa retirada ser um dos motivos para o setor de energia usar o maior volume de água entre as atividades econômicas.

Por fim, na formulação das categorias, foi classificada como "exportação" a água recebida pelo restante do mundo e como "importação" a água fornecida. No caso de Botsuana, por exemplo, existe importação de água proveniente da África do Sul, por meio da Barragem de Molatedi (Republic of Botswana, 2017).

Quanto ao fluxo da economia para o meio ambiente, considera-se "fornecedora" a unidade econômica responsável pela descarga (indústrias, famílias e restante do mundo), enquanto o "destino" desses fluxos é o meio ambiente (United Nations, 2012). Pela análise, nota-se que todos os países evidenciaram ao menos o retorno total de água para o meio ambiente. Porém, quando existe uma desagregação dessa conta "título" entre os recursos, o comportamento se altera de acordo com a realidade de cada país. Como exemplo, considerando o retorno para a água do mar (41), quatro dos países que não evidenciam e não se situam em regiões litorâneas para justificar tal retorno – Armênia, Botswana, Uganda e Zâmbia.

Quanto à conta de "retorno de água de resfriamento" (47), esta é apresentada apenas pela Holanda. Em seu relatório é comentado que, mesmo havendo grandes volumes de retirada de água para resfriamento, após o seu uso o fluxo geralmente retorna ao meio ambiente (Statistics Netherlands, 2017). Esse tipo de fluxo pode ser denominado de uso não consuntivo, ou seja, quando a água é utilizada por um processo econômico, e retorna quase que integralmente ao meio ambiente, sem alterações físicas ou químicas significativas (Banco Central de Costa Rica, 2019; IBGE, 2018; Inegi, 2019).

Com um nível de evidenciação um pouco maior (54%), a conta de "perdas devido a vazamentos" (49) foi observada em sete países. Entre eles, a Ruanda comenta que esses vazamentos são causados, em grande parte, pela infraestrutura de abastecimento de água existente ser antiga e danificada, com manutenção deficiente e avarias gerais (Government of Rwanda, 2019). Já as "perdas na distribuição não causadas por vazamentos" (53), são as perdas que não retornam diretamente aos recursos hídricos. Entre elas, pode-se citar: perdas com evaporação (México); erros no medidor (Costa Rica); ineficiência na cobrança (Botsuana); uso ilegal dos recursos hídricos (Costa Rica); perdas no processo de purificação (Fiji); e incorporação da água nos produtos (Uganda).

4.2 CONTAS DE EMISSÕES NA ÁGUA

Dando sequência às TFFUA, a segunda seção de categorias aborda as contas de emissões na água. Como pode ser observado na Matriz 2, apenas dois países (15%) evidenciaram informações relacionadas a elas – Costa Rica e México.

Matriz 2 – Contas de Emissões na Água

	Armênia	*Austrália*	*Botsuana*	*Brasil*	*Colômbia*	*Costa Rica*	*Fiji*	*Holanda*	*Ilhas Maurício*	*México*	*Ruanda*	*Uganda*	*Zâmbia*	*Total Países*	*%*
54										■				1	8%
55						■				■				2	15%
56														0	0%
57						■								1	8%
58														0	0%
59														0	0%
60														0	0%
61														0	0%
62						■								1	8%

	Armênia	Austrália	Botsuana	Brasil	Colômbia	Costa Rica	Fiji	Holanda	Ilhas Maurício	México	Ruanda	Uganda	Zâmbia	Total Países	%
63														1	8%
64														0	0%
65														0	0%
66														0	0%
67														0	0%
68														0	0%
69														1	8%
Total	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**7**	
%	0%	0%	0%	0%	0%	31%	0%	0%	0%	13%	0%	0%	0%	3%	

Legenda:

Cores das contas de água (1ª coluna): Vide categorias no Quadro 1

Matriz "x" (conta da água) por "y" (países): Não evidenciada | Evidenciada

Gradiente de cores das porcentagens: 0% ... 100%

Fonte: Elaborada pelos autores (2023).

Percebe-se que a única conta evidenciada em comum pelos dois países é a de "emissão de poluentes liberados pelas atividades econômicas" (55). No caso do México, o país comenta em seu relatório que a compilação desta surgiu a partir de informações disponíveis da emissão de toneladas de demanda bioquímica de oxigênio (DBO) do setor de indústria e serviços.

Ainda sobre essa conta, a Costa Rica detém uma legislação que facilita a compilação desses dados. De acordo com um regulamento do país, qualquer entidade geradora que descarte águas residuais no esgoto sanitário tem a obrigação de apresentar um relatório operacional ao Ministério da Saúde, indicando o fluxo descarregado e parâmetros resultantes de uma análise laboratorial (Banco Central de Costa Rica, 2019). Por fim, ao observar a conta de "pessoas com acesso a saneamento adequado" (69) na Costa Rica, percebe-se que, em 2016, 99,60% da população fazia uso de saneamento adequado.

Embora sejam reconhecidas as dificuldades de se compilar contas de emissões na água, espera-se que um número maior de países inicie o seu desenvolvimento. Estas são um diferencial do SEEA-*Water*, preenchendo essa lacuna advinda do SEEA-*Central Framework*. Assim, as contas de emissão constituem uma ferramenta útil para projetar instrumentos econômicos, incluindo novos regulamentos destinados a reduzir as emissões na água (United Nations, 2012).

4.3 CONTAS HÍBRIDAS

A evidenciação das contas híbridas é apresentada na Matriz 3. Contas híbridas são aquelas que apresentam informações monetárias (categorias em amarelo) e físicas (categorias em laranja) sobre o fornecimento e uso de água (United Nations, 2012).

Matriz 3 – Contas Híbridas

	Armênia	Austrália	Botsuana	Brasil	Colômbia	Costa Rica	Fiji	Holanda	Ilhas Maurício	México	Ruanda	Uganda	Zâmbia	Total Países	%
70														6	46%
71														5	38%
72														5	38%
73														4	31%
74														3	23%
75														4	31%
76														6	46%
77														6	46%
78														5	38%
79														6	46%
80														6	46%
81														3	23%
82														4	31%
83														3	23%
84														5	38%
85														3	23%
86														3	23%
87														4	31%
88														4	31%
89														3	23%
90														3	23%
91														5	38%
92														5	38%
93														4	31%
94														3	23%
95														5	38%
96														5	38%
97														3	23%
98														1	8%
Total	**28**	**18**	**0**	**27**	**0**	**13**	**0**	**0**	**0**	**28**	**0**	**0**	**8**	**122**	
%	97%	62%	0%	93%	0%	45%	0%	0%	0%	97%	0%	0%	28%	32%	

Legenda:

Cores das contas de água (1ª coluna): Vide categorias no Quadro 1

Matriz "x" (conta da água) por "y" (países): Não evidenciada | Evidenciada

Gradiente de cores das porcentagens: 0% — 100%

Fonte: Elaborada pelos autores (2023).

Em relação às contas híbridas, evidenciadas por seis países, a Armênia, o Brasil e o México as divulgam quase que em sua totalidade. A Austrália e a Costa Rica também apresentaram contas híbridas, porém

com um formato não tão condizente com a metodologia SEEA-*Water*, influenciando seu nível de evidenciação. Já a Zâmbia optou por evidenciar apenas as contas monetárias, deixando suas contas físicas apenas nas TFFUA.

Quanto à compilação dos agentes fornecedores e/ou usuários dos serviços relacionados à água, as atividades econômicas compõem as contas híbridas na maioria dos países. A Austrália é uma exceção pela não apresentação da conta "produção de água pelas atividades econômicas"; porém o país justifica a sua omissão alegando que faltam dados confiáveis para gerar as estimativas adequadas, visto que é elevado o número de empresas que retiram água para uso próprio (Australian Bureau of Statistics, 2019).

As famílias também são figuras presentes nas contas híbridas. Na Armênia e no México, existe uma desagregação da conta "famílias" em "consumo final" e "transferências sociais do governo". Isso ocorre porque os serviços de água não são adquiridos diretamente pelas famílias, mas são fornecidos gratuitamente, ou quase gratuitamente, pelo governo e pelas instituições sem fins lucrativos (Inegi, 2019). Assim, existe outro agente usuário dos serviços de água, o governo (81). Todavia, apenas a Armênia, o Brasil e o México fazem uso dessa categoria.

4.4 ATIVOS HÍDRICOS

Quanto aos estoques, ou contas de ativos hídricos, a Matriz 4 resume essa evidenciação. Percebe-se que apenas cinco países (45,45%) evidenciam tais contas – Brasil, Costa Rica, Holanda, Ilhas Maurício e Ruanda. Destes, é notável que a estrutura-base do SEEA-*Water*, ou das categorias em questão, é respeitada por todos. O que modifica o nível de evidenciação de cada país é o nível de desagregação de determinada informação.

Matriz 4 – Ativos Hídricos

	Armênia	*Austrália*	*Botsuana*	*Brasil*	*Colômbia*	*Costa Rica*	*Fiji*	*Holanda*	*Ilhas Maurício*	*México*	*Ruanda*	*Uganda*	*Zâmbia*	*Total Países*	*%*
99														5	38%
100														5	38%
101														5	38%
102														5	38%
103														2	15%
104														5	38%
105														5	38%
106														5	38%
107														5	38%
108														5	38%
109														2	15%
110														5	38%
111														5	38%
112														5	38%
113														5	38%
114														5	38%
115														3	23%

	Armênia	Austrália	Botsuana	Brasil	Colômbia	Costa Rica	Fiji	Holanda	Ilhas Maurício	México	Ruanda	Uganda	Zâmbia	Total Países	%
116														3	23%
117														3	23%
118														0	0%
119														5	38%
120														5	38%
Total	**0**	**0**	**0**	**21**	**0**	**16**	**0**	**18**	**19**	**0**	**19**	**0**	**0**	**93**	
%	0%	0%	0%	95%	0%	73%	0%	82%	86%	0%	86%	0%	0%	33%	

Legenda:

Cores das contas de água (1ª coluna): Vide categorias no Quadro 1

Matriz "x" (conta da água) por "y" (países): Não evidenciada | Evidenciada

Gradiente de cores das porcentagens: 0% 100%

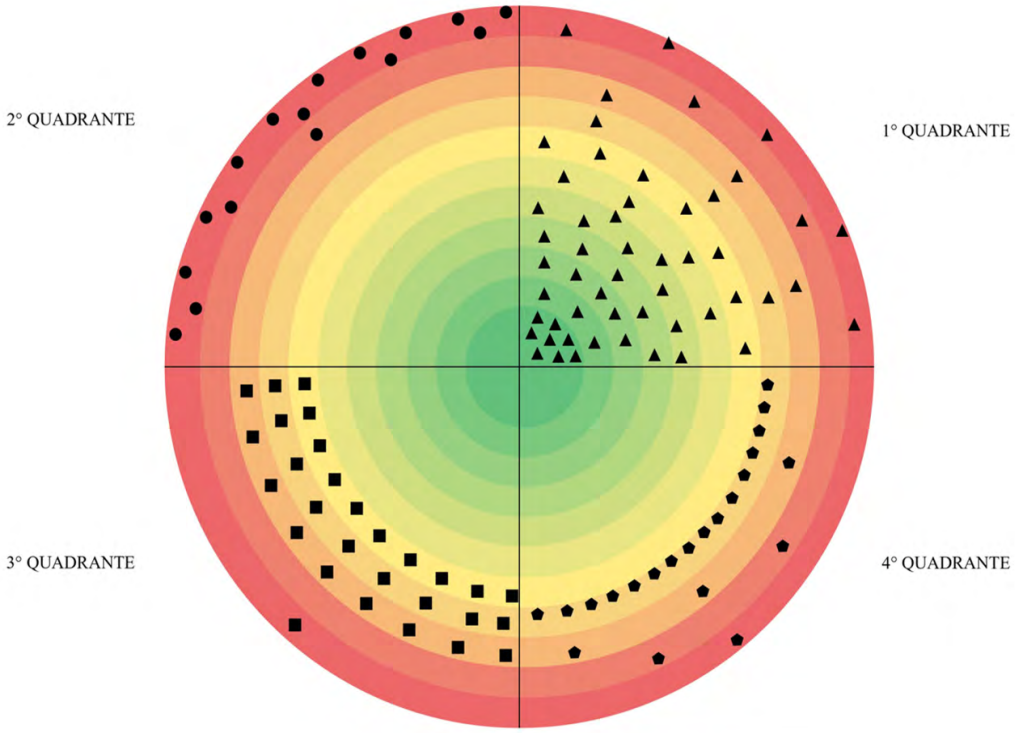
Fonte: Elaborada pelos autores (2023).

Quanto à desagregação das contas de águas superficiais em reservatórios artificiais, lagos e rios (115, 116 e 117), por exemplo, ressalta-se a dificuldade de mensurar separadamente tais recursos hídricos. Mesmo havendo apresentado a desagregação das contas de águas superficiais, Ruanda sinalizou essa dificuldade com limites entre as classificações nem sempre precisos.

Sobrepondo a dificuldade de mensuração, pode não haver evidenciação de contas que não condizem com o contexto do país. Esse é o caso da conta "águas superficiais – neve, gelo e geleiras" (118) não evidenciada por nenhum país da amostra, já que a maioria dos países em questão é caracterizada por um clima que não condiz com a presença desses recursos.

4.5 ANÁLISE GERAL

Após a análise específica das categorias evidenciadas, a presente seção se propõe a fornecer uma visualização mais ampla dos níveis de evidenciação. Por esse motivo, a Figura 1 resume a porcentagem de países que evidenciaram cada uma das 120 categorias determinadas. O primeiro quadrante demonstra o nível de evidenciação das 53 categorias das TFFUA; o segundo, as 16 contas de emissões na água; o terceiro quadrante, 29 contas híbridas; e o quarto, 22 contas de ativos hídricos. Além disso, sabendo que cada ponto representa uma das 120 categorias, quanto mais próximo da circunferência encontra-se esse ponto, menos aquela categoria foi evidenciada. No mesmo sentido, quanto mais o ponto se aproxima do centro, melhor o seu nível de adoção pelos países.



Legenda:

1º Quadrante: Tabelas Físicas de Fornecimento e Uso da Água

2º Quadrante: Contas de Emissões na Água

3º Quadrante: Contas Híbridas

4º Quadrante: Contas de Ativos Hídricos

Gradiente de cores da evidenciação: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Figura 1 – Evidenciação das Categorias Propostas

Fonte: Elaborada pelos autores (2023).

A partir da figura, nota-se uma maior aderência dos países nas TFFUA, com um nível de evidenciação de, no mínimo, 50% para a maioria das suas contas. Essa é a única grande categoria a deter um número expressivo de aderência entre os países. Ainda, percebe-se que os países fazem uso dessas categorias como "ponto de partida" para a compilação de contas da água.

Contudo, pela análise das contas de emissões na água, o comportamento se distingue. Com níveis de evidenciação que não ultrapassam a casa dos 20%, este não parece ter sido priorizado pelos países. A indisponibilidade de dados necessários para realizar a devida compilação é a justificativa apresentada por alguns países.

Por fim, percebe-se um comportamento semelhante entre a evidenciação das contas híbridas e das contas de ativos hídricos. Ambas as suas categorias se encontram em um período inicial de desenvolvimento. Além disso, essas grandes categorias dispõem de algumas contas cujas informações são derivadas das TFFUA, reiterando a importância da compilação destas últimas e justificando a maior disponibilidade de dados evidenciados.

Outra análise abrangente para complementar a análise categorial desenvolvida é apresentada na Matriz 5, que retoma o nível de evidenciação de cada uma das quatro grandes categorias desenvolvidas, adicionando o nível de evidenciação total dos países analisados.

Matriz 5 – Análise Conjunta das Categorias

	Armênia	*Austrália*	*Botsuana*	*Brasil*	*Colômbia*	*Costa Rica*	*Fiji*	*Holanda*	*Ilhas Maurício*	*México*	*Ruanda*	*Uganda*	*Zâmbia*	*Total*
TFFUA	49%	66%	66%	75%	68%	68%	60%	55%	55%	62%	68%	57%	34%	60%
Emissões	0%	0%	0%	0%	0%	31%	0%	0%	0%	13%	0%	0%	0%	3%
Híbridas	97%	62%	0%	93%	0%	45%	0%	0%	0%	97%	0%	0%	28%	32%
Estoque	0%	0%	0%	95%	0%	73%	0%	82%	86%	0%	86%	0%	0%	33%
Total	**45%**	**44%**	**29%**	**73%**	**30%**	**58%**	**27%**	**39%**	**40%**	**53%**	**46%**	**25%**	**22%**	

Legenda:

TFFUA: Tabelas Físicas de Fornecimento e Uso da Água

Emissões: Contas de Emissões na Água

Híbridas: Contas Híbridas

Estoque: Contas de Ativos Hídricos

Gradiente de cores das porcentagens: 0% 100%

Fonte: Elaborada pelos autores (2023).

A partir desses dados, é possível reconhecer o Brasil como país que mais evidenciou as contas de água seguindo o modelo de categorias proposto (73%). Embora não tenha compilado contas de emissões na água, é reconhecido seu alto nível de adequação, principalmente nas contas híbridas e ativos hídricos. Na sequência, observamos a Costa Rica (58%) como país em destaque, seguida do México (53%).

Já no caso da Costa Rica, este foi o único país a evidenciar informações relacionadas às quatro grandes categorias de análise; porém não expôs um aprofundamento em nenhuma delas.

O México, por sua vez, destacou-se no nível de evidenciação das contas híbridas, com 97% de alinhamento. Contudo, contas de ativos hídricos não foram apresentadas e evidenciou apenas 13% das contas de emissões na água.

Zâmbia, Uganda, Fiji, Botswana e Colômbia, nesta ordem, foram os países que se mostraram menos engajados com as contas da água. Esses, com exceção da Zâmbia, foram os únicos a evidenciar informações em apenas um grupo de categorias – TFFUA. Zâmbia, embora tenha apresentado algumas contas híbridas (apenas monetárias), teve pequeno engajamento às contas da água, com 22% de evidenciação. Todavia, deve-se ressaltar que o país destaca em seu relatório que essa é uma apresentação preliminar de suas contas da água. Posto isso, desenvolvimentos futuros devem demonstrar maior engajamento entre esses países e novos aderentes ao SEEA-*Water*.

5 CONSIDERAÇÕES FINAIS

A presente pesquisa se propôs a analisar como diferentes países evidenciam suas contas econômicas ambientais da água respaldados na metodologia SEEA-*Water*. A pesquisa emprega, portanto, análise categorial abarcando 120 categorias, subdivididas em: TFFUA, contas de emissões na água, contas híbridas e contas de ativos hídricos.

À vista disso, percebeu-se que as TFFUA costumam ser as primeiras informações evidenciadas pelos países que desenvolvem contas da água, visto que o nível de aderência a essas é expressivo. E, contrapondo essa observação, as contas de emissões na água foram as menos evidenciadas. A indisponibilidade e a dificuldade para obter dados dessas contas são algumas das justificativas elencadas por aqueles que não as divulgam.

Quanto ao nível de evidenciação das contas híbridas e das contas de ativos hídricos, percebe-se uma taxa similar entre os países. Com cerca de metade dos países apresentando algumas dessas contas, estas parecem estar em fase de desenvolvimento. Tal comportamento é observado pelo interesse de futuras compilações elencadas por alguns países.

No tocante às contribuições da presente pesquisa, contribuições econômicas, ambientais, gerenciais e sociais são realçadas. Econômicas por promover o reconhecimento da água como capital natural, evidenciando suas informações em termos físicos e monetários. As contribuições ambientais e sociais surgem pela maneira como a pesquisa incentiva a evidenciação de informações sobre os recursos hídricos. Esta, por sua vez, promove um maior engajamento com a gestão e preservação do recurso, ao desenvolverem dados de maneira organizada que impulsiona tomadas de decisões mais conscientes. Isso impulsiona o desenvolvimento de políticas públicas que visem à preservação da água, evitando situações de estresse hídrico e garantindo a qualidade do recurso.

No que tange às limitações da pesquisa, a indisponibilidade de algumas contas, relatórios e informações sobre as contas da água de alguns países que acabaram não sendo analisados precisa ser reconhecida. Também vale citar que o idioma de algumas publicações pode ter dificultado a análise da evidenciação das contas de água em alguns casos, como as da Armênia.

REFERÊNCIAS

AUSTRALIAN BUREAU OF STATISTICS. **Water Account, Australia**. 2019.

BAGHERI, A.; BABAEIAN, F. Assessing water security of Rafsanjan Plain, Iran – Adopting the SEEA framework of water accounting. **Ecological Indicators**, v. 111, p. 105959, 2020. Disponível em: https://doi.org/10.1016/j.ecolind.2019.105959

BAGSTAD, K. J. *et al.* Integrating physical and economic data into experimental water accounts for the United States: lessons and opportunities. **Ecosystem Services**, v. 45, 2020. Disponível em: https://doi.org/10.1016/j.ecoser.2020.101182

BANCO CENTRAL DE COSTA RICA. **Cuenta de Agua**. 2019. Disponível em: https://www.bccr.fi.cr/seccion-cuentas-ambientales/cuentas-ambientales.

BARDIN, L. **Análise de Conteúdo**. 4. ed. Lisboa: Edições 70, 2010.

BERGER, M. *et al.* Enhancing the Water Accounting and Vulnerability Evaluation Model: WAVE+. **Environmental Science & Technology**, v. 52, n. 18, p. 10757–10766, 2018. Disponível em: https://doi.org/10.1021/acs.est.7b05164

CAVALLETTI, B.; CORSI, M. The system of environmental and economic accounting and the valuation problem: a review of the literature. **Journal of Environmental Planning and Management**, v. 65, n. 11, p. 1999–2028, 2022.

CHALMERS, K.; GODFREY, J. M.; LYNCH, B. Regulatory theory insights into the past, present and future of general purpose water accounting standard setting. **Accounting, Auditing & Accountability Journal**, v. 25, n. 6, p. 1001–1024, 2012.

CHALMERS, K.; GODFREY, J.; POTTER, B. Discipline-Informed Approaches to Water Accounting. **Australian Accounting Review**, v. 22, n. 3, p. 275–285, 2012. Disponível em: https://doi.org/10.1111/j.1835-2561.2012.00175.x

CHRIST, K. L. Water management accounting and the wine supply chain: empirical evidence from Australia. **British Accounting Review**, v. 46, n. 4, p. 379–396, 2014. Disponível em: https://doi.org/10.1016/j.bar.2014.10.003

CHRIST, K. L.; BURRITT, R. L. The role for transdisciplinarity in water accounting by business: reflections and opportunities. **Australasian Journal of Environmental Management**, v. 25, n. 3, 2018. Disponível em: https://doi.org/10.1080/14486563.2018.1460631

COLIATH, G. C. A Contabilidade como Ciência Social e sua contribuição para o Capitalismo. **Revista Eniac Pesquisa**, v. 3, p. 152, 2014. Disponível em: https://doi.org/10.22567/rep.v3i2.157

DUTTA, D. et al. Development and application of a large scale river system model for National Water Accounting in Australia. **Journal of Hydrology**, v. 547, p. 124–142, 2017. Disponível em: https://doi.org/10.1016/j.jhydrol.2017.01.040

ESEN, S. E.; HEIN, L. Development of SEEA water accounts with a hydrological model. **Science of the Total Environment**, v. 737, p. 140168, 2020. Disponível em: https://doi.org/10.1016/j.scitotenv.2020.140168

FERRER, L. M. *et al.* Composition of the social urban water shortage vulnerability index (SUWSVI) applied to São José dos Campos, SP, Brazil. **Sustainability in Debate**, v. 13, n. 3, p. 173–188, 2022. Disponível em: https://doi.org/10.18472/SustDeb.v13n3.2022.4552

GAN, H. *et al.* Development and Application of the System of Environmental –Economic Accounting for Water in China. *In:* **Water Accounting:** international approaches to policy and decision-making. Cheltenham: Edward Elgar, 2012. p. 139–161.

GOVERNMENT OF RWANDA. **Rwanda Natural Capital Accounts – Water**. 2019. Disponível em: https://www.wavespartnership.org/en/knowledge-center/rwanda-water-accounting-report-2012-2015.

GRAY, D. E. **Pesquisa no mundo real**. 2016.

IBGE. **Contas Econômicas Ambientais da Água no Brasil**. 2018. Disponível em: https://www.ibge.gov.br/estatisticas/economicas/contas-nacionais/20207-contas-economicas-ambientais-da-agua-brasil.html?=&t=o-que-e.

INEGI. **Memoria de Cálculo de las Cuentas Económico-Ambientales Integradas del Agua**. 2019.

KILIMANI, N.; VAN HEERDEN, J.; BOHLMANN, H. Water resource accounting for Uganda: use and policy relevancy. **Water Policy**, v. 18, n. 1, p. 161–181. 2016. Disponível em: https://doi.org/10.2166/wp.2015.035

OBST, C. G. Reflections on natural capital accounting at the national level. **Sustainability Accounting, Management and Policy Journal**, v. 6, n. 3, p. 315–339, 2015. Disponível em: https://doi.org/10.1108/SAMPJ-04-2014-0020

PINTO FILHO, J. L. DE O.; RÊGO, A. T. A. DO; LUNES, A. R. DA S. Management of water resources in semi-arid: assessment of the drinking water supply in rural communities of Chapada do Apodi-RN. **Sustainability in Debate**, v. 10, n. 3, p. 276–319, 2019. Disponível em: https://doi.org/10.18472/SustDeb.v10n3.2019.24398

REPUBLIC OF BOTSWANA. **Botswana Water Accounting Report**. 2017. Disponível em: https://www.wavespartnership.org/en/knowledge-center/botswana-water-accounting-report-201516.

ROMEIRO, A. R.; KUWAHARA, M. Y. Avaliação e contabilização de impactos ambientais. **Revista de Economia Mackenzie**, v. 3, n. 3, p. 186–195, 2004.

RUSSELL, S. Water. *In:* **Routledge Handbook of Environmental Accounting**. New York, NY: Routledge, 2021.

SETLHOGILE, T.; ARNTZEN, J.; PULE, O. B. Economic accounting of water: the Botswana experience. **Physics and Chemistry of the Earth**, v. 100, p. 287–295, 2017. Disponível em: https://doi.org/10.1016/j.pce.2016.10.007

SIGNORI, S.; BODINO, G. A. Water management and accounting: remarks and new insights from an accountability perspective. *In*: **Studies in Managerial and Financial Accounting**. Bingley: Emerald Group, 2013. v. 26, p. 115–161. Disponível em: https://doi.org/10.1108/S1479-3512(2013)0000026004

STATISTICS NETHERLANDS. **Physical water accounts for the Netherlands**. 2017. Disponível em: https://www.cbs.nl/en-gb/background/2017/38/physical-water-accounts-for-the-netherlands.

STATISTICS SOUTH AFRICA. **Global Assessment of Environmental-Economic Accounting and Supporting Statistics**. 2017. Disponível em: https://seea.un.org/sites/seea.un.org/files/area_d_gap_analysis_v3.0.pdf.

SUN, P. *et al.* **Study on Water Assets Accounting under the Concept of Sustainable Development**. Proceedings of the 6th International Conference on Energy, Environment and Sustainable Development. Paris, France: Atlantis Press, 2017. Disponível em: https://doi.org/10.2991/iceesd-17.2017.91

TAPSUWAN, S. *et al.* Valuing ecosystem services of urban forests and open spaces: application of the SEEA framework in Australia. **Australian Journal of Agricultural and Resource Economics**, v. 65, p. 37–65, 2021. Disponível em: https://doi.org/10.1111/1467-8489.12416

TELLO, E.; HAZELTON, J. The challenges and opportunities of implementing general purpose groundwater accounting in Australia. **Australasian Journal of Environmental Management**, v. 25, n. 3, p. 285–301, 2018. Disponível em: https://doi.org/10.1080/14486563.2018.1431157

TORRES LÓPEZ, S.; BARRIONUEVO, M.; RODRÍGUEZ-LABAJOS, B. Water accounts in decision-making processes of urban water management. **Sustainable Cities and Society**, v. 50, 2019. Disponível em: https://doi.org/10.1016/j.scs.2019.101676

UN-WATER. Summary Progress Update 2021: SDG 6 – Water and sanitation for all. **UN-Water**, p. 1–58, 2021.

UNITED NATIONS. **System of Environmental-Economic Accounting for Water**. 2012. Disponível em: https://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf.

UNITED NATIONS. **Blueprint for Acceleration**: Sustainable Development Goal 6 Synthesis Report on Water and Sanitation 2023. New York: United Nations, 2023.

VARDON, M. *et al.* The system of environmental-economic accounting for water: development, implementation and use. *In:* **Water Accounting:** international approaches to policy and decision-making. Edward Elgar, 2012. p. 32–57.

WATER ACCOUNTING STANDARDS BOARD. **Water Accounting Conceptual Framework for the Preparation and Presentation of General Purpose Water Accounting Reports**. 2014. Disponível em: http://www.bom.gov.au/water/standards/wasb/documents/Water-Accounting-Conceptual-Framework-Accessible.pdf.

WEALTH ACCOUNTING AND THE VALUATION OF ECOSYSTEM SERVICES. **Knowledge Center**. 2021. Disponível em: https://www.wavespartnership.org/en/knowledge-center.

WORLD HEALTH ORGANIZATION. **World Water Day**. 2017.

WORLD WATER FORUM. **Declaração de Sustentabilidade**. 2018. Disponível em: http://8.worldwaterforum.org/pt-br/documents-0.

YANG, Y. *et al.* Urban natural resource accounting based on the system of environmental economic accounting in Northwest China: a case study of Xi'an. **Ecosystem Services**, v. 47, p. 101233, 2021. Disponível em: https://doi.org/10.1016/j.ecoser.2020.101233

Transboundary conflicts and water governance in the Paraguay River Basin – South America

Conflitos e governança da água transfronteiriça na Bacia Hidrográfica do Rio Paraguai – América do Sul

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ARTICLE-VARIA

ABSTRACT

This article analyses the conflicts and the structure of water governance in the Paraguay River Basin – South America – based on a review of documentary sources, specialised literature, and interviews with key stakeholders operating in the basin. The study shows that the internal asymmetry of Brazil and between this country and Paraguay is crucial in the definition of water use in the Basin, thus resulting in conflicts. The results of the study highlight the need for advances in the implementation of agreements for the basin and the fact that these should include instruments that encompass new scales of management and cooperation opportunities from local stakeholders, who have been neglected in decisions despite the coexistence of informal agreements between the parts.

Keywords: Transboundary Waters. Paraguay River Basin. Water Governance. International Cooperation. Conflicts over water.

RESUMO

Este artigo analisa os conflitos e a estrutura da governança da água na Bacia do Rio Paraguai – América do Sul – com base em uma revisão de fontes documentais, literatura especializada e entrevistas com principais atores que atuam na bacia. O estudo mostra que a assimetria interna do Brasil, e entre este país e o Paraguai, é crucial na definição do uso da água na bacia, resultando assim em conflitos. Os resultados do estudo destacam a necessidade de avanços na implementação de acordos para a bacia e o fato de que estes devem incluir instrumentos que abranjam novas escalas de gestão e oportunidades de cooperação dos atores locais, que têm sido negligenciados nas decisões, apesar da coexistência de acordos informais entre as partes.

Palavras-chave: *Águas Transfronteiriças. Bacia Hidrográfica do Rio Paraguai. Governança Hídrica. Cooperação Internacional. Conflitos pela água.*

1 INTRODUCTION

The Paraguay River Basin is part of the La Plata Basin – the second largest in the South American continent – and is facing a situation of water scarcity due to the intensification of extreme events, the environmental impacts caused by economic activities, and problems related to management and inadequate public water policies.

As an international Basin, it features a particular geomorphology composed of relationships between the plateaus surrounding it, which shelter the headwaters of the rivers located upstream and the plain areas located in the central portion and downstream. It has regional and international economic relevance, as its main watercourse, the Paraguay River, makes up the Paraná-Paraguay Waterway, a corridor that connects the central region of South America to the Atlantic Ocean, through which most agricultural and mineral commodities are transported, comprising the main export matrix on the continent. Additionally, fishing (artisanal, professional, and tourist) and livestock activities are also developed in the basin, and many of its water courses are used for hydropower generation. This set of economic activities characterises the private sector's stakeholders in the use of water resources in the basin. Different traditional communities also inhabit the river basin.

The social and environmental impacts are increasing as water use and land occupation intensify, varying highly at the regional level and being driven by local economies. In the Upper Paraguay Portion, located upstream of the river, the process of silting and sedimentation of watercourses increases as agricultural progress takes place, as shown by studies by Souza et al., 2017. In the area of the Pantanal shared between Brazil, Bolivia, and Paraguay, the impacts caused by the increasing fires reported in the last years have resulted in changes in the quality and quantity of water courses. The fires consumed approximately 4 million hectares of the biome in 2020 and more than 1 million hectares in 2021 (Lasa, 2022), directly affecting traditional communities. In the Chaco plain, deforestation caused by the expansion and intensification of agriculture to produce commodities – such as soy – has an excessive impact on biodiversity and many endemic species. These situations characterise threats and conflicts – real or potential, direct or indirect – over water use in the basin.

Governments and water and environmental management measures directly interfere in minimising or amplifying impacts on water. The discussion at the international level that the water crisis is, above all, a crisis of governance is widely acknowledged, comprising a concept that has become a benchmark on the agenda of agencies, domestic and international organisations, and research institutions such as the Water Governance Facility or the Daegu Multi-Stakeholder Declaration on the OECD Principles of Water Governance (CASTRO, 2007; RIBEIRO; JOHNSSON, 2018).

In the case of transboundary waters, these tasks are even more difficult, as such waters are shared between nation-states, which makes the decision-making process in pursuit of common goals difficult (Ribeiro, 2012). Moreover, any actions produced in a riparian State fall on the others located in the basin, which may become a source of political tensions that can lead to conflict (Ribeiro, 2008b; Sant'Anna; Villar, 2014) The impacts on transboundary waters in an international water basin, such as that of the Paraguay River, can be of an economic, environmental or social nature, among others, and involve the power and sovereignty relations of riparian States (Ribeiro, 2008a, 2008b).

This article analyses the conflicts and structure of water governance in the Paraguay River Basin, focusing on the relations between Brazil and Paraguay.

2 METHODS

This study is based on a review of documentary sources on managing water resources in the Paraguay Basin. It also analysed the specialised literature on drainage basin, territory, conflicts, and water

governance. In order to complement gaps raised in the literature review and expand the understanding, in-depth individual interviews were carried out following the guidelines of Gil, 2008, featuring 11 key stakeholders who work in the basin, representatives of the segments of the public authority, and civil society, from July to September 2021, in the online format, based on the following structuring topics: context of the drainage basin – situation analysis and conflicts over water use; water governance – institutional arrangement/structure; management methods – instruments, mechanisms, etc.; and governance monitoring and evaluation.

2.1 STUDY AREA

The Paraguay River Basin (Figure 1) covers four riparian nation states with its water courses – Brazil, Uruguay, Paraguay, and Argentina – and shelters the complex formation of the Pantanal region, with significant international social and environmental importance, as it comprises the largest wetland in the world, as well as being listed as National Heritage of Brazil and a Biosphere Reserve designated by Unesco (Rabelo *et al.*, 2021).

In the literature, the Paraguay River Basin is rarely studied in its entirety. Generally, it is presented as a division between the Upper Paraguay region (upstream of the Apa River) and the Lower Paraguay (drainage from the Apa River to downstream of Paraná River) or integrated with the La Plata Basin. It should be noted that the Upper and Lower Paraguay regions have -different impacts.

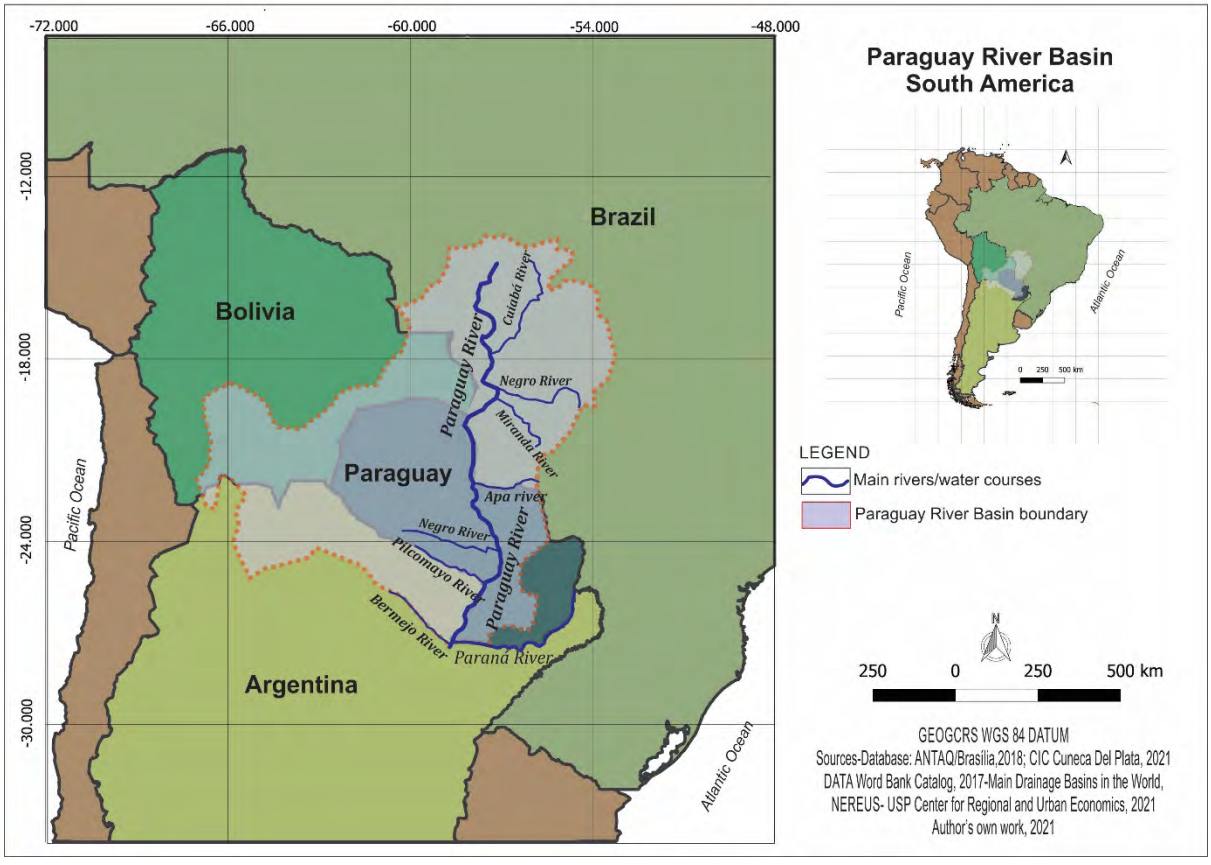

Figure 1 – Delimitation of the Paraguay River Drainage basin in South America.

Source: The authors (2021).

Studies by Rabelo *et al.* (2021) and Souza *et al.* (2017) have identified that deforestation, followed by the inappropriate use of land for cultivation and urbanisation, accelerate erosive processes,

modifying the river dynamics of the region (Upper Paraguay) and subsequently, causing an increase in sedimentation across several points and water courses. The advance of the agricultural frontier in the region, particularly towards the plateau areas, takes place with the cultivation of soy, corn, and beef cattle. Also, the dredging and diversion of river channels are responsible for silting watercourses. In Lower Paraguay, there is a prevalence of impacts related to erosion and river morphological changes, contamination by mineral activities, water contamination by urban and industrial activities and vulnerabilities caused by floods (CIC, 2017). In the Chaco Plain, deforestation caused by using land for the expansion and intensification of agriculture to produce commodities – such as soy – has a major impact on biodiversity and many endemic species (Semper-Pascual *et al.*, 2018).

3 INTERNATIONAL WATER BASIN: A SHARED TERRITORY?

A territory can be defined as an area appropriated by a social group where power is exercised (Ribeiro, 2008b; Sant'anna; Villar, 2014, 2015). Conversely, a drainage basin can be defined, based on a physical-natural understanding, as an area physically delimited by a topographic divider, in which all the water that falls on this area is drained into a main watercourse, which flows into an outlet, where it is possible to quantify the hydrological regime (Barbosa, 2019).

The drainage basin has become the ideal territory for managing water and water resources from the local to the international level, particularly since the 1990 Dublin Summit (Davidson; De Loë, 2014; Ribeiro, 2008b). Abers and Keck (2017) and Barbosa (2019) argue that the drainage basin is a suitable territorial unit for water management and implementation of a management system for its uses, as it enables the integration of multidisciplinary research and activities, having a physical boundary that can be well defined at different scales, and allowing the interrelationship between natural, social, economic and cultural components. In turn, authors such as Davidson and De Loë (2014), Furlong (2006), Warner *et al.* (2014) and Zeitoun *et al.* (2014) argue that this scale for water management may obscure policy issues. According to them, stakeholders' responses to management occur as they perceive their interests, regardless of the natural dimension of the basin. Warner *et al.* (2014) argue that the drainage basin is not an administrative political unit containing the social segments' political links. Therefore, adopting it as a political scale masks the political importance of water.

In the case of the international drainage basin, it appears as a truncated territory since, in addition to the specific social and political characteristics of each country, it reflects the power relations between countries and within them, which should determine the use of water, as the territory is also understood as the result of power relations (Haesbaert, 2021). It is clear that power relations do not only involve the use of water. Nevertheless, it is essential to remember that all productive sectors, from irrigation to construction, rely on the licensing or granting of water, such as in the Brazilian case. This truncated territory would be related to the territorial trap that Furlong (2006) cited. According to the author, if the State separates foreign policy from domestic policy, it can assign to multilateral international institutions the responsibility for maintaining cooperation between riparian States. Zeitoun *et al.* (2011) note that soft power can be important for international cooperation but not consistently enough, leading to possible tensions and conflicts that may involve the use of force in the international basin. In other words, hard power would prevail.

The discussion on the management of international basins and transboundary waters, as Furlong (2006) addressed, has been guided by hegemony and realistic rationalities, in which the "coloniality of power" is a key element. In the South American case, this coloniality calls into question the very existence of original or traditional communities (Haesbaert, 2021). In the case of water management in an international river basin, the approach by the States, which predominates, especially in poor/peripheral countries, follows a top-down realistic dynamic. Zeitoun *et al.* (2014) argue that the treaties signed in these basins tend to be mostly utilitarian, as they aim at efficiency and greater benefit to the hegemonic States, even though it costs their people dearly. It is also important to identify the dominant

hegemonic power to prevent national and international organisations from ordering the territory of the basin, which is usually disguised as conflict mediation and disregards local and institutional cultures, as Furlong (2006) discussed.

All action occurs in space-time, a fundamental geographic category for understanding any process. The time of social actions in a drainage basin is different from the time of the physical dynamics of the drainage basin. In an international basin, one must still consider other times that involve the sovereignty of riparian States in contrast to the time of traditional communities, which, for example, subsist on artisanal fishing on the banks of rivers, sharing the same waters in territories of different States, as well as on the margins of water management decisions, simultaneously subject to a certain degree of "deterritorialisation," reaching "terricide," a term borrowed from Haesbaert (2021). Conversely, there is the power of private sectors to dominate localities and the struggles of internationalised riverside populations. Therefore, it is possible to think of overlapping times when constructing the same space-territory of the international basin. This process may have a rationality imposed or constructed in a shared and collaborative, institutional or informal way.

In a basin shared between countries, it is necessary to understand how they are organised and the form and regime of governments, which comprise factors that affect the governance structure and water management instruments. The basin can be understood as a water management territory, and its control contributes to the search for sovereignty (Ribeiro, 2012).

4 CROSS-BORDER WATER GOVERNANCE: SOVEREIGNTY, COOPERATION OR INTEGRATION?

Two situations may occur between riparian states involving transboundary waters: dispute/conflict and cooperation. These situations, we add, do not depend on the existence of an international treaty and may even coexist (Espíndola; Ribeiro, 2020; Sant'anna; Villar, 2015; Zeitoun; Warner, 2006), in the same space-time frame. Espíndola and Ribeiro (2020) discuss the understanding that these waters should be understood as shared waters, even though they are under the sovereignty of States. Providing equitable access to water, without the power relations between States interfering with water security, should be a premise for agreements between countries.

The analysis of the structure and governance model adopted in an international basin becomes important for the search for equitable access to water by neighbouring States. According to Zeitoun *et al.* (2011), there will always be winners and losers in power and sovereignty relations between States, and some stakeholders may change their interests to seek the best of a given situation in their favour. Based on these authors' analysis of power and sovereignty, it is possible to envision an initial moment in which water governance can be structured from a foundation of hard power, in which actions and discussions will be centred exclusively on the State, not yet corresponding to a State policy, but rather to a government policy, which can make decisions more unstable. In turn, the governance structure can be based on soft power, which can be used to promote cooperation or, if even softer, integration.

In this discussion, governance cannot be reduced to an instrument for implementing public policy but rather understood as the political process formed by the exercise of asymmetrical power between political stakeholders for decision-making based on values. It is asymmetrical because the stakeholders participating in the process have different proportions of political power and knowledge (Castro, 2007), and all the elements of this political process – power relations between the stakeholders involved, knowledge, and values – will lead to a certain governance structure, which comprises cooperation, integration, or centralisation.

For transboundary waters, governance generally occurs through the formalisation of management instruments, such as agreements and treaties, as well as organisations of joint institutions between

riparian States, even if respecting the territorial autonomy of a given State (Villar *et al.*, 2018). Despite that, countries face difficulties in moving towards cooperation. Therefore, to understand the strength and consent between stakeholders in an international river basin, considering the context and power relations, it is essential to understand how agreements are signed and structured in these basins. Zeitoun *et al.* (2014) have obtained data showing that most agreements between countries have a basis of justice arising from the utilitarian theory, favouring efficiency. Zeitoun and Carrasco Vintimilla (2020, p. 44) note that "one must seek and interpret how attempts have been made – both by non-hegemonic and hegemonic stakeholder, to resolve – or manage – the conflict, whether it is moral, legal, market-related, or technocratic." It should be noted that, in the Paraguay River Basin, several cooperation instruments exist between Brazil and Paraguay for water management, which will be discussed later.

It should be noted that an agreement cannot resolve all conflicts in an international basin, let alone involve all interested stakeholders (Villar *et al.*, 2018). Nevertheless, they can move forward and establish a governance structure, goals and financial resources, which are key items to facilitate cooperation and legitimation of actions that may occur. The importance of state capacities is highlighted for this purpose.

Abers and Keck (2017) study the importance of capacities, especially at the state level, which ranges from the physical structure of institutions to the forms of dialogue with society. This discussion can be adapted when considering the governance of international basins. In this case, State capabilities would not only be the bureaucratic attributes of States but also conditions for their actions, showing what the state is capable of mobilising. This, however, is not about the total hegemony of the State or the State as a container, as mentioned by Furlong (2006). The State, or its representative, cannot exercise its isolated desire but rather the people's collective desire, with laws that must be formulated based on the collective desire (Barbosa, 2019; Ribeiro, 2012). In this sense, an ideal governance model in the international basin should simultaneously include States (and their capacities), agreements between international organisations, and local or subnational demands, including a collective construction of water management practices. When each riparian State reaches this level of organisation, the agreements and decisions will have advanced to a higher level of governance, thus making it necessary to verify first the extent to which the institutions are operating to enable a later understanding of governance in its complexity.

While formal institutional interaction is challenging, interaction with non-formal aspects is an even greater challenge in transboundary water management, particularly regarding the interaction with communities and local stakeholders. The construction of the formal institutional apparatus in international basins, which includes agreements, is not an easy task, as it requires the engagement of all public or private stakeholders. Involving the local community is even more difficult, as agreements fail to provide for the possibility of including these stakeholders (Villar *et al.*, 2018), which restricts participation to specific groups, such as large corporations. As Villar *et al.* (2018) suggested, an analysis focused on the State ignores other existing relationships, such as those at the local level. Interstate relations are the most widely analysed in studies on transboundary basins. Conversely, other relationships and stakeholders at subnational or local scales are neglected, which justifies the importance of studies considering other scales. Furlong (2006) makes this same observation when studying international relations and water in the South African context.

5 WATER POLICY IN BRAZIL AND PARAGUAY

The State is the first prominent stakeholder in the governance of transboundary waters since it holds political and territorial sovereignty. Therefore, it is important to understand its organisation in riparian countries with different regulations for the domain and competency over water, involving different institutions, instruments, and management bodies.

The Brazilian State is organised as a federative republic that comprises the Union (Federal Government), the States, the Federal District, and the Municipalities, all operating autonomously (Brasil, 1988). All of them are responsible for "registering, monitoring and inspecting the concessions of rights to research and exploration of water and mineral resources in their territories" (Brasil, 1988, Item XI, Chapter II, Article 23). Paraguay is organised in a social State governed by law, being Unitary, indivisible, and decentralised. The Paraguayan territory is divided into 17 departments, composed of 254 districts (municipalities) with their own administration and autonomy in the collection and application of resources (Paraguay, 1992). Surface and groundwater are in the public domain. The country's Constitution does not mention transboundary water management, coordinated by the Ministry of Foreign Affairs (Brito; Missio, 2019) alongside the Ministry of the Environment and Sustainable Development (Mades).

5.1 WATER POLICIES

In Brazil, water governance is related to the public-private domain, which results in a dispute over its multiple uses in light of organised sectoral interests (Barbosa, 2019). The basin is the fundamental territorial unit to apply the management instruments, as stipulated and implemented by the National Water Resources Policy (PNRH), Federal Act 9,433 of 1997, which has a decentralised and participatory character, aiming to promote, among other things, the rational and integrated use of water resources. The Water Resources Policy was constructed based on a diversified scenario. On the one hand, some stakeholders reinforced the centralised and technocratic model of water resources management in the country of the previous decades, when these resources were considered properties of private domain. On the other hand, some stakeholders discussed the need to strengthen horizontal, decentralised, participatory and integrated management, as discussed in the global scenario (Barbosa, 2019). Nevertheless, one of the main political events that allowed the discussion of new principles applied in the PNRH was the process of (re-) democratisation of the country, culminating in the 1988 Constitution.

In Brazil, until 2018, there was a Permanent Technical Chamber for the Management of Transboundary Water Resources in the context of the National Water Resources Council. In 2019, this Chamber was terminated, and its agenda was transferred to the Technical Chamber of Integration with Environmental and Territorial Management. Such changes may further remove local or subnational stakeholders from decision-making, and new conflicts over water use may be activated.

According to Facetti (2014), water governance has been uncoordinated in Paraguay since the 1990s. He points to interference by international institutions, including the World Bank, Unesco, and the Inter-American Development Bank, in an attempt to reach an institutional arrangement that made each stakeholder's responsibility clear. The result was the drafting of the Regulatory Framework for drinking water and sanitation services and the creation of a National Environmental System in the year 2000 and, later, the Water Resources Act, established by Act 3,239 of 2007 – ten years after the implementation of the Water Resources policy in Brazil – in a process that involved civil society organisations that pressured the government for its formulation. Despite Act 3,239, there is great difficulty in establishing its regulation and implementation. There is no agreement between economic sectors to define values for the use of water for companies.

According to interviews carried out for this study, the private sector aims to continue using water without paying fees or charges. One of the core principles of Paraguayan law on water resources states that the State must guarantee water – with quality and quantity – for the population while highlighting the river basin as a decentralised, participatory management unit with a gender perspective (Paraguay, 2007). In Paraguay, the movement by society, which reached the government for the formulation of Act 3,239, acted for the recognition of water as a human right, which could not be privatised, predating Resolution A/RES/64/292 of 2010 – which declared clean water and sanitation a human right (UN, 2010). Privatisation was stopped for the sanitation sector, and according to Facetti (2014) and some interviewees, with support from the World Bank.

Paraguayan law proposes, at different times, the integrated water management with environmental management, which is a positive factor, especially to advance in a governance that considers the importance of ecosystems and wetlands in the Paraguay basin based on sustainable management. In turn, Brito and Missio (2019) present an overview demonstrating that the water management structure in Paraguay is still dispersed and uncoordinated.

Brazilian law states that transboundary waters will be represented by the Ministry of Foreign Affairs when River Basin Committees exist, yet it does not mention how water will be managed. On the other hand, Paraguayan law indicates that water management in shared basins will be carried out through agreements, treaties, and agreements but does not specify the role of representatives or the collegiate instance in which the management will take place. Such a situation can be an obstacle to the advancement of cooperation agreements for the management of the Paraguay Basin, mainly because this basin still has no International Committee. It should be noted that neither of the two legislations provides for International River Basin Committees. Additionally, despite the two legislations establishing the Basin Plan as a management instrument, there is also no provision for International Basin Plans.

Differences between the preparation and implementation of management instruments provided for in legislation can also hinder cooperation between countries for the management of international waters, particularly in contiguous rivers, such as the establishment of the grant to withdraw water from these rivers.

6 PARAGUAY BASIN: CONFLICTS AND MAIN POLITICAL SUBJECTS

Water conflicts can be defined as the different forms resulting from tensions generated by water use disputes (Espíndola; Ribeiro, 2020; Houdret, 2005; Le Billon; Duffy, 2018; Martinez-Alier, 1995; Nincic; Weiss, 2016; Ribeiro *et al.*, 2019; Ribeiro; Santanna, 2014). In the case of a basin, they may gain a supranational dimension, as discussed in this article, which also reflects each country's territorial organisation.

In Brazil, the Paraguay River Basin is part of the Paraguay Hydrographic Region (Paraguay HR), one of the twelve hydrographic regions for water management. It occupies part of the Federation Units of Mato Grosso (MT) and Mato Grosso do Sul (MS). In 2018, the Water Resources Plan for the Paraguay Hydrographic Region (PRH) was defined, despite lacking an Interstate CBH, as the result of an articulation between the National Water and Sanitation Agency (ANA), the National Water Resources Council (CNRH), the Secretariat of Water Resources and Environmental Quality (SRHQ), and civil society, started in 2012, given the social and environmental urgency, particularly in the Pantanal region. The Monitoring Group accompanied the entire discussion for the Preparation of PRH Paraguay (GAP). In 1996, the Upper Paraguay Pantanal River Basin Integration Committee (CIBHAPP) was implemented and demobilised in 1999. The reasons for the discontinuation of this Committee included the failure to describe its physical area of operation, lack of frequency of meetings, and lack of operational and legal compliance (Engecorps; ANA, 2017). The implementation of a new Committee in the Upper Paraguay Region is a matter of discussion, according to the interviewees, especially among representatives of public bodies from MT and MS, who argue that charging for the use of water is the main difficulty in establishing a consensus. The territories of MT and MS are important because they are home to the headwaters of the watercourses of the Paraguay Basin, which gives special attention to the subnational policies of water resources and the environment of these Federation Units and to the national territory itself, resulting in an asymmetrical power relationship in the basin in relation to Paraguay. According to the interviewees, effective actions have failed to advance, and there are no discussions on the subject in the CBHs.

In the Brazilian portion of the Paraguay basin, there are three major economic sectors that politically influence decisions: agribusiness, which exerts great pressure on water resources and land use and

occupation through deforestation, mainly in the plateau areas of Paraguay HR; the hydropower sector, which is impacting upstream areas in the Paraguay HR with pressure for the construction of new Small Hydropower Power Plants (SHP) that could cause changes in the hydrological regimes of water courses and fish reproduction; and the waterway sector of the Paraguay-Paraná Waterway, which includes a project to expand the North Section in MT and MS, which do not have good navigation conditions. All uses impact the Pantanal, which is highly susceptible to impacts that the projects can generate.

Conversely, the Paraguay HR includes traditional communities with an interdependent relationship with water, such as riverside dwellers, Pantanal dwellers, artisanal fishermen, indigenous peoples, and *quilombolas* (settlers comprising descendants of former African slaves). These stakeholders do not have great decision-making power in the face of State hegemony, although they are often the ones closest to dialogue with other communities in neighbouring countries. Water resource demand and multiple uses also involve other stakeholders: the sanitation sector, fisheries, aquaculture, and tourism.

The inter-municipal consortium is a major player in the Paraguay HR. At least two consortia have been established whose sector of activity is the environment and water (Cidema – Intermunicipal Consortium for the Integrated Development of the Miranda and Apa River Basins; and Cointa – Intermunicipal Consortium for the Sustainable Development of the Taquari River Basin) (Engecorps; ANA, 2017). The consortia are legal entities and comprise alternatives that involve local stakeholders in water management, being able to promote partnerships with municipalities in neighbouring countries in border regions, as has been the case with the Consortium of the Apa River Basin. Sant'Anna and Villar (2014, p.1110) observe that "consortia play an essential role in the process of governance and management of transboundary water resources," as they provide a role "greater than that of national institutions and regional integration processes underway, even if they have special programs for border regions." Nevertheless, the Consortia face challenges such as restrictive legislation or lack of institutional support (Engecorps; ANA, 2017).

Paraguay's territory is in two distinct hydrographic regions, which have highly particular characteristics in ecological terms and for the application of legislation and governance structure. One of them is the eastern region, more densely populated, with plains irrigated by the Paraguay River and part of the Paraná River Basin, occupied by the Atlantic Forest, where the largest concentration of wetlands is located, and featuring a diversity of economic activities aimed at agribusiness and agroindustry, production forestry, among others. This portion presents a few remnants of natural areas, which are pressured by irrigators that generate water stress. The other is the western region, composed mainly of the Chaco-Seco region, which is the least inhabited in the country, integrating the Paraguay River Basin, but with impacts generated by extensive cattle ranching and the advance of soy production and deforestation, affecting indigenous communities that directly use the rivers. It should be noted that Act 422 of 1973 states that rural properties larger than 20 hectares must keep 25% of their surface covered by continuous natural forests.

When analysing the two areas, it is possible to verify that the country's economic matrix is based on agribusiness. Paraguay has been the sixth-largest producer and fourth-largest exporter of soy and the ninth-largest exporter of beef since 2012. These activities coexist alongside family and peasant farming, which supplies the cities, confirming the demand for water for irrigation in the country and creating points of tension of territorial dispute between large producers and peasants (Sili, 2019). Another highlight are the demands of traditional communities with their own territorial claims. These are major stakeholders that must be considered for governance in the basin. Companies in the area include transnational economic groups from Brazil and Paraguay, such as CNH (Case IH and New Holland), AGCO (AGCO, Valtra and Massey Ferguson); Cargill and ADM (operating throughout the U.S. chain), Agrotec and Grupo Favero (Brazil), and the Gimenez Family, who own the largest chain of port terminals in Paraguay (Dos Santos; Wesz Junior, 2018). Because its territory does not have an outlet to the sea, waterways mainly transport production and the Paraguay River stands out as the main transport and integration route. In this sense, new stakeholders enter the scene, such as the Gimenez Family group,

owner of the largest chain of port terminals in Paraguay (Dos Santos; Wesz Junior, 2018). It should be noted that approximately 75% of ports in the country are privately owned (Silveira *et al.*, 2019).

The Paraguay basin also includes Hydropower Generation Plants (HGP), Hydropower Power Plants (UHE) and Small Hydropower Plants (SHP), mainly upstream. The construction of the projects has the financial support of the BNDS for companies such as Itiquira Energética and Energética Ponte Alta S.A., Arapucel Ombeira S.A., and Santa Gabriela Energética S.A. Brennand Energia Gerem. Both the waterway sector and the energy sector are involved in conflicts over the use of water, even though the use of water for these sectors is non-consumptive. These conflicts involve issues related to traditional communities and impacts on riverbeds and ecosystems. The sanitation sector, another major stakeholder in water governance, is distributed among public, private, and mixed-capital entities. It should be noted that more than 13% of the population in the country, especially in rural areas, are supplied by the so-called *aguateros* (water carriers), and approximately 36% of water and sewage services come from the Environmental Sanitation Councils, both comprising private operating systems (Brito; Missio, 2019), whose permission and concession of use is regulated by Act 3,239.

Furthermore, various international stakeholders contribute to producing or disseminating data on governance and water management in Paraguay, such as the Global Water Partnership, Data for Now/Cepei, and the UN/UNDP. It is necessary, however, to question the rationale behind the intentions of these institutions and programs. These institutions must promote a participatory diagnosis, considering local communities and civil society, which would allow for a counterpoint to the segments of large water users, part of them multinational, which have a direct interest in water use for the maintenance of the productive sector.

6.1 CONFLICTS AND AVENUES FOR COOPERATION

Conflict and cooperation relations coexist between Brazil and Paraguay in the Paraguay Basin despite agreements and treaties between the countries. For the interviewees who have addressed this topic, cooperation is unsatisfactory.

An asymmetry between countries affects decisions on cross-border issues and impacts agreements and treaties, as analysed by Zeitoun *et al.* (2014). The Brazilian state has been hegemonic in the relationship. One must consider the power asymmetries between Brazil and Paraguay for new agreements. Furthermore, in the Brazilian case, decisions on the management of water resources are coordinated by the Ministry of Foreign Affairs, which is alien to the country's water management systems.

Both countries are part of the Intergovernmental Coordinating Committee for the La Plata Basin (CIC), the La Plata Basin Treaty, and the RAMSAR Convention on Wetlands of International Importance (CIC, 2017), which was widely cited by respondents, especially regarding the situation of the serious water scarcity that affected the Pantanal at the time of the interviews. The CIC and the Treaty are considered the landmark of the creation of an institutional framework to manage transboundary water resources in the La Plata Basin, but they have assumed a biased position towards energy production. The Treaty formalised the river basin as a water management unit, promoted international cooperation and established a major financial mechanism, the Financial Fund for the Development of the La Plata Basin (Fonplata). The CIC, in turn, was created to achieve the Treaty's goals. According to Villar *et al.* (2018), cooperation between the countries based on the Treaty has focused on contiguous rivers, and this is due to the principle of sovereignty that States would have in the border strip. They would have a joint sovereignty in contiguous rivers that they would not have in successive rivers. The Treaty stipulated the legal framework for advancing transboundary management in the La Plata basin, but actions are taking place slowly. This process is even slower in the sub-basins, which have far fewer bilateral agreements.

The interviewees did not identify the role of the CIC in the Paraguay Basin, although one of the areas of interest to them is the Upper Paraguay-Pantanal sub-basin due to the value of its wetland ecosystem and the key role it plays in the water regulation of the La Plata Basin set (CIC, 2017). The composition of the CIC is centred on the Ministries of Foreign Affairs, a government body responsible for signing international treaties and addressing foreign policy issues (Sant'anna; Villar, 2015). These hampers decentralised actions for the La Plata sub-basins, which are directed to governments' interests and the discussion on energy use, being restricted to formal diplomatic agents. Sant'Anna and Villar (2015) argue that the CIC is structured as a supranational organisation and does not have mechanisms to include the participation of subnational bodies and civil society in the La Plata sub-basins. Therefore, despite being a regional cooperation mechanism, the CIC does not resolve local conflicts.

Still on the regional scale, there is the Mercosur Framework Agreement on the Environment, whose environmental actions are hampered by the bloc's institutional problems (Ribeiro, 2008b; Sant'anna; Villar, 2015; Villar; Ribeiro, 2011). Other institutional organisations in the Paraguay River Basin are the Intergovernmental Committee of the Paraguay-Paraná Waterway (CIH) and the River Transport Agreement for the Paraguay-Paraná Waterway. The waterway is a major navigation axis in South America, and an important part of its course is in the Paraguay River. Improvements in the waterway are the responsibility of the States in their respective branches. Nevertheless, the agreement allows for the possibility of obtaining funds for Fonplata or the Inter-American Development Bank (Sant'anna; Villar, 2015). In the Brazilian portion of the waterway, there are tensions between the State and the private sector, on the one hand, and between civil society groups and non-governmental organisations, on the other, who defend the non-expansion of the waterway to the northern section, as it would impact the Pantanal.

There is no effective integration for the management of the Paraguay River Basin and the transboundary waters between the two countries. Instead, legislation is enforced with a top-down approach and closed actions in the territories of each of the countries, which fail to incorporate the idea that the international basin should have actions aimed at cooperation and integration. In fact, the two countries have asymmetry in the management and institutional frameworks concerning water resources policies, as systematised in Table 1.

Table 1 – Comparison between the Water Policies – Brazil and Paraguay

	Brazil	*Paraguay*
Act/Year	*Act 9,433 of 1997*	*Act 3,239 of 2007*
Management System and Hierarchy	• Ministry of Regional Development (MDR) National Water Resources Council (CNRH) • Water Security Secretariat • State Water Resources Councils River Basin Committees (CBH)* • Bodies/entities with competencies related to water resources management • Basin Agencies and National Water and Sanitation Agency (ANA)	• Ministry of Environment and Sustainable Development (MADES) • General Board for the Protection and Conservation of Water Resources (DGPCRH) – This is the managing and coordinating body of the Water Councils • Water Councils**
Management instruments	• Water Resources Plans • Classification of bodies of water according to the main water uses • Granting of rights for the use of water resources; Charge for the use of water resources • Water Resources Information System	• National Water Resources Plan*** • National Water Inventory National Water Resources Registry, to regulate the demand, considering the Water Balance for permission or not of grants-concessions (Paraguay, 2007) • Granting – permissions and concessions

	Brazil	Paraguay
Act/Year	Act 9,433 of 1997	Act 3,239 of 2007
Transboundary waters – direct mention in the law	"On the River Basin Committees of boundary and transboundary river basins of shared management, the Union's representation must include a representative of the Ministry of Foreign Affairs" (Article 39, § 2).	"The management of water resources shared with other countries shall be governed and regulated by treaties, agreements and international covenants that are approved and ratified by the National Congress and are in force" (Article 8).

Source: The authors (2024)

* There are 6 state committees in the Paraguay Hydrographic Region.
** 18 councils were created for aspects of the Paraguay River Basin.
*** As of the article's writing date, it has not yet been prepared.

This situation impacts the cooperation between the countries. In the Paraguay River Basin, between Brazil and Paraguay, the 2006 Cooperation Agreement for Sustainable Development and Integrated Management of the Apa River Basin (CIC, 2017) and the Apa River Mixed Commission, which cover the border area, stand out as the main highlights. Mobilisation for the Working Group began in 1998 when the Intermunicipal Consortium for the Integrated Development of the Miranda and Apa River Basins (Cidema) was formed. The Rio Apa Agreement came into force in 2009 (Sant'anna; Villar, 2015) and was the result of a movement organised by several Brazilian and Paraguayan stakeholders and municipalities to share the waters and banks of the Apa River, as well as the need for these municipalities to address water management and the environmental situation of the basin. Despite being a transboundary agreement, it has been driven by local mobilisation, influencing national institutions (Sant'anna; Villar, 2015) and reaching the local management scale. It is noted, however, that given the failure to establish effective governance, with delegation of responsibilities to the institutions, the Agreement has failed to advance in some of its objectives, such as the development of specific projects of mutual interest or the raising of the socioeconomic level of the inhabitants of the Basin.

Many agreements signed with stakeholders on a local scale in the Paraguay River Basin are not institutionalised. Nevertheless, most respondents mentioned the importance of these agreements in water management.

7 CONCLUSIONS

This article confirms that governance in an international basin is a complex process, as it involves different scales and levels of development of social segments and the power relations between the States that make up the basin. In the relations between Brazil and Paraguay, the first is hegemonic in relation to decisions on water management in the Paraguay River Basin. This scenario results in conflicts between stakeholders and water disputes that are reflected internally and between the two countries.

The few existing agreements in the Paraguay River Basin do not have a governance structure. They are not prepared to incorporate the initiatives of local stakeholders at the legal or institutional level, who solve immediate and urgent problems informally resulting from localised conflicts. Two of the agreements identified are included in the Paraguay River Basin area: the Rio Apa Agreement and the Rio Apa Commission. Other agreements cover the La Plata Basin or on an international scale and end up covering the Paraguay Basin indirectly, namely, CIC La Plata; Treaty of the La Plata Basin; RAMSAR Convention on Wetlands of International Importance; Mercosur Framework Agreement on the Environment; and the River Transport Agreement for the Paraguay-Paraná Waterway.

The asymmetries between Brazil and Paraguay must be reduced to advance the governance structure of transboundary waters. Paraguay should advance in implementing the instruments of its Water Policy, while Brazil is left with the need to consider other matrices in its foreign policy aimed at

transboundary waters, which consider social and environmental dimensions. The analysis showed that the predominant rationality between the two countries for the management of transboundary waters is the economic one, which aims to support only large enterprises and corporations in a process that weakens attempts at agreements for development based on the rationality of social and environmental sustainability of the Paraguay River Basin and results in internal and international conflicts, even if small, but which may increase in intensity and regularity.

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REFERENCES

ABERS, R. N.; KECK, M. E. **Autoridade Prática**: ação criativa e mudança institucional na política das águas do Brasil. 1. ed. Rio de Janeiro: Fiocruz, 2017. v. 1

BARBOSA, F. D. **Comitês de Bacias Hidrográficas, representação e participação**: desafios e possibilidades à gestão da água e dos recursos hídricos no Brasil. (Tese de Doutorado) São Carlos: Universidade Federal de São Carlos (UFSCar), 9 maio 2019.

BRASIL. **Constituição da República Federativa do Brasil**. Presidência da República, 1988.

BRITO, A. R.; MISSIO, F. J. Regulação e hidropolítica na fronteira Brasil-Paraguai. **Desenvolvimento e Meio Ambiente**, v. 52, 2019. DOI: http://dx.doi.org/10.5380/dma.v52i0.65310

CASTRO, J. E. Water governance in the twentieth-first century. **Ambiente & Sociedade**, v. 10, n. 2, p. 97–118, dez. 2007. DOI: https://doi.org/10.1590/S1414-753X2007000200007

CIC. **Análise Diagnóstico Transfronteiriço da Bacia do Prata – ADT**. Estados Unidos: 2017.

DAVIDSON, S. L.; DE LOË, R. C. Watershed Governance: transcending boundaries. **Water Alternatives**, v. 7, n. 2, p. 367–387, 2014.

DOS SANTOS, W.; WESZ JUNIOR, V. J. Concentração empresarial nas exportações do complexo soja no Paraguai (2000-2016). **Desenvolvimento em Debate**, v. 6, n. 1, p. 1–18, 2018.

ENGECORPS; ANA. **PRODUTO PARCIAL PP-06**. Plano de Recursos Hídricos da Região Hidrográfica do Paraguai – PRH Paraguai. Brasília: 2017.

ESPÍNDOLA, I. B.; RIBEIRO, W. C. Transboundary waters, conflicts and international cooperation – examples of the La Plata basin. **Water International**, v. 45, n. 4, p. 329–346, 18 maio 2020. DOI: https://doi.org/10.1080/02508060.2020.1734756

FACETTI, J. F. La reforma del sector hídrico en el Paraguay: una tarea inconclusa. **Debate. Revista Digital de Políticas Públicas**, v. 1, n. 1, 2014.

FURLONG, K. Hidden theories, troubled waters: international relations, the 'territorial trap', and the Southern African Development Community's transboundary waters. **Political Geography**, v. 25, n. 4, p. 438–458, maio 2006. DOI: https://doi.org/10.1016/j.polgeo.2005.12.008

GIL, A. C. **Métodos e técnicas de pesquisa social**. 6. ed. São Paulo: Atlas, 2008. v. 1

HAESBAERT, R. A corporificação "natural" do território: do territcídio à multiterritorialidade da Terra. **GEOgraphia**, v. 23, n. 50, 15 mar. 2021. DOI: https://doi.org/10.22409/GEOgraphia2021.v23i50.a48960

HOUDRET, A. La goutte d'eau qui fait déborder... Coopération et conflit autour de l'eau au niveau international et national. **GÉOCARREFOUR**, v. 80, n. 4, p. 285–295, 2005.

LASA. **Alerta rápido de área queimada**. 2023.

LE BILLON, P.; DUFFY, R. Conflict ecologies: connecting political ecology and peace and conflict studies. **Journal of Political Ecology**, v. 25, n. 1, 3 jan. 2018. DOI: https://doi.org/10.2458/v25i1.22704

MARTINEZ-ALIER, J. Indicadores de sustentabilidad y conflictos distributivos ecológicos. **Ecología Política**, v. 10, p. 35–43, 1995.

NINCIC, M.; WEISS, M. The Future of Transboundary Water Conflicts. **Political Science Quarterly**, v. 131, n. 4, p. 717–748, dez. 2016. DOI: http://www.jstor.org/stable/45175751

PARAGUAY. **Constitución Nacional de la República del Paraguay**. La Constitución Nacional. Gobierno Paraguay. Convención Nacional Constituyente, 1992.

PARAGUAY. **Ley N° 3239 / de los Recursos Hídricos del Paraguay**. Gobierno Paraguay. Congreso Nacional. Biblioteca y Archivo Central del Congreso Nacional, 2007.

RABELO, M. O. *et al.* Participação social no diagnóstico e prognóstico do Plano de Recursos Hídricos da Região Hidrográfica do Paraguai. **Research, Society and Development**, v. 10, n. 10, 17 ago. 2021. DOI: https://doi.org/10.33448/rsd-v10i10.18137

RIBEIRO, N. B.; JOHNSSON, R. M. F. Discussions on water governance: patterns and common paths. **Ambiente & Sociedade**, v. 21, n. 0, 8 out. 2018. DOI: https://doi.org/10.1590/1809-4422asoc0125r2vu18L1AO

RIBEIRO, W. C. **Geografia política da água**. 1. ed. São Paulo: Annablume, 2008a.

RIBEIRO, W. C. Aquífero Guarani: gestão compartilhada e soberania. **Estudos Avançados**, v. 22, n. 64, p. 227–238, 1 dez. 2008b. DOI: https://doi.org/10.1590/S0103-40142008000300014

RIBEIRO, W. C. Soberania: conceito e aplicação para a gestão da água. **Scripta Nova Revista Electrónica de Geografía y Ciencias Sociales**. Nueva serie de Geo Crítica. Cuadernos Críticos de Geografía Humana, v. XVI, n. 418 (28), 1 nov. 2012.

RIBEIRO, W. C.; SANTANNA, F. M. Water security and interstate conflict and cooperation – (Seguretat hídrica i conflicte i cooperació interestatals). **Documents d'Anàlisi Geogràfica**, p. 573–596, 2014. DOI: https://doi.org/10.5565/rev/dag.150

RIBEIRO, W. C.; SANTOS, C. L.; SILVA, L. P. Conflito pela água, entre a escassez e a abundância: marcos teóricos. **Ambientes: revista de Geografia e Ecologia Política**, v. 1, p. 11–37, 2019. DOI: https://doi.org/10.48075/amb.v1i2.23619

SANT'ANNA, F. M.; VILLAR, P. C. A governança de recursos hídricos nas áreas de fronteira: integração e ordenamento territorial. VI CONGRESSO IBEROAMERICANO DE ESTUDIOS TERRITORIALES Y AMBIENTALES. *In:* Estudios Territoriales. **Anais [...]**. São Paulo: Estudios Territoriales, 12 set. 2014.

SANT'ANNA, F. M.; VILLAR, P. C. Gobernanza de las aguas transfronterizas: fragilidades institucionales en América del Sur. **America Latina Hoy**, v. 69, p. 53–74, 2015. DOI: https://doi.org/10.14201/alh2015695374

SEMPER-PASCUAL, A. *et al.* Mapping extinction debt highlights conservation opportunities for birds and mammals in the South American Chaco. **Journal of Applied Ecology**, v. 55, n. 3, p. 1218–1229, maio 2018. DOI: https://doi.org/10.1111/1365-2664.13074

SILVEIRA, C. V. DA *et al.* Dinâmica regional da economia paraguaia: o caso da soja e carne. (ENANPUR, Ed.) *In:* XVIII ENANPUR. **Anais [...]**. Natal: ENANPUR, 31 maio 2019.

SOUZA, C. A. DE *et al.* Aporte de sedimentos dos afluentes da margem direita do Rio Paraguai, pantanal superior – Mato Grosso. **Ciência Geográfica**, Bauru XXI, v. XXI, n. 1, p. 18–31, jan. 2017.

VILLAR. P. C.; RIBEIRO, W. C. The Agreement on the Guarani Aquifer: a new paradigm for transboundary groundwater management? **Water International**, v. 36, p. 646-660, 2011. DOI: https://doi.org/10.1080/02508060.2011.603671

VILLAR, P. C.; RIBEIRO, W. C.; SANT'ANNA, F. M. Transboundary governance in the La Plata River basin: status and prospects. **Water International**, v. 43, n. 7, p. 978–995, 3 out. 2018. DOI: https://doi.org/10.1080/02508060.2018.1490879

WARNER, J. F.; WESTER, P.; HOOGESTEGER, J. Struggling with scales: revisiting the boundaries of river basin management. **Wiley Interdisciplinary Reviews: Water**, v. 1, n. 5, p. 469–481, set. 2014. DOI: https://doi.org/10.1002/wat2.1035

ZEITOUN, M. *et al.* Transboundary water justice: a combined reading of literature on critical transboundary water interaction and 'justice', for analysis and diplomacy. **Water Policy**, v. 16, n. S2, p. 174–193, 1 nov. 2014. DOI: https://doi.org/10.2166/wp.2014.111

ZEITOUN, M.; CARRASCO VINTIMILLA, A. I. Justicia del agua transfronteriza: una lectura combinada de la literatura crítica sobre la interacción del agua transfronteriza y la 'justicia', para el análisis y la diplomacia. **Relaciones Internacionales**, n. 45, p. 31–51, 31 out. 2020. DOI: https://doi.org/10.15366/relacionesinternacionales2020.45.001

ZEITOUN, M.; MIRUMACHI, N.; WARNER, J. Transboundary water interaction II: the influence of 'soft' power. **International Environmental Agreements**: politics, law and economics, v. 11, n. 2, p. 159–178, 8 maio 2011. DOI: https://doi.org/10.1007/s10784-010-9134-6

ZEITOUN, M.; WARNER, J. Hydro-hegemony – a framework for analysis of trans-boundary water conflicts. **Water Policy**, v. 8, n. 5, p. 435–460, 1 out. 2006. DOI: https://doi.org/10.2166/wp.2006.054

Considerations for science and technology policies in the context of Amazon sustainability

Considerações para as políticas de Ciência e Tecnologia no contexto da sustentabilidade da Amazônia

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ARTICLE-VARIA

ABSTRACT

This paper presents a brief overview of Science and Technology in the Amazon from a regional perspective. We discuss the role of universities, scientific and technological institutions, and centres of knowledge, and we elaborate on the challenges of mobilising these institutions for sustainable territorial development, considering some territorial attributes and regional actors. For this purpose, we used national data and indicators of postgraduate studies, investments, and geographical distribution of Public Teaching and Research Institutions in the Amazon. Finally, we present paths for developing a regional Science and Technology strategy. We conclude that, despite considerable advances in recent decades, we still face a reality of insignificant investments in the region. It is imperative to have a

project that incorporates Science, Technology, and Innovation into productive dynamics capable of shaping a new development model in the Brazilian Amazon.

Keywords: Amazon. Regional development. Science and Technology in the Amazon. Territorial Development.

RESUMO

O artigo apresenta um breve panorama da Ciência e Tecnologia na Amazônia em uma perspectiva regional, discute o papel das universidades, instituições científicas e tecnológicas e centros de saberes, e discorre sobre os desafios para a mobilização dessas instituições para o desenvolvimento territorial sustentável, considerando alguns atributos territoriais e atores regionais. Para tanto, foram utilizados dados e indicadores nacionais da pós-graduação, investimentos e distribuição geográfica das instituições públicas de ensino e pesquisa na Amazônia e, ao final, são apresentados caminhos para o desenvolvimento de uma estratégia regional de Ciência e Tecnologia. Conclui-se que, apesar do considerável avanço nas últimas décadas, ainda se tem uma realidade de investimentos inexpressivos na região e que é imperativo um projeto que incorpore Ciência, Tecnologia e Inovação às dinâmicas produtivas, capazes de conformar um novo modelo de desenvolvimento na Amazônia brasileira.

Palavras-chave: *Amazônia. Desenvolvimento regional. Ciência e Tecnologia na Amazônia. Desenvolvimento territorial.*

1 INTRODUCTION

The expansion of the agricultural and economic frontier into the Amazon, presented as a project of national integration associated with the ideology of progress and development during the Military Dictatorship in the 1960s, was the response of both national and international capital, coordinated with the Brazilian state, to the new dynamics of the world system (Castro, 2010). The development model, devoid of adherence to territorialities and the traditional peoples and communities of the Region but integrated into the space of globalisation through an enclave economy, from mining to agribusiness – including soybeans, livestock, black pepper, eucalyptus, and oil palm, among others – persists. The construction of transportation, energy, and communication infrastructure, carrying human, ecological, economic, and cultural impacts, adapted the Amazon to capitalist objectives throughout the second half of the 20th century (Silva, 1999).

The expansion of extractive activities such as large-scale mining and agricultural projects, and in the western part of the Amazon, the promotion of subsidised industrialisation in the Manaus Free Trade Zone, promoted new urbanisation dynamics in the Region (Sathler *et al.*, 2009). It intensified an unprecedented trajectory of conflicts between these capital interests and local populations, including indigenous peoples, quilombolas, squatters, and traditional populations.

From a critical perspective of this model, this article reflects on strategies for promoting Science and Technology, starting from the realisation that these capital-carrying dynamics to the central regions of capitalism in Brazil and the world have not yet internalised, on a scale, the fruits of knowledge enough to generate sustainable socioeconomic dynamics and the provision of quality public services in the Region. On the contrary, the integration of the Amazon into national and global capital dynamics has sharpened social inequalities. This work focuses its analysis on the inequality of investments in Science and Technology, considering that the economic enclaves of the development model implemented in the Amazon have shown little capacity to produce and disseminate knowledge for the protection and sustainable use of natural resources (Becker; Stenner, 2008).

Quality education and research are fundamental to enable universal access to housing, clean energy, mobility, sanitation, security, internet, productive development, and job and income generation in an

innovative and lasting manner. As such, they are structural elements to generate innovative, productive dynamics, territorialised, that optimise the use of natural resources (Becker, 2010) from the perspective of the six axes of the ongoing Federal Government's ecological transformation plan: (i) sustainable finance; (ii) technological deepening; (iii) bioeconomy; (iv) energy transition; (v) circular economy; and (vi) infrastructure and climate adaptation (Brazil, 2023).

The institutional framework of Science, Technology, and Innovation (ST&I) plays a crucial role in consolidating the capacity of Amazonian territories to offer products, processes, and services. This dimension is essential for promoting sustainable development with endogenous and lasting bases, significantly contributing to regional development strategies (Monteiro, 2010). Due to the cultural diversity, size, peculiarities, and increasing fragility of the ecosystems in the world's largest tropical forest, Higher Education Institutions (HEIs) and Scientific and Technological Institutions (STIs) in the region should be the guiding element for planning and implementing public policies in the Amazon (Candotti *et al.*, 2023).

The Ministries of Science and Technology (in Portuguese, MCTI) and Education (in Portuguese, MEC) in Brazil have been responsible for the policy and management of Science, Technology, and Innovation (ST&I). They have focused on horizontally promoting research and personnel training through agencies such as the National Council for Scientific and Technological Development (CNPq), the Financing Agency for Studies and Projects (Finep), and the Coordination for the Improvement of Higher Education Personnel (Capes). The policy developed by these entities, particularly between 2005 and 2014, aimed to strengthen existing Higher Education Institutions (HEIs) and Scientific and Technological Institutions (STIs). It also aimed to establish new teaching and research units in the Legal Amazon region and expand campuses in rural areas. This initiative resulted in the creation of an unprecedented educational, scientific, and technological infrastructure in the region, supported by substantial investments (Candotti, 2023b).

However, this virtuous cycle, which also brought about the inclusion of indigenous peoples, quilombolas, and students from the poorest segments of the population through the Affirmative Action Law (Law 12.711/2012), was abruptly interrupted in 2016 with the Constitutional Amendment n 95 establishing a spending cap. Between 2005 and 2015, new universities and federal institutes were built, campuses expanded to medium-sized municipalities in the Amazon, teaching and research laboratories constructed in rural areas, and undergraduate and graduate courses diversified. However, the investments made to train qualified human capital have not yet been able to develop local productive forces on a sustainable basis. One reason for this gap is that qualified professionals have not been integrated into retention policies in their municipalities and regions, and the knowledge produced by HEIs and STIs is not integrated into the social demands of municipal governments, social organisations, and local productive processes managed by associations and cooperatives (Candotti *et al.*, 2023).

This scenario raises the issue that educational and research institutions and centres of regional knowledge and expertisehave not yet been able to fully contribute to regional development or integrate into national government policies, with a leading role in formulating and implementing those policies. This process of alienation, inherited from colonial times, wherein external economic and political agents think, plan, and execute qualified services (Gonçalves, 2015) in the region, reproduces the abysmal gap of inequalities reflected in all spheres of economic and social life in the Amazon, making it vulnerable to attacks from backward sectors of the agrarian and mineral economy integrated into national and global chains.

2 METHODOLOGY

The initial references for this article were gathered from the coordination of the Amazon Working Group of the Council for Sustainable Economic and Social Development (CDESS/Secretariat of Institutional

Relations), led by Professor Ennio Candotti. Candotti's contributions and his thesis on strengthening Amazonian institutions of S&T, ICTs, and HEIs, and the necessary direct involvement of the large contingent of graduates and postgraduates from the region in the effort to promote economies and social well-being, with conservation and value addition of material and immaterial aspects of the Amazon, are fully reproduced in this article. Ennio's academic contribution and leadership within the Brazilian scientific community and the Amazon have witnessed that knowledge integrated with territorial demands provides consistent advancements in collective practices and visions for paradigm shifts in development.

In order to reflect on the considerations presented to the CDESS by Candotti, a survey of national postgraduate indicators was conducted, allowing us to assess the inequalities in investment in Science and Technology when comparing the Amazon with other regions. For example, the concentration areas of postgraduate courses, the number of graduated students, and the production of scientific articles were analysed. The geographic distribution of ICTs in the Region and investments in public HEIs in the Amazon were also examined, aiming to outline a brief overview of the challenges for mobilising HEIs and ICTs in a strategy aimed at reducing inequalities as a regional development policy on territorial bases, addressing their specificities and multiple scales.

A selected bibliography on regional development and disparities in scientific and technological infrastructure among regions was consulted. Institutional portals of the federal government containing public information were digitally collected, especially from the Coordination for the Improvement of Higher Education Personnel (Capes), to organise quantitative data illustrating this work, which were organised into tables and graphs and served as inputs for outlining this brief overview of ST&I in the Amazon.

Finally, recommendations are presented for the integration of the Amazon into the national plan for ecological transformation, which aims to change the foundations of Brazilian industrial production towards a sustainable matrix, with Bioeconomy among its main lines. Additionally, proposals are put forward that relate reducing social inequalities to strengthening and activating higher education and technological formation systems and scientific development, integrated into sustainable territorial development in a broad sense.

3 INEQUALITIES IN SCIENCE AND TECHNOLOGY

The Military Dictatorship organised the occupation of the Amazon for the benefit of large national and international capital through growth poles implemented with tax benefits and financing provided by a framework of policies and institutionalities implemented by Sudam (Superintendence for the Development of the Amazon) and the Bank of the Amazon (Basa). Activities considered potential for economic growth in the region were "livestock, agriculture, plant, mineral, and animal extraction, and industry" (Sudam, 2019).

The implementation of the policies of the military governments was influenced, among other factors, by the theory of poles by François Perroux, a French economist, which proposed inducing growth through the allocation of resources to activities with recognised regional comparative advantages capable of radiating development and altering rural and urban dynamics:

> Thus, they were anchored in a vision of regional development based on the need for spatial concentration of capital, capable of producing imbalances, and, as a result of these indirect development processes through the emergence of a chain of forward and backward linkages of productive activities considered "key" (Monteiro, 2005).

Nearly sixty years later, the development of the Amazon is still dependent on the dynamics derived from these poles, whether from the industrial one of the Manaus Free Trade Zone, created in 1967, or

from the Agribusiness, Agrominerals, and Forest poles, as described by the Polamazônia program of 1974, which advanced over the forests, soils, and subsoils of the Amazon in this period. The mineral economy, with highlights such as Carajás, Trombetas, and Amapá, has seen a dizzying advancement since the publication of the Brazilian Mineral Yearbook I in 1972.

This model promoted the growth of agricultural activities in the Amazon and regional specialisation in the export of raw materials, led by enterprises that operate as enclaves, more or less intensive in technologies and innovations but incapable of transferring knowledge and well-being to local populations. On the contrary, it led to the territorial expropriation of small family producers, indigenous peoples, quilombolas, and other traditional peoples, normalised by new state legislative and administrative instruments, such as, for example, in 1971, which established the Union's domain over unoccupied lands within 100 km along federal highways. The new public policies shaped state intervention according to the different territorial arrangements required during the international division of labour and the needs of large capitals, especially agribusiness and mining monopolies.

Science in the Amazon was originally linked to the interests of global geopolitics and the national state in the exploitation of the region's natural resources, from research to improve extractive and agricultural production to providing adequate sanitary conditions for the economic extraction of resources and the construction of infrastructures that would enable enterprises to compete in the international market (Nonato; Pereira, 2013). The region's new role as a frontier for exporting natural products conferred upon it the "character of a 'scientific frontier,' that is, a socioterritorial unit capable of being incorporated within a State project that takes it as a challenge for knowledge" (Faulhaber, 2005, p.241). The author refers to Arthur Cézar Ferreira Reis's Report of 1956, which draws the Brazilian state's attention to the fact that the Amazon is "a world to be discovered and identified."

The first public scientific institutions established in the Amazon were the Emílio Goeldi Paraense Museum, still in the 19th century, followed in the 20th century by the School of Pharmacy of Pará; the Faculty of Dentistry, Medicine, and Surgery of Pará; the School of Engineering of Pará, the Evandro Chagas Institute; the Agronomic Institute of the North, and the School of Agronomy of the Amazon. In the 1950s, influenced by the post-war technological race, the National Institute of Amazonian Research and the Federal University of Pará were created (Nonato; Pereira, 2013).

In the 1960s and 70s, the Federal Universities of Amazonas, Maranhão, and Acre were inaugurated. The Free University School of Manáos (1909) and the University of Manaus (1913) are considered the first universities in Brazil in the History of Ufam. Between the years of foundation or reestablishment, from the 1950s to the 1990s, the growth of these institutions was inertial.

During the 2000s, there was a significant effort to decentralise universities that, in the previous period, were restricted to the main capitals of the Region, Belém and Manaus. Today, the nine states of Legal Amazonia gather in 160 of its municipalities, 300 campuses of Federal Universities, Federal Institutes of Higher Education, and public Institutes of Science and Technology (Almeida, 2023).

There have been many significant advances in teaching, research, and development in the last twenty years and technologies kept within institutions or published in specialised media. However, the knowledge produced in the Amazon has not yet been able to change the regional development model broadly and systemically. There are several products, processes, and biodiversity value chains benefiting from innovations originating in local scientific institutions; however, these initiatives have not shown the strength to influence a shift away from the primacy of the primary-exporter model as a drain on natural resources and the flows of public and private investments directed to the Region. Similarly, knowledge and technologies for management, production, and processing of products generated by public research have not yet been the subject of diffusion and extension capable of promoting innovations and economic and social dynamics with an impact on reducing inequalities among local populations.

Not only in the Amazon but throughout Brazil, the profile of Brazilian science has undergone a major transformation in recent decades. On one hand, there has been a considerable increase in national scientific production linked to the vertiginous growth of postgraduate education in the last 20 years (Schwartzman, 2022). However, this growth is still marked by significant inequality among the five regions.

The availability of higher education courses in the North region[1] is proportionally much lower when compared to the Southeast region, for example. In 2022, there were 387 courses offered in the North region, representing only 12% of the 3,181 courses offered in the Southeast region (Brazil, 2024). Additionally, there is a pronounced shortage of Exact and Earth Sciences and Engineeringpostgraduate programs, representing only 13% of the courses offered in the North region (Figure 1) (Brazil, 2024). This situation limits the possibility for young people to choose careers in these areas. For instance, there are only two Botany programs and two Geology programs, and out of the more than sixty units of Embrapa, only nine are located in the Amazon. The budget for these units, along with 26 stations and nuclei of the Company, in 2022 was R$480 million, 15.4% of Embrapa's global budget, which was R$3.1 billion in the same year (Candotti, 2023a).

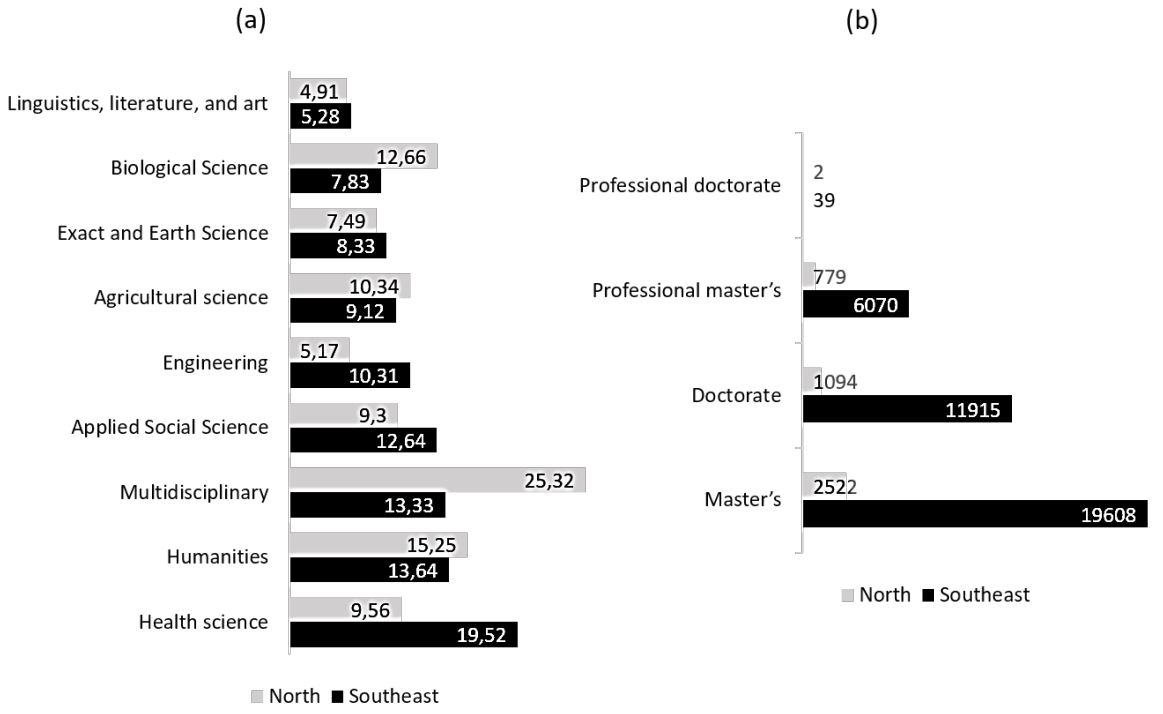

Figure 1 – (a) Percentage of postgraduate courses by major areas - North and Southeast regions; (b) Graduates by academic degree in the North and Southeast regions

Source: Brazil (2024). Authors' elaboration.

In the same year, in the North region, 4,397 students were awarded degrees, including masters and doctors, about 19 masters and 4.5 doctors per 100,000 inhabitants, just over 10% of those awarded in the Southeast region, which totalled 37,632 postgraduates, 30 masters, and 14 doctors per 100,000 inhabitants (Figure 1b).

The qualifications of researchers, the availability of courses, and the scientific and technological infrastructure reflect regional scientific production's performance. While in the Southeast, there were 16 publications of articles in journals or magazines per 100,000 inhabitants, in the North region, this indicator reached only 5 publications (Brazil, 2024).

Considering the criteria of the main Research and Development (R&D) calls, these distortions penalise the allocation of resources for the Amazon and reduce the capacity of regional ICTs to compete with those of the Southeast-South, and consequently isolate the knowledge about the region in institutions outside its territory, with low involvement of Amazonian society. This is a problem that historically repeats itself with the place of the Amazon in Brazil's development, that is, a logic of the region being seen in a reductionist way as a stock of raw materials, with a predominance of commodity exports (Monteiro, 2021). An expectation is projected for the Amazon to resolve the enormous problems caused by the imbalances of sixty years of a model that destabilised its socio-environmental conditions with its own means in conditions where the inequality of all economic, social, and infrastructure factors are not considered.

Indeed, in recent years, few policies have advanced in the effort to consider the territorialities and specificities of the region, among them health, special selection processes for indigenous and quilombola peoples, tropical research and health programs from Fiocruz, network doctorates like Bionorte, among other successful efforts.

At the heart of the issue is how to treat unequal things as unequal. This is the guideline that guided Celso Furtado's formulations about the Northeast and elevated regional development planning policies in Brazil to a higher level. To the historical construction of regional asymmetries inherited from the colonial period and the way we constituted ourselves as Empire and Republic, Furtado (2013a) associated the Brazilian industrialisation policy, driven by strong political centralism, since Getúlio Vargas, which shaped the division of labour in the country, between an industrialised Center-South and the other regions producing raw materials, subordinate to it.

This diagnosis marked a disruptive change of course led by Celso Furtado, taking Sudene from Rio de Janeiro to the Northeast and, from there, redesigning regional policies based on territorialised studies and human capital (Theodoro, 2020). The clash of interests faced by Celso Furtado in the course of building policies that would withdraw control of federal resources from the northeastern oligarchies and give these resources a social and economic purpose of reducing structural inequalities was a new approach in the conception of macro public policies, guided by the need for regionalisation radicalisation.

Already in the 2000s, reflecting on what the author called the "Metamorphoses of Capitalism," he denounced the increasingly greater income disparities between peripheral and central countries and the emergence of "a time of great enrichment of humanity and, at the same time, of aggravation of the misery of a broad majority" (Furtado, 2013b, p. 452). To face these trends increasingly associated with the capitalist accumulation process, Furtado indicated strategic thinking about the future and its possibilities:

> More than ever, the new challenges will be of a social nature, and not mainly economic, as occurred in previous phases of capitalist development. Political imagination will thus have to take precedence. It is wrong to pretend that there is no longer room for utopia. This is the greatest challenge facing the new generation; I invite them to take it on without fear. (Furtado, 2013, p. 457)

Over these sixty years, the Amazon has not benefited from policies commensurate with its social, environmental, and economic challenges. Income transfer programs like Bolsa Família, housing programs like Minha Casa Minha Vida, have had emancipatory impacts on the most vulnerable families. However, the program with the most structural impact was the University Restructuring Program (Reuni), with the creation of two Federal Universities in the interior of the state of Pará[2] and the expansion of campuses to municipalities with more than 50,000 inhabitants. In the wake of these investments, there was also a multiplication of interiorised Technological Institutes and State Universities campuses.

It is important to note that, over the past sixty years, regional development policies for the Amazon have not had a structural character of reducing inequalities with a social component, as in the Northeast, with specificities aimed at the region benefiting from industrial deconcentration that occurred from

the 1980s onwards. Along with industrialisation, universities in the Northeast followed this dynamism, expanding their formative spectrums and thus integrating themselves into the country's knowledge system at higher levels (Bacelar, 2014).

A recent study by Elsevier reported in the press (Yamamoto, 2023) identified that Brazilian universities and research centres were the main contributors to publications on the Amazon, made between 2012 and 2021 and that the University of São Paulo (USP) is the institution that publishes the most about the region, with over four thousand articles in the period. In second, third, and fourth places are the Federal University of Pará (UFPA), the National Institute of Amazon Research (Inpa), and the Federal University of Amazonas (Ufam), based in Pará and Amazonas.

However, academic rankings must consider the sizes of the institutions. In this case, when considering the publication/researcher indicator in relation to the number of publications, the results would be very different: "the productivity of Amazonian institutions is much higher (about three articles published per person in the period from 2012 to 2022) compared to any Brazilian University (less than one article per person in the same period)" (Pedro Pequeno, personal communication). Having profiles and focus on regional issues in their various themes and contexts, even with very limited resources, researchers from Amazonian institutions continue to maintain their productivity. With more doctors, masters, and research resources, Amazonian institutions would significantly increase scientific production and, more than that, grow in the impact of knowledge on human, economic, and environmental development in the region.

A recent study on the distribution of funding and scholarships from CNPq and Capes in Brazil for biodiversity studies (Stegmann *et al.*, 2024) highlights that, although per capita allocation is equitable between regions, aspects such as the geographical dimension and ecological relevance of the Brazilian Amazon must be considered. In the North region, 1.5 times more researchers are working on biodiversity programs than in the Southeast region, a scenario that reverses when it comes to resource distribution. While the Southeast region received about US$ 2 per km^2 to finance biodiversity research through CNPq's Universal call, the North region received US$ 0.13. This deficit in research investment is incompatible with the hyper-diversity of the forest valorisation strategy through technological enhancement.

The numbers mentioned here demonstrate high productivity per researcher, even in adverse situations of infrastructure, continental geographic distances, and discontinuity in research funding. This means that the insertion of these researchers into the ST&I environment, even with adversities, makes research cheaper than for external researchers and their insertion into the territorial realities in which they study.

4 THE ROLE OF UNIVERSITIES, SCIENTIFIC AND TECHNOLOGICAL INSTITUTIONS, AND CENTERS OF KNOWLEDGE

Despite the unfavourable investment scenario compared to other regions of the country, since 2005, Amazonian Higher Education Institutions have graduated an unprecedented number of professionals, more than doubling the number of master's degrees and quadrupling the number of doctoral degrees (Almeida, 2023). The educational, scientific, and technological infrastructure responsible for these results is present in 166 municipalities, where there are 330 campuses linked to 34 research institutes and public federal and state universities, as well as other scientific institutions (Almeida, 2023).

The expansion of Higher Education and Science, Technology, and Environment Institutes to the interior of the Amazon and beyond was a political guideline of the Lula and Dilma governments[3]. These institutions now employ hundreds of professionals, graduates, masters, and doctors who are educating thousands of young people from urban and rural peripheries and forest peoples.

Moreover, these institutions play a fundamental economic role for the municipalities where they are located by directing a significant flow of public resources to these cities, such as the R$ 7.6 billion budgeted for 2024 in the North region. These resources are extremely significant, as can be observed when comparing these values with municipal budgets. With the exception of Belém and Manaus, which are atypical cases because the resources received by the federal universities of Pará and Amazonas are redistributed to several campuses within these states, the dimension of the financial contribution of HEIs can be assessed by their budgets. In this regard, in at least five capitals of the Region: Macapá, Rio Branco, Boa Vista, Porto Velho, and Palmas, the budgets of Higher Education Institutions correspond, on average, to 26% of municipal budgets, as detailed in Table 1.

Table 1 – Higher Education Institutions (HEIs) - Financial contribution to the municipality seats in absolute values and relative to the public budgets of each municipality seat (Current values in R$ millions of 2024)

Municipality seat	*Universities and Federal Institutions*	*Budget of HEIs*		*Budget of the municipality seat (B)*	*(A/B) %*
		By institution	*By municipality seat (A)*		
Belém	Universidade Federal do Pará	1.802,30	2.740,03	5.300,00	51,7
	Instituto Federal do Pará	626,94			
	Universidade Federal Rural da Amazônia	310,8			
Santarém	Universidade Federal do Oeste do Pará	243,92	243,92	1.804,55	13,52
Marabá	Universidade Federal do Sul e Sudeste do Pará	174,05	174,05	1.996,17	8,72
Manaus	Fundação Universidade do Amazonas	974,66	1.438,96	9.088,00	15,83
	Instituto Federal do Amazonas	464,3			
Macapá	Universidade Federal do Amapá	288,96	418,09	1.620,91	25,79
	Instituto Federal do Amapá	129,13			
Rio Branco	Universidade Federal do Acre	441,46	605,73	2.231,59	27,14
	Instituto Federal do Acre	164,27			
Boa Vista	Fundação Universidade Federal de Roraima	301,83	472,01	2.452,36	19,25
	Instituto Federal de Roraima	170,18			
Porto Velho	Universidade Federal de Rondônia	368,99	718,13	2.640,86	27,19
	Instituto Federal de Rondônia	349,13			
Palmas	Fundação Universidade Federal do Tocantins - Palmas	381,46	694,47	2.291,00	30,31
	Instituto Federal de Tocantins	313,01			
Araguaína	Universidade Federal do Norte de Tocantins	116,53	116,53	1.120,99	10,39
	TOTAL	**7.621,92**	**7.621,92**	**30.546,43**	**24,57**

Source: https://portaldatransparencia.gov.br/. Annual Budget Law (LOA, 2024) of the host municipalities.Accessed on 12/02/2024. Authors' elaboration.

According to Table 1, the institutions mentioned are located in capital and medium-sized cities. The potential of these institutions for promoting endogenous development is vast and multidimensional, especially if policies regarding Teaching, Research, and Extension are coordinated around common goals in each of the municipalities where they are located. For a more precise assessment of this potential, the scientific and technological infrastructure of other institutions should be included, such as Embrapa, which is present in all states of the Amazon and has 26 experimental campuses and various laboratories, including those for soil and plant physiology, agribusiness, fishery technology,

entomology, biological control, and animal and plant health, among many others, being an example of the possibilities open to interinstitutional territorial arrangements in the Amazon.

These numbers demonstrate that overcoming the relative lag of the Amazon in the country's scientific and technological race requires a bold and continuous plan to increase the capacity for training professionals at the undergraduate and graduate levels, associated with an increase in scholarships and other incentives for research development on a large scale, as well as mechanisms to encourage the retention of PhDs in the region (Monteiro; Albuquerque; Albuquerque, 2024).

Currently, however, it is observed that HEIs and ICTs could expand articulation and cooperation among themselves, coordinating their Institutional Development Plans (IDPs) with joint goals and strengthening strategies that encourage complementarity between these institutions, with more network projects, especially in graduate education and research. What prevails is a race that does not connect the knowledge generated in universities and ICTs with the relevant social processes for local and regional development, with the central axis being the ecosystem needs and territorial specificities (Monteiro, 2021).

Therefore, it becomes fundamental for the Brazilian government to continue the program of internalising education and research institutions in the Amazon, which is still heavily concentrated in the region's largest cities, with great potential to become increasingly widespread. In addition to the coordinated expansion, the profound challenges of Amazonian realities and diversities require continuous stimulus for internal cooperation among institutions. Their trained professionals can amplify the impact of knowledge production and Extension on productive processes, innovative social initiatives, and efficiency in implementing public policies emanating from state and national governments.

The network of protected areas in the Amazon, including Indigenous Lands and Conservation Units (UCs) for sustainable use and integral protection at the three levels of government, covers 198 million hectares, equivalent to 47% of the biome's territory (MMA, 2023). About 28% are UCs, and 72%, or 115 million hectares, correspond to the extension of Indigenous Lands. On the other hand, the populations living in urban areas of the Amazon amount to 28 million inhabitants (IBGE, 2021), in a network of cities that grows without infrastructure and with low physical and telecommunications connectivity with other regions of the country.

The forms of occupation and land use in the Amazon are decisive for the development of the territorial strategy. A strategy for inducing good productive practices and protecting peoples and ecosystems can be successful if it starts with socioeconomic segments linked to the territories of agrarian reform settlements, extractive reserves, quilombola territories, Indigenous Lands, and riverine peoples of the Amazon. Increasing the productive and social efficiency of these territories is essential to protect areas that still hold forests (about 50% of the Amazon) and to stimulate other segments to choose sustainable production systems, as well as to add value to natural resources wasted or exported as commodities, which prevails in the current economic matrix of the Amazon.

To have an idea of the magnitude of the challenge, the number of Extractive Reserves (Resex) existing in Brazil from 1990 to 2019 reached 95 units, corresponding to an area of 15.5 million hectares, with 29 states (30.53%) and 66 federal (69.47%) reserves, with a population of over 60 thousand people (Brazil, 2020). Of these, 72 are continental Resex, and 23 are marine Resex, corresponding, respectively, to 1.38% of the national territory and 0.17% of the coastal area. In the Amazon biome, 80% of the Resex are located, representing 95% of the total area of these UCs (Euler; Silva; Almeida, 2021).

Figure 2 highlights the advancement of the agricultural frontier over the Amazon and the location of HEIs and ICTs that could be mobilised for research development with a strong identity with the needs of the territories, considering the impacts already consolidated, those in progress, and those projected in the medium and long term.

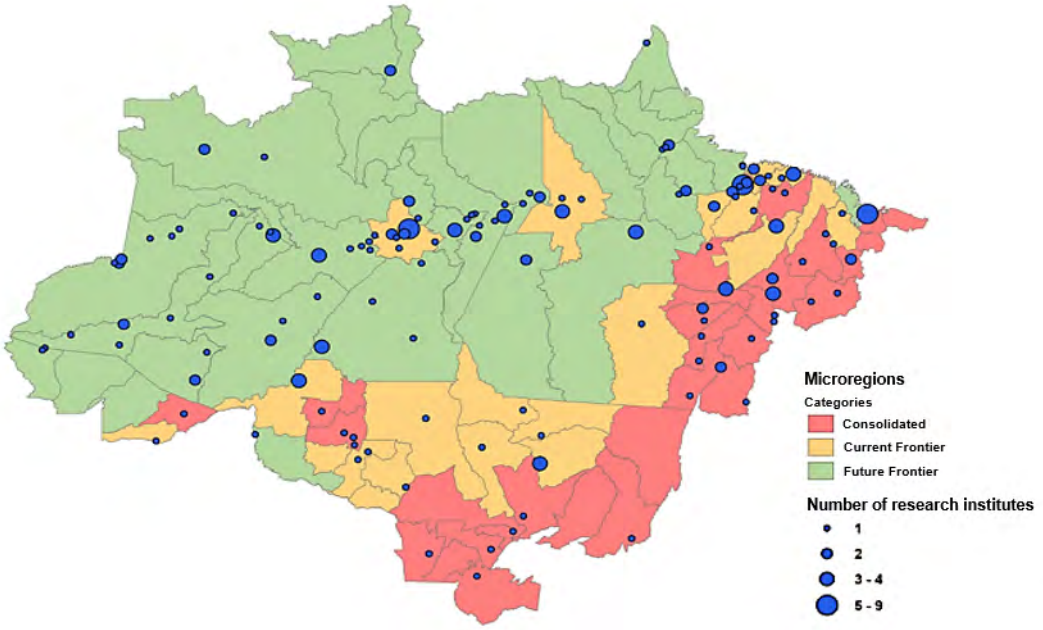

Figure 2 – Number of education and research institutions in microregions – agricultural frontier advancement

Prepared by: José Maria Cardoso da Silva and Ima Vieira (Unpublished data).

The Amazon biome comprises 85 microregions in different stages of economic frontier advancement, considering the percentage of native vegetation as follows: below 50% - consolidated; between 50-80% - current frontier; and above 80% - future frontier. These regions adhere to an occupation model based on the exploitation of natural resources and forest conversion, which implies biodiversity loss on a large scale (Vieira *et al.,* 2005; Vieira; Silva, 2024). An approach of bioeconomy as a solution to ensure "standing forests" requires strong governance, coordination, and integration with various sectors and social participation. This includes valuing regional human and social capital and the knowledge rooted in local communities (Vieira, 2023).

5 CHALLENGES FOR MOBILISING SCIENTIFIC INSTITUTIONS FOR REGIONAL DEVELOPMENT

The current contingent of qualified teachers and researchers in various fields of knowledge, such as Engineering, Botany, Sociology, Health, Law, Economics, Biotechnology, among dozens of other disciplines, "awaits to be summoned to participate as citizens, politicians, and professionals in the battle for respect for rights, environments, and diversity currently being waged in the Amazon". (Candotti, 2023b, p.1).

Higher education institutions and research institutes in the Amazon mobilise intelligence and knowledge that occupy territories close to the fields where the battle for development, knowledge, and conservation is being fought. The qualified human resources of these institutions can and are interested in contributing to the definition of the modes of implementation of social, economic, scientific, and environmental policies determined by the government. This mobilisation of forces can be accompanied by another, which offers a training program for forest peoples in community centres and campuses of universities and Federal Institutes installed in the interior, enabling them to participate and earn income in efforts to effectively utilise natural products, reforestation, collection of forest products, and management of conservation units. In short, participating in programs that recognise the value of the botanical and social diversity of the forest.

Professor Ennio Candotti proposed as a guideline "strengthening community centres and campuses of public universities in the interior of the Amazon" to mobilise citizens and young people from the interior

and expand regional capacity in Sciences and in the execution of policies for the region and beyond, and facing the challenge of keeping qualified young people in the interior of the Amazon, allowing public policies to be guided by citizens who live in the region, in the countryside, in urban areas, in floodplains, and along the rivers for cultural, scientific, and sustainable economic development.

> It is noted that from the seeds planted in 2005, we are harvesting important fruits for the development of the Amazon interior that can now help address the challenges posed by the devastations of recent years: in the last twenty years, the campuses of Federal and State Universities, Embrapa, and other Institutes, installed in the municipalities of the interior of the Amazon, have multiplied (Candotti, 2023b, p.1).

Ennio Candotti formulated a proposal, forwarded to the Council for Sustainable Economic and Social Development – CDESS, where he was a representative for the Amazon, for a scholarship program that guarantees a continuous training process in postgraduate studies, with the counterpart of providing services to federal, state, and municipal public bodies committed to local development consultations for sustainable territorial development.

In this sense, a Science, Technology, and Innovation System in the Amazon should be created, advised by a regional conference, to, among other things, outline a research agenda oriented towards local needs, as well as define strategic fields of knowledge with innovative potential for inclusive and sustainable regional development.

The proposed strategy for mobilising the capacities of ST&I installed in the interior of the Amazon and their articulation with the territorialisation of priority segments for the development proposed here: family farmers, indigenous peoples, populations of urban social and economic peripheries, quilombolas, extractivists, and fishermen, among other traditional peoples of the Region, can be made viable by a mix of research, extension, and continuing education scholarships and by government actions and programs and projects aimed at boosting sustainable solutions for the Amazon.

The idea is to territorialise the ST&I infrastructure, with the main agents of action being the graduates of educational and research institutions trained in the first wave of investments in higher education in the interior of the Amazon during the Lula and Dilma governments. From the perspective of innovation, the sense of systemic integration with social, cultural, and continuous productive modernisation processes is mentioned here (Cassiolato; Lastres, 2005). The authors converge on the understanding of this article concerning stimulating local and multi-scalar creativity.

> ...the relevance of incremental and radical innovations and the complementarity between them, as well as between organisational and technical innovations and their distinct internal and external sources (...). This, in turn, is seen as an organisation inserted in socio-economic and political environments that reflect specific trajectories. Thus, each case must be understood according to its peculiarities, its position, and its role in national and international contexts, in order to evaluate which strategy should be most appropriate for its development (Cassiolato; Lastres, 2005, p. 37).

The statement below, uttered by Professor Ennio Candotti in his efforts to be heard in the profusion of solutions for the Amazon, presented in the current context by multiple agents of the national and international scene, is mentioned here as a general recommendation:

> The Amazon rainforest, its ecosystems, and diverse peoples attract worldwide ecological, cultural, and climatic attention. Its documented and consolidated knowledge cannot be neglected. The communities and associations living in the interior must actively participate in this mission of monitoring and research (Candotti *et al.*, 2023, p.3).

Next, we reproduce in full the proposals sent by Ennio Candotti, as notes for discussion at the Amazon Summit.

August Letter (suggestions from Ennio Candotti of the Museum of the Amazon)

When addressing Regional Integration, among the recurring themes is the challenge of how to promote an educational program committed to training and retaining young people - including young people from forest peoples - in the region, enabling them to master the art of knowing and sustainably exploring, with science, technology, experience, and traditional knowledge, the forest, the biodiversity and geodiversity of the lakes, surface waters, and groundwater of the Amazon.

To the goals of intensifying youth training, we must add the education and vocational training of farmers and fishermen, who live in the interior of the Amazon, allowing them to master agroforestry techniques, seed collection, pasture restoration, reforestation, and environmental monitoring as well as the management and use of fishery resources.

In Brazil, we propose to train young people and farmers not only in large urban centres but mainly in the interior of the Amazon, in the municipalities and territories immersed in natural laboratories, in the numerous campuses of public institutes and universities located there, and offer them quality of life, economic, and cultural conditions to remain there, close to the battlefields of forest and water defence, human rights, indigenous, and community rights (...).

The great challenge we face in institutionalising centres, stations, or institutes in the interior is to equip them with investments, skills, and infrastructure so that they can contribute to the development of local production systems, particularly in agricultural, fishing, extractive, handling, or bioeconomy industries (...). We ask under what conditions development poles can prosper (exploiting natural ecosystems and the bioeconomy)?

In response, we mention items that require attention from Public Policies to address deficiencies in: quality of basic education, health care and prevention, energy stability and internet access, access to clean water and sanitation, speed in production transportation, and also the absence of basic instruments of the Judiciary System such as the Public Defender's Office (there are only two Public Defenders in the region occupied by São Gabriel da Cachoeira, Santa Isabel, and Barcelos in Amazonas, an area of approximately 50,000 km2 - equivalent to a Paraíba).

The design of public policies capable of promoting higher education, vocational training, and the desired development should initially observe which investments are being made by the Union and States, in each municipality headquarters of campuses of public education institutions and dimension the costs of the recommended interventions to promote the retention of trained young people, doctors, engineers, anthropologists, etc. (...) However, resources for operational and capital costs are insufficient to operate and utilise the installed human resources infrastructure, even if precariously.

How then to finance the equipment of the campuses and improve the urban infrastructure of these municipalities? We suggest integrating the institutes and their campuses (and the investments made in salaries, etc.) into a Development Project that contemplates strengthening not only higher education in the interior but also health, environment, and education institutes, energy sources, the telecommunications network, and seek new resources to finance them in their own funds or in C&T funds such as the FNDCT4, environmental funds like the Amazon Fund, or incentives for R&D in Suframa of MDIC, FUST, telecommunications, BNDES, SUDAM, and State FAPES of the Amazon (...). The creation of an Institute of the Mouth of the Amazon (with campuses in different states such as Amapá and Pará) dedicated to research and monitoring of coastal and marine environments, the transition of life between freshwater (Amazon River) and saltwater (Oceanic) environments is being proposed by the institutes of Pará and Amapá (Candotti, 2023).

To the above-mentioned vocalised proposals, the need to link national strategies to the goals of the Belém Charter, the Amazon Summit, and intergovernmental efforts to reduce carbon dioxide (CO2)

emissions through the sustainable use of natural resources and the insertion of the Amazon in Brazil's new industrialisation efforts is added. Amazonian translations for productive promotion policies and production and territorial engagement of scientific knowledge and local knowledge are necessary.

According to Bourg (2002 *apud* Freitas, 2023, p.213), he states: "the political-institutional principles that legitimise the implementation of education, science, technology, and art programs to development models are social and political requirements." In the case of the Amazon, the author adds that the principles that should guide the implementation of educational, scientific, and technological policies and programs should be guided by the assumption of the "political commitment to instrumentalise it to combat poverty and social inequality (...), building sustainable bases for the cycle of lasting development for Brazil" (Freitas, 2023, p.213).

Regional development planning, based on territorial and ecosystemic bases, presents itself as imperative since it is in the territories where the problems occur and the chances of the most effective solutions involving local intelligence happen. The interaction of human action in Amazonian landscapes interconnects productive processes, cultures, contextualised environmental dynamics (Vieira, 2023), and these are important aspects for an interdisciplinary scientific agenda for the region.

The idea of ecosystemic integration that occurs in the frameworks of environmental and human degradation, when applied to solutions for development in sustainable territorial bases, enhances the incorporation of local factors, notably the knowledge and efforts of its qualified professionals.

6 CONCLUSIONS

The promotion of sustainability policies in the Amazon depends on territorially referenced knowledge, with broad engagement of HEIs and ICTs, acting in cooperative strategies and oriented towards short, medium, and long-term results. Overcoming inequalities in investments in Science, Technology, and Innovation, as well as in research incentives, contextualised in local problems to be addressed so that the region enters a cycle of green economy, broadly, multiscale, and inclusive.

The ideas and proposals presented here suggest that it is necessary and urgent to formulate a strategy that enables the integration of graduates from Amazonian educational and research institutions directly into the advisory of productive processes and through a continuous training process, with the counterpart of providing services to federal, state, and municipal public agencies, in programs aimed at sustainable territorial development.

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NOTES

1 | The data from Capes is for the North region and not for Legal Amazonia.

2 | Federal University of Western Pará (Ufopa) and Federal University of Southern and Southeastern Pará (Unifesspa). Accessible at https://reuni.mec.gov.br/, accessed on 02.02.2024.

3 | Available at https://reuni.mec.gov.br/, accessed on 02.02.2024.

4 | FNDCT – National Fund for Scientific and Technological Development; MDIC - Ministry of Industry and Commerce; Fust - Telecommunications Service Universalization Fund.

REFERENCES

ALMEIDA, A. W. B. *et al.* **Projeto Universidades, Institutos de Pesquisa e Museus na Amazônia**, citado por CANDOTTI, E. Grupo de Trabalho Amazônia, CDESS/SRI, Presidência da República, 2023.

BACELAR, T. Nordeste: desenvolvimento recente e perspectivas. *In:* GUIMARÃES, P. F. *et al.* (org.). **Um olhar territorial para o desenvolvimento**: Nordeste. Rio de Janeiro: Banco Nacional de Desenvolvimento Econômico e Social, 2014. p. 540-560. Available in: http://web.bndes.gov.br/bib/jspui/handle/1408/14600. Acessed in: 10 abr. 2024.

BECKER, B.; STENNER, C. **Um futuro para a Amazônia**. São Paulo: Oficina de Textos, 2008. 152 p.

BECKER, B. K. Novas territorialidades na Amazônia: desafio às políticas públicas. **Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas**, v. 5, n. 1, p. 17–23, jan. - abr. 2010. DOI: https://doi.org/10.1590/S1981-12220100000100003.

BOURG, D. Les fondements du développement durable: la limite et les fins. *In:* DUCROUX, A. M. **Les nouveaux utopistes du développement durable**. Éditions Autrement - Collection Mutations, France, 2002.

BRASIL. Ministério da Educação. Capes. **Plataforma Sucupira**. Available in: https://sucupira.capes.gov.br/sucupira/. Acessed in: 08 fev. 2024.

BRASIL. Ministério da Fazenda. **Transformação Ecológica**: exemplos de ações em andamento. Ministério da Fazenda, 2023. 11p. Available in: https://www.gov.br /fazenda/pt-br/acesso-a-informacao/acoes-e-programas/transformacaoecologica/ apresentacoes/transformacao-ecologica.pdf. Acessed in: 10 abr. 2024.

BRASIL. Ministério do Planejamento e Orçamento. IBGE. SIDRA. **População por grupos de idade**. Available in: https://sidra.ibge.gov.br/tabela/1209#resultado. Acessed in: 14 fev. 2024.

CANDOTTI, E. *et al.* **Amazônia em 14 tempos. Jornal da Ciência**, SBPC, 19 jul. 2023. Available in: https://www.jornaldaciencia.org.br/amazonia-em-14-tempos/. Acessed in: 28 fev. 2024.

CANDOTTI, E. **Amazônia Sustentável, contribuições das ciências sociais, do multilateralismo e da sociedade civil**. 5 de agosto de 2023a. Apresentação em Power Point. Belém (PA), Seminário Flacso e Fundação Alexandre Gusmão.

CANDOTTI, E. **Carta Aberta ao Presidente Luís Inácio Lula da Silva**, manuscrito, Manaus, 2023b.

CASSIOLATO, J. E.; LASTRES, H. M. M. Sistemas de inovação e desenvolvimento: as implicações de política. **São Paulo em Perspectiva**, v. 19, n. 1, p. 34–45, mar. 2005. DOI: https://doi.org/10.1590/S0102-88392005000100003.

CASTRO, E. **Amazônia na encruzilhada**: saque colonial e lutas de resistência. São Paulo (SP): Globo, 2010. p. 105 -122.

EULER, A. M. C.; SILVA, J. E. C. DA; ALMEIDA, H. S. Reservas extrativistas. *In:* CRESTANA, S.; CASTELLANO, E. G.; ROSSI, A. (ed.). **Espaços especialmente protegidos e o Direito Ambiental**. Brasília, DF: Embrapa, 2021. cap. 13, p. 755-770. (Direito Ambiental, v. 4).

FAULHABER, P. A história dos institutos de pesquisa na Amazônia. **Estudos Avançados**, v. 19, n. 54, p. 241–257, ago. 2005. DOI: https://doi.org/10.1590/S0103-40142005000200014

FURTADO, C. A Operação Nordeste. *In:* D'AGUIAR, R. F. (org.). **Essencial Celso Furtado**. São Paulo: Penguin Classics. Companhia das Letras, 2013a, p. 337-361.

FURTADO, C. Metamorfoses do capitalismo. *In:* D'AGUIAR, R. F. (org.). **Essencial Celso Furtado**. São Paulo: Penguin Classics. Companhia das Letras, 2013b, p. 450-457.

GONÇALVES, C. W. P. **Amazônia, Amazônias**. São Paulo: Editora Contexto, 2015. 178p.

MONTEIRO, M. DE A. A institucionalidade da ciência, tecnologia e inovação na Amazônia e a conformação de trajetórias e paradigmas tecnológicos. **Novos Cadernos NAEA**, v. 13, n. 2, p. 235-260, 2010. DOI: http://dx.doi.org/10.5801/ncn.v13i2.480.

MONTEIRO, M. DE A. Meio século de mineração industrial na Amazônia e suas implicações para o desenvolvimento regional. **Estudos Avançados**, v. 19, n. 53, p. 187–207, abr. 2005. DOI: https://doi.org/10.1590/S0103-40142005000100012

MONTEIRO, R. **Amazônia**: espaço-estoque, a negação da vida e esperanças teimosas. Belém: Editora Dalcídio Jurandir, 2021.

MONTEIRO, R.; ALBUQUERQUE, E.; ALBUQUERQUE, I. A Bioeconomia como oportunidade e desafio para o desenvolvimento industrial, a preservação da vida e do bem-estar na Amazônia. *In:* **Tensões e Vivências Afirmativas na Amazônia Brasileira**. Espanha: Edições Universidade de Salamanca, 2024.

NONATO, J. M. D.; PEREIRA, N. M. Histórico da ciência na Região Norte do Brasil: a ciência em ação na Amazônia brasileira. **Perspectivas: Revista de Ciências Sociais**, v. 44, p. 93-124, 2013.

SATHLER, D.; MONTE-MÓR, R. L.; CARVALHO, J. A. M. DE. As redes para além dos rios: urbanização e desequilíbrios na Amazônia brasileira. **Nova Economia**, v. 19, n. 1, p. 11–39, 2009. DOI: https://doi.org/10.1590/S0103-63512009000100002

SCHWARTZMAN, S. Pesquisa e Pós-Graduação no Brasil: duas faces da mesma moeda? **Estudos Avançados**, v. 36, n. 104, p. 227–254, abr. 2022. DOI: https://doi.org/10.1590/s0103-4014.2022.36104.011.

SILVA, M. C. DA. **Metamorfoses da Amazônia**. Manaus: Editora da Universidade do Amazonas, 1999. 309 p.

STEGMANN, L. F. *et al.* Brazilian public funding for biodiversity research in the Amazon. **Perspectives in Ecology and Conservation**, v. 22, n. 1, p.1-7, 17 jan. 2024. DOI: https://doi.org/10.1016/j.pecon.2024.01.003

SUDAM. **Sistematização da produção bibliográfica do programa de polos agropecuários e agrominerais da Amazônia – Polamazônia**. Belém: SUDAM, 2019. 64p.

THEODORO, M. Entrevista com o professor Celso Furtado. *In:* QUINTELA *et al.* (org.). **Celso Furtado**: os combates de um economista. São Paulo: Fundação Perseu Abramo: Expressão Popular, 2020, p. 29-51.

VIEIRA, I. C. G. Desafios para o enfrentamento da crise ambiental da Amazônia. **Revista Ciência & Cultura**, 2023. Available in: https://revistacienciaecultura.org.br/?artigos=desafios-para-o-enfrentamento-da-crise-ambiental-da-amazonia. Acessed in: 20 fev. 2024.

VIEIRA, I. C. G.; SILVA, J. M. C. DA. Zero deforestation and degradation in the Brazilian Amazon. **Trends in Ecology & Evolution**, 28 mar. 2024. DOI: https://doi.org/10.1016/j.tree.2024.03.004

VIEIRA, I. C. G.; SILVA, J. M. C. DA; TOLEDO, P. M. DE. Estratégias para evitar a perda de biodiversidade na Amazônia. **Estudos Avançados**, v. 19, n. 54, p. 153–164, ago. 2005. DOI: https://doi.org/10.1590/S0103-40142005000200009

YAMAMOTO, E. USP é a universidade que mais publica artigos científicos sobre a Amazônia. **Jornal da USP**. 05 nov. 2023. Available in: https://jornal.usp.br/institucional/usp-e-a-universidade-que-mais-publica-artigos-cientificos-sobre-a-amazonia/. Acessed in: 20 fev. 2024

Considerações para as políticas de Ciência e Tecnologia no contexto da sustentabilidade da Amazônia

Considerations for science and technology policies in the context of Amazon sustainability

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ARTICLE-VARIA

RESUMO

O artigo apresenta um breve panorama da Ciência e Tecnologia na Amazônia em uma perspectiva regional, discute o papel das universidades, instituições científicas e tecnológicas e centros de saberes, e discorre sobre os desafios para a mobilização dessas instituições para o desenvolvimento territorial sustentável, considerando alguns atributos territoriais e atores regionais. Para tanto, foram utilizados dados e indicadores nacionais da pós-graduação, investimentos e distribuição geográfica das instituições públicas de ensino e pesquisa na Amazônia e, ao final, são apresentados caminhos para o desenvolvimento de uma estratégia regional de Ciência e Tecnologia. Conclui-se que, apesar do considerável avanço nas últimas décadas, ainda se tem uma realidade de investimentos inexpressivos na região e que é imperativo um projeto que incorpore Ciência, Tecnologia e

Inovação às dinâmicas produtivas, capazes de conformar um novo modelo de desenvolvimento na Amazônia brasileira.

Palavras-chave: Amazônia. Desenvolvimento regional. Ciência e Tecnologia na Amazônia. Desenvolvimento territorial.

ABSTRACT

This paper presents a brief overview of Science and Technology in the Amazon from a regional perspective. We discuss the role of universities, scientific and technological institutions, and centres of knowledge, and we elaborate on the challenges of mobilising these institutions for sustainable territorial development, considering some territorial attributes and regional actors. For this purpose, we used national data and indicators of postgraduate studies, investments, and geographical distribution of Public Teaching and Research Institutions in the Amazon. Finally, we present paths for developing a regional Science and Technology strategy. We conclude that, despite considerable advances in recent decades, we still face a reality of insignificant investments in the region. It is imperative to have a project that incorporates Science, Technology, and Innovation into productive dynamics capable of shaping a new development model in the Brazilian Amazon.

Keywords: *Amazon. Regional development. Science and Technology in the Amazon. Territorial Development.*

1 INTRODUÇÃO

O avanço da fronteira agrícola e econômica sobre a Amazônia apresentado como projeto de integração nacional, associado à ideologia de progresso e ao desenvolvimento, durante a Ditadura Militar, na década de 1960, foi a resposta do capital nacional e do capital internacional, articulados ao Estado brasileiro, à nova dinâmica do sistema mundo (Castro, 2010). O modelo de desenvolvimento sem aderência às territorialidades e aos povos e comunidades tradicionais da região, mas integrado ao espaço da globalização, a partir de uma economia de enclaves, da mineração ao agronegócio – da soja, da pecuária, da pimenta do reino, do eucalipto e do dendê, entre outras –, permanece. A construção de infraestrutura de transportes, energia e de comunicação, carreadora de impactos humanos, ecológicos, econômicos e culturais, serviu para adequar o espaço da Amazônia aos objetivos capitalistas ao longo da segunda metade do século XX (Silva, 1999).

A expansão de atividades extrativas de matérias-primas, como grandes projetos minerais e agropecuários e, na parte ocidental da Amazônia, a promoção da industrialização subsidiada, na Zona Franca de Manaus, promoveram novas dinâmicas de urbanização na região (Sathler, *et al.*, 2009) e intensificaram uma trajetória inaudita de conflitos entre esses capitais e as populações locais, incluindo indígenas, quilombolas, posseiros e populações tradicionais.

Em uma perspectiva crítica desse modelo, este artigo reflete sobre estratégias para a promoção da Ciência e da Tecnologia, a partir da constatação de que essas dinâmicas carreadoras de capital para as regiões centrais do capitalismo no Brasil e no mundo ainda não internalizaram, em escala, os frutos do conhecimento ao ponto de gerar dinâmicas socioeconômicas sustentáveis e a provisão de serviços públicos de qualidade na região. Ao contrário, a integração da Amazônia às dinâmicas nacionais e globais do capital aguçou desigualdades sociais. Este trabalho centra sua análise na desigualdade de investimentos em Ciência e Tecnologia, considerando que os enclaves econômicos do modelo de desenvolvimento implantado na Amazônia se mostraram pouco capazes de produzir e horizontalizar conhecimento para a proteção e uso sustentável dos recursos da natureza (Becker; Stenner, 2008).

Educação e pesquisa de qualidade são fundamentais para possibilitar o acesso universal a moradias, energia limpa, mobilidade, saneamento, segurança, internet, desenvolvimento produtivo e geração

de emprego e renda de forma inovativa e duradoura. Como tal, são elementos estruturais para gerar dinamismos produtivos inovadores, territorializados, que otimizem o uso dos recursos naturais (Becker, 2010), numa perspectiva dos seis eixos do plano de transformação ecológica do governo federal em curso: (i) finanças sustentáveis; (ii) adensamento tecnológico; (iii) bioeconomia; (iv) transição energética; (v) economia circular; e (vi) infraestrutura e adaptação climática (Brasil; Ministério da Fazenda, 2023).

O arcabouço institucional da Ciência, Tecnologia e Inovação (CT&I) desempenha um papel crucial na consolidação da capacidade dos territórios amazônicos de oferecer produtos, processos e serviços. Essa dimensão é essencial para promover um desenvolvimento sustentável com bases endógenas e duradouras, contribuindo significativamente para as estratégias de desenvolvimento na região (Monteiro, 2010). Em função da diversidade cultural, da dimensão, das peculiaridades e da fragilidade crescente dos ecossistemas da maior floresta tropical do mundo, as Instituições de Ensino Superior (IESs) e as Instituições Científicas e Tecnológicas (ICTs) da região devem ser o elemento orientador do planejamento e da implementação de políticas públicas na Amazônia (Candotti *et al.*, 2023).

A política e a gestão da Ciência, Tecnologia e Inovação (CT&I) no Brasil têm sido conduzidas pelos Ministérios da Ciência, Tecnologia e Inovação (MCTI) e da Educação (MEC), responsáveis pela promoção horizontal da investigação e formação de pessoal por intermédio de suas agências, nomeadamente: o Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), a Financiadora de Estudos e Projetos (Finep) e a Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes). A política desenvolvida por essas entidades, particularmente entre 2005 e 2014, fortaleceu as IESs e as ICTs existentes, além de dotar a Amazônia Legal de novas unidades de ensino e pesquisa e de multiplicar os *campi* do interior, instalando na região uma inédita infraestrutura educacional, científica e tecnológica (Candotti, 2023b), onde foram investidos substantivos recursos.

No entanto, esse ciclo virtuoso, que trouxe junto a inclusão de indígenas, quilombolas e os alunos dos segmentos mais pobres da população pela Lei de Cotas (Lei 12.711/2012), foi bruscamente interrompido, em 2016, com a Emenda Constitucional n.° 95 do Teto dos Gastos Públicos. De 2005 a 2015, foram dez anos de investimentos em novas Universidades e Institutos Federais, expansão de *campi* aos municípios médios da Amazônia, estruturação de laboratórios de ensino e pesquisa no interior da região e diversificação de cursos de graduação e pós-graduação. No entanto, os investimentos realizados para formar capital humano qualificado ainda não têm alcançado o objetivo de desenvolver as forças produtivas locais em bases sustentáveis. Uma das razões para essa lacuna é que os profissionais qualificados não foram integrados às políticas de retenção em seus municípios e região, assim como o conhecimento produzido pelas IESs e ICTs não está integrado às demandas sociais dos governos municipais, das organizações, e dos processos produtivos locais geridos por associações e cooperativas de pequenos produtores e empreendedores rurais (Candotti, *et al.*, 2023).

O problema que se levanta é que, diante dessa realidade, pode-se afirmar que as instituições de ensino e pesquisa e os centros de conhecimento e saberes regionais[1] não tiveram ainda a oportunidade de contribuir plenamente para o desenvolvimento regional e nem de se integrar às políticas emanadas do Estado nacional, com protagonismo na formulação e na execução destas. Esse processo de alienação, herdado de tempos coloniais, em que o agente econômico e político externo pensa, planeja e executa os serviços qualificados (Gonçalves, 2015) na região, reproduz o fosso abissal de desigualdades refletidas em todas as esferas da vida econômica e social na Amazônia, tornando-a vulnerável aos ataques dos setores atrasados da economia agrária e mineral, integrados em cadeias nacionais e globais.

2 METODOLOGIA

As referências iniciais para este artigo foram colhidas com a coordenação do Grupo de Trabalho Amazônia, do Conselho de Desenvolvimento Econômico e Social Sustentável (CDESS/Secretaria de Relações Institucionais), exercida pelo professor Ennio Candotti. As contribuições de Candotti

e sua tese sobre o fortalecimento das instituições amazônicas de CT&I, ICTs e IESs, e o necessário envolvimento direto do grande contingente de graduados e pós-graduados da região, no esforço de promover economias e bem-estar social, com conservação e agregação de valor material e imaterial da Amazônia, são integralmente reproduzidos neste artigo. A contribuição acadêmica e a liderança de Ennio à frente da comunidade científica brasileira e da Amazônia deixaram testemunhos de que o conhecimento integrado às demandas territoriais proporciona avanços consistentes nas práticas e visões coletivas para a mudança de paradigmas do desenvolvimento.

Visando refletir sobre as considerações apresentadas ao CDESS por Candotti, foi realizado levantamento dos indicadores nacionais de pós-graduação que nos permitiu avaliar as desigualdades de investimentos em Ciência e Tecnologia na comparação entre a Amazônia e outras regiões. Por exemplo, as áreas de concentração dos cursos de pós-graduação, a quantidade de discentes titulados e a produção de artigos científicos. Procedeu-se a análise da distribuição geográfica das Instituições Científicas e Tecnológicas (ICTs) na região e os investimentos nas Instituições de Ensino Superior (IESs) públicas na Amazônia, visando traçar um breve panorama dos desafios para a mobilização das IESs e das ICTs numa estratégia redutora de desigualdades como política de desenvolvimento regional em bases territoriais tratada em suas devidas especificidades e múltiplas escalas.

Recorreu-se a uma bibliografia selecionada sobre o tema do desenvolvimento regional e sobre as disparidades de infraestrutura científica e tecnológica entre as regiões. Portais institucionais do governo federal, com informações públicas coletadas digitalmente, especialmente da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes), foram mobilizados para a organização dos dados quantitativos que ilustram este trabalho, organizados em tabelas e gráficos, e se constituíram em insumo para traçar este breve panorama de CT&I na Amazônia.

Ao final, apresentam-se recomendações para a inserção da Amazônia no plano nacional de transformação ecológica, que visa mudar os fundamentos da produção industrial brasileira para uma matriz sustentável, tendo entre suas principais linhas a bioeconomia. São apresentadas adicionalmente propostas que relacionam a redução de desigualdades sociais ao fortalecimento e acionamento dos sistemas de formação superior e tecnológico e do desenvolvimento científico, integrados ao desenvolvimento territorial sustentável *lato sensu*.

3 DESIGUALDADES EM CIÊNCIA E TECNOLOGIA

A Ditadura Militar organizou a ocupação da Amazônia para usufruto do grande capital nacional e internacional, por meio de polos de crescimento implementados com benefícios fiscais e financiamentos proporcionados por um arcabouço de políticas e institucionalidades, implementados pela Superintendência do Desenvolvimento da Amazônia (Sudam) e pelo Banco da Amazônia (Basa). As atividades consideradas potenciais de crescimento econômico da região foram a "pecuária, agricultura, o extrativismo vegetal, mineral e animal, e a indústria" (Sudam, 2019).

A implementação da política dos governos militares teve, entre outras influências, a teoria dos polos de François Perroux, economista francês que propunha a indução do crescimento por meio da aplicação dos recursos em atividades com reconhecidas vantagens comparativas regionais, com capacidade de irradiar o desenvolvimento e alterar as dinâmicas rurais e urbanas:

> Ancoravam-se, portanto, numa visão de desenvolvimento regional que tinha por fundamento a necessidade de concentração espacial de capitais, capazes de produzir desequilíbrios, e, em decorrência desses processos indiretos de desenvolvimento, por meio do surgimento de uma cadeia de ligações para frente e para trás das atividades produtivas consideradas "chave" (Monteiro, 2005, p.188).

Após quase 60 anos, o desenvolvimento da Amazônia ainda é dependente das dinâmicas derivadas desses polos, seja do industrial da Zona Franca de Manaus, criado em 1967, ou dos polos Agropecuários, Agrominerais e Florestais, assim descritos pelo programa Polamazônia, de 1974, e que avançaram sobre as florestas, solos e subsolos amazônicos nesse período. A economia mineral, com destaque para Carajás, Trombetas e Amapá, teve um avanço vertiginoso desde a publicação do I Anuário Mineral Brasileiro, de 1972.

Esse modelo promoveu o crescimento das atividades agropecuárias na Amazônia e a especialização regional na exportação de matérias-primas, conduzido por empreendimentos que atuam como enclaves, mais ou menos intensivos em tecnologias e inovações, mas incapazes de transferir conhecimento e bem-estar às populações locais. Pelo contrário, levaram à expropriação territorial dos pequenos produtores familiares, de povos indígenas, quilombolas e demais povos tradicionais, normalizada por novos instrumentos estatais legislativos e administrativos, como, por exemplo, em 1971, o que estabeleceu o domínio da União sobre terras devolutas na faixa de até 100 km ao longo das rodovias federais. Os novos dispositivos públicos moldaram a intervenção estatal aos diferentes arranjos territoriais exigidos em cada momento da divisão internacional do trabalho e às necessidades dos grandes capitais, especialmente os monopólios da agropecuária e da mineração.

A ciência na Amazônia esteve, na sua origem, vinculada aos interesses da geopolítica mundial e do Estado nacional na exploração dos recursos naturais da região, desde a pesquisa para o aprimoramento da produção extrativa e agropecuária quanto a provisão de condições sanitárias adequadas à extração econômica dos recursos e à construção de infraestruturas que viabilizassem os empreendimentos e a comercialização dos seus produtos de forma competitiva no mercado internacional (Nonato; Pereira, 2013). O novo papel da região como fronteira de exportação de produtos da natureza conferiu à região amazônica o "caráter de "fronteira científica", ou seja, unidade socioterritorial passível de incorporação, dentro de um projeto de Estado que a toma como um desafio para o conhecimento (Faulhaber, 2005, p.241). A autora se refere ao relatório de Arthur Cézar Ferreira Reis, de 1956, em que o autor chama atenção do Estado brasileiro para o fato de que a Amazônia é "um mundo por descobrir e identificar".

As primeiras instituições científicas públicas constituídas na Amazônia foram o Museu Paraense Emílio Goeldi, ainda no século XIX, seguido, no século XX, da Escola de Farmácia do Pará; a Faculdade de Odontologia, de Medicina e Cirurgia do Pará; a Escola de Engenharia do Pará; o Instituto Evandro Chagas; o Instituto Agronômico do Norte e a Escola de Agronomia da Amazônia. Na década de 1950, influenciado pela corrida tecnológica do Pós-Guerra, foi criado o Instituto Nacional de Pesquisas da Amazônia e a Universidade Federal do Pará (Nonato; Pereira, 2013).

Nas décadas de 1960 e 1970, foram inauguradas as Universidades Federais do Amazonas, do Maranhão e do Acre. A Escola Universitária Livre de Manáos (1909) e Universidade de Manaus (1913) é considerada a primeira Universidade no Brasil, na história da Ufam. Entre os anos de fundação ou refundação, a partir dos anos 1950 até década de 1990, o crescimento dessas instituições foi inercial.

Durante os anos 2000, houve um grande esforço de interiorização das universidades que, no período anterior, estavam restritas às principais capitais da região, Belém e Manaus. Hoje, os nove estados da Amazônia Legal reúnem em 160 de seus municípios 300 *campi* de Universidades, Institutos Federais de Ensino Superior e Institutos de Ciência e Tecnologia públicos (Almeida, 2023).

São muitos e significativos os avanços em ensino, pesquisa e desenvolvimento dos últimos 20 anos, assim como tecnologias guardadas nas instituições ou publicadas em meios especializados. No entanto, o conhecimento produzido na Amazônia ainda não foi capaz de alterar o modelo de desenvolvimento regional de forma ampla e sistêmica. São vários os produtos, os processos e as cadeias produtivas da biodiversidade beneficiados por inovações originadas nas instituições científicas locais, porém, essas iniciativas não têm demonstrado força para influenciar uma inflexão na primazia do modelo primário-exportador como sorvedouro de recursos naturais e dos fluxos de investimentos públicos

e privados direcionados à região. Além disso, o conhecimento e as tecnologias de manejo, produção e beneficiamento de produtos gerados pela pesquisa pública ainda não foram objeto de difusão e extensão capazes de promover inovações e dinamismos econômicos e sociais com impacto na redução de desigualdades entre as populações locais.

Não apenas na Amazônia, mas em todo o Brasil, o perfil da ciência brasileira passou por uma grande transformação nas últimas décadas. De um lado, houve aumento considerável da produção científica nacional, ligado ao crescimento vertiginoso da pós-graduação nos últimos 20 anos (Schwartzman, 2022). No entanto, esse crescimento ainda é marcado por uma grande desigualdade entre as cinco regiões.

A oferta de cursos superiores na Região Norte[2] é proporcionalmente muito inferior quando comparada com a da Região Sudeste, por exemplo, em 2022, foram ofertados 387 cursos na Região Norte, o que representa apenas 12% dos 3.181 cursos ofertados na Região Sudeste (Brasil, 2024). Além disso, há acentuada carência de pós-graduação em Ciências Exatas e da Terra e nas Engenharias[3], que representam apenas 13% dos cursos ofertados na Região Norte (Figura 1) (Brasil, 2024). Esse retrato limita a possibilidade de os jovens optarem por carreiras nessas áreas. Para se ter uma ideia, há apenas dois programas de Botânica e dois de Geologia e, das mais de 60 unidades da Embrapa, somente nove estão na Amazônia. O orçamento dessas unidades e de mais 26 estações e núcleos da empresa, em 2022, foi de R$ 480 milhões, 15,4% do orçamento global da Embrapa que, no mesmo ano, foi de R$ 3,1 bilhões (Candotti, 2023a).

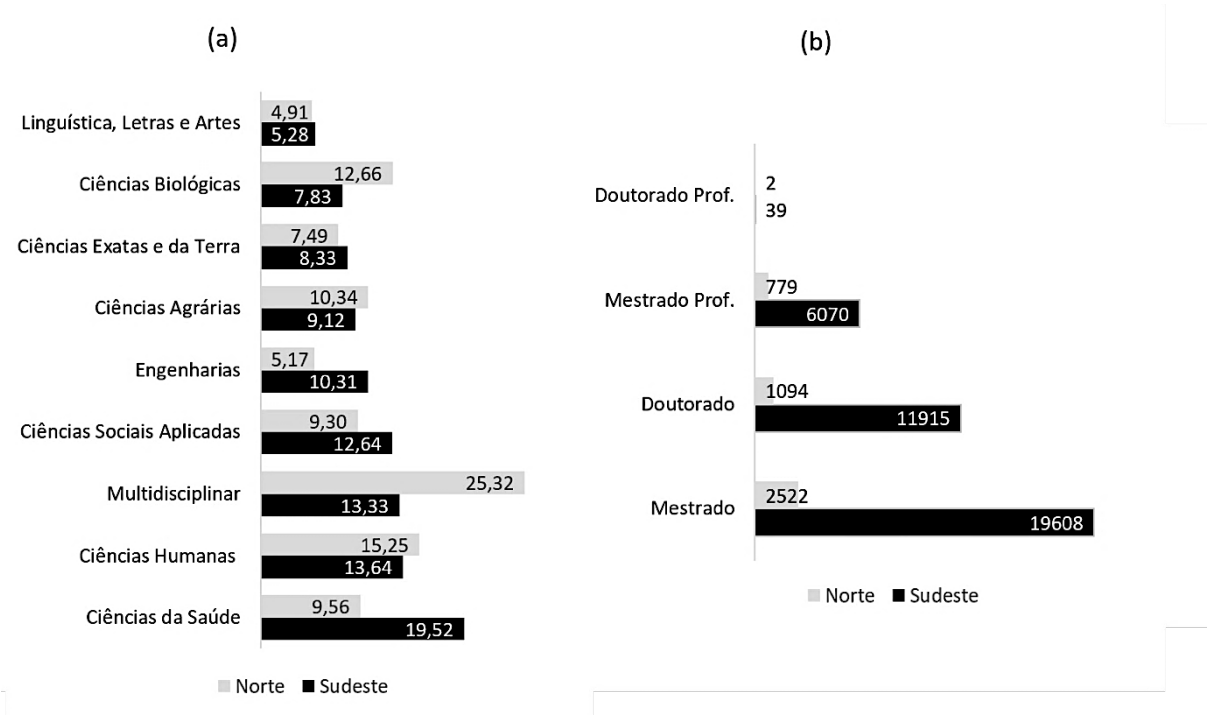

Figura 1 – (a) Porcentagem dos cursos de pós-graduação, por grandes áreas – regiões Norte e Sudeste; (b) Discentes titulados por grau acadêmico nas regiões Norte e Sudeste

Fonte: Brasil. Capes (2024). Elaboração dos autores.

No mesmo ano, na Região Norte foram titulados 4.397 discentes, entre mestres e doutores, cerca de 19 mestres e 4,5 doutores, por 100 mil habitantes, pouco mais de 10% dos titulados na Região Sudeste, que somaram 37.632 pós-graduados, 30 mestres e 14 doutores por 100 mil habitantes (Figura 1b).

A qualificação dos pesquisadores, a dotação de cursos e a infraestrutura científica e tecnológica disponível refletem no desempenho da produção científica regional. Enquanto no Sudeste houve 16 publicações de artigos em jornais ou revistas, por 100 mil habitantes, na Região Norte esse indicador alcançou apenas cinco publicações (Brasil, 2024).

Considerando os critérios dos principais editais de Pesquisa e Desenvolvimento (P&D), essas distorções penalizam a alocação de recursos para a Amazônia e reduzem a capacidade das ICTs regionais em concorrerem com as do Sudeste e Sul e, em consequência, insula o conhecimento sobre a região em instituições externas ao seu território, com baixo envolvimento da sociedade amazônica. Esse é um problema que se repete historicamente com o lugar da Amazônia no desenvolvimento do Brasil, ou seja, uma lógica da região ser vista de forma reducionista como um estoque de matérias-primas, com predomínio de exportação de *commodities* (Monteiro, 2021). Projeta-se para a Amazônia uma expectativa de resolução dos vultuosos problemas causados pelos desequilíbrios de 60 anos de um modelo desestruturador de suas condições socioambientais com seus próprios meios, em situações em que a desigualdade de todos os fatores econômicos, sociais e de infraestrutura não é levada em conta.

De fato, nos anos mais recentes, poucas políticas avançaram no esforço de considerar as territorialidades e especificidades da região, entre elas louva-se a saúde, os processos seletivos especiais para indígenas e quilombolas, programas de pesquisa e saúde tropical, da Fiocruz, doutorados em rede, como Bionorte, entre outros esforços bem-sucedidos.

No centro da questão, está como tratar desiguais como desiguais. Essa é a diretriz que moveu as formulações de Celso Furtado sobre o Nordeste e alçou a um patamar superior as políticas de planejamento do desenvolvimento regional no Brasil. À construção histórica das assimetrias regionais, herança do período colonial e da forma como nos constituímos Império e República, Furtado (2013a) associou a política de industrialização brasileira, conduzida por um forte centralismo político, desde Getúlio Vargas, que moldou a divisão do trabalho no país, entre um Centro-Sul industrializado e as demais regiões produtoras de matérias-primas, a ele subordinadas.

Esse diagnóstico marcou a mudança de rota, disruptiva, conduzida por Celso Furtado, levando a Sudene do Rio de Janeiro para o Nordeste e, a partir de lá, redesenhando as políticas da região com base em estudos e capital humano territorializados (Theodoro, 2020). O choque de interesses enfrentado por Celso Furtado no curso da construção de políticas que retirassem o controle dos recursos federais das oligarquias nordestinas e dessem a esses recursos uma finalidade social e econômica de redução de desigualdades estruturais foi uma abordagem nova na concepção das políticas públicas macro orientada pela necessidade da radicalização da regionalização.

Já nos anos 2000, refletindo sobre o que o autor denominou de “Metamorfoses do Capitalismo”, ele denunciou as disparidades cada vez maiores de renda entre países periféricos e centrais, e a emergência de “uma época de grande enriquecimento da humanidade e, ao mesmo tempo, de agravação da miséria de uma ampla maioria” (Furtado, 2013b, p. 452). Para enfrentar essas tendências cada vez mais associadas ao processo de acumulação capitalista, Furtado indicava pensar estrategicamente o futuro e suas possibilidades:

> Mais que nunca os novos desafios serão de caráter social, e não principalmente econômico, como ocorreu em fases anteriores do desenvolvimento do capitalismo. A imaginação política terá, assim, que passar ao primeiro plano. Equivoca-se quem pretende que já não existe espaço para a utopia. Esse é o desafio maior que enfrenta a nova geração, convido-a a assumi-lo sem temores”. (Furtado, 2013, p. 457)

A Amazônia, ao longo desses 60 anos, não foi beneficiada por políticas à altura dos seus desafios sociais, ambientais e econômicos. Programas de transferência de renda, como Bolsa Família, e habitacionais, como Minha Casa Minha Vida, promoveram impactos emancipadores entre as famílias mais vulneráveis. Porém, o programa de maior impacto estrutural foi o Programa de Reestruturação das Universidades (Reuni), com a criação de duas Universidades Federais no interior do estado do Pará[4] e a expansão de *campi* para municípios com mais de 50 mil habitantes. No lastro desses investimentos, multiplicaram-se também *campi* interiorizados dos Institutos Tecnológicos e das Universidades Estaduais.

Importante observar que, ao longo dos últimos 60 anos, as políticas de desenvolvimento regional para a Amazônia não tiveram um caráter estrutural de redução de desigualdades com componente social, como

no Nordeste, com especificidades orientadas para que a região viesse a se beneficiar da desconcentração industrial ocorrida a partir dos anos 1980. Junto com a industrialização, as universidades do Nordeste acompanharam esse dinamismo, ampliando seus espectros formativos e, com isso, se integrando ao sistema de conhecimento do país em patamares mais elevados (Bacelar, 2014).

Recente estudo da Elsevier veiculado na imprensa (Yamamoto, 2023) identificou que as universidades e os centros de pesquisa brasileiros foram os principais responsáveis pelas publicações sobre a Amazônia, feitas entre 2012 e 2021, e que a Universidade de São Paulo (USP) é a instituição que mais publica sobre a região, com mais de quatro mil artigos no período. Na segunda, terceira e quarta posições estão a Universidade Federal do Pará (UFPA), o Instituto Nacional de Pesquisa da Amazônia (Inpa) e a Universidade Federal do Amazonas (Ufam), sediadas no Pará e no Amazonas.

Porém, *rankings* acadêmicos têm que considerar os tamanhos das instituições. E, nesse caso, ao considerar o indicador publicação/pesquisador, em relação ao número de publicações, os resultados seriam bem diferentes: "a produtividade das instituições da Amazônia mostra-se bem maior (cerca de três artigos publicados por pessoa no período de 2012 a 2022), em relação aos estudos amazônicos, do que qualquer universidade brasileira (menos de um artigo por pessoa no mesmo período)" (Pedro Pequeno, comunicação pessoal). Com perfis e foco nos problemas regionais, em seus diversos temas e contextos, mesmo com recursos muito reduzidos, pesquisadores e pesquisadoras das instituições amazônicas continuam mantendo sua produtividade. Com mais doutores, mestres e recursos para pesquisa, as instituições amazônicas saltariam consideravelmente na produção científica e, mais que isso, cresceriam em impacto dos conhecimentos no desenvolvimento humano, econômico e na conservação ambiental da região.

Recente levantamento sobre a distribuição de financiamentos e bolsas de estudo do CNPq e Capes no Brasil para estudos da biodiversidade (Stegmann *et al.*, 2024) destaca que, embora a alocação *per capita* seja equitativa entre as regiões, é necessário considerar aspectos como o a dimensão geográfica e a relevância ecológica da Amazônia brasileira. Na Região Norte, há 1,5 mais pesquisadores atuando em programas de biodiversidade do que na Região Sudeste, cenário que se inverte quando se trata da distribuição de recursos. Enquanto a Região Sudeste recebeu cerca de US$ 2 por km^2 para financiar pesquisas em biodiversidade pelo edital Universal do CNPq, a Região Norte recebeu US$ 0,13. Esse déficit de investimentos em pesquisa é incompatível com a hiperdiversidade de estratégia de valorização da floresta pelo incremento tecnológico.

Os números aqui mencionados demonstram a alta produtividade por pesquisador, mesmo atuando em situações adversas de infraestrutura, distâncias geográficas continentais e descontinuidade no financiamento da pesquisa, o que significa que a inserção desses pesquisadores no ambiente de pesquisa, mesmo com as adversidades, torna a pesquisa mais barata do que para os pesquisadores de fora e a sua inserção nas realidades territoriais em que estudam.

4 O PAPEL DAS UNIVERSIDADES, INSTITUIÇÕES CIENTÍFICAS E TECNOLÓGICAS E CENTROS DE SABERES

Apesar do quadro desfavorável em investimentos em relação às outras regiões do país, desde 2005 as Instituições de Ensino Superior amazônicas formaram uma quantidade inédita de profissionais, mais do que duplicou a formação de mestres e quadruplicou a formação de doutores (Almeida, 2023). A infraestrutura educacional, científica e tecnológica responsável por esses resultados está presente em 166 municípios, onde há 330 *campi* vinculados a 34 institutos de pesquisa e universidades públicas federais e estaduais e outras instituições científicas (Almeida, 2023).

A expansão para o interior dos Institutos de Ensino Superior e de Ciência, Tecnologia e Meio Ambiente, na Amazônia e fora dela, foi uma diretriz política dos governos Lula e Dilma[5]. Essas instituições, hoje,

empregam centenas de profissionais, graduados, mestres e doutores, que estão formando milhares de jovens das periferias urbanas e rurais e povos da floresta.

Além disso, essas instituições cumprem um papel econômico fundamental para os municípios onde estão instaladas ao direcionarem para essas cidades um fluxo significativo de recursos públicos como, por exemplo, os R$ 7,6 bilhões, previstos para 2024, na Região Norte. Esses recursos são extremamente significativos, o que pode ser observado quando se compara esses valores com os orçamentos municipais. À exceção de Belém e de Manaus, que são casos atípicos porque os recursos recebidos pelas universidades federais do Pará e do Amazonas são redistribuídos para vários *campi* no interior desses estados, pode-se avaliar a dimensão da contribuição financeira das IESs pelos seus orçamentos. Nesse sentido, pelo menos em cinco capitais da região – Macapá, Rio Branco, Boa Vista, Porto Velho e Palmas, os orçamentos das Instituições de Ensino Superior correspondem, em média, a 26% dos orçamentos municipais, como detalhado na Tabela 1, a seguir.

Tabela 1 – Instituições de Ensino Superior (IESs) – contribuição financeira para os municípios-sede em valores absolutos e relativos aos orçamentos públicos de cada município-sede (valores correntes em R$ milhões de 2024)

Município-sede	*Universidades e Institutos Federais*	*Orçamento das IESs*		*Orçamento do município-sede (B)*	*(A/B) %*
		Por instituição	*Por município-sede (A)*		
Belém	Universidade Federal do Pará	1.802,30	2.740,03	5.300,00	51,7
	Instituto Federal do Pará	626,94			
	Universidade Federal Rural da Amazônia	310,8			
Santarém	Universidade Federal do Oeste do Pará	243,92	243,92	1.804,55	13,52
Marabá	Universidade Federal do Sul e Sudeste do Pará	174,05	174,05	1.996,17	8,72
Manaus	Fundação Universidade do Amazonas	974,66	1.438,96	9.088,00	15,83
	Instituto Federal do Amazonas	464,3			
Macapá	Universidade Federal do Amapá	288,96	418,09	1.620,91	25,79
	Instituto Federal do Amapá	129,13			
Rio Branco	Universidade Federal do Acre	441,46	605,73	2.231,59	27,14
	Instituto Federal do Acre	164,27			
Boa Vista	Fundação Universidade Federal de Roraima	301,83	472,01	2.452,36	19,25
	Instituto Federal de Roraima	170,18			
Porto Velho	Universidade Federal de Rondônia	368,99	718,13	2.640,86	27,19
	Instituto Federal de Rondônia	349,13			
Palmas	Fundação Universidade Federal do Tocantins - Palmas	381,46	694,47	2.291,00	30,31
	Instituto Federal do Tocantins	313,01			
Araguaína	Universidade Federal do Norte do Tocantins	116,53	116,53	1.120,99	10,39
	TOTAL	**7.621,92**	**7.621,92**	**30.546,43**	**24,57**

Fonte: https://portaldatransparencia.gov.br/. Lei Orçamentária Anual (LOA, 2024) dos municípios-sede. Acesso em 12/02/2024. Elaboração dos autores.

De acordo com a Tabela 1, as instituições referidas estão localizadas nas capitais e nas cidades médias. É grande e multidimensional o potencial dessas instituições para a promoção do desenvolvimento endógeno, especialmente se as políticas de Ensino, Pesquisa e Extensão forem coordenadas em torno de objetivos comuns em cada um dos municípios onde estão localizadas. Para uma avaliação mais precisa

desse potencial, deve-se agregar a infraestrutura científica e tecnológica de outras instituições, como a Embrapa, que está presente em todos os estados da Amazônia e conta com 26 *campi* experimentais e diversos laboratórios, como os de solo e fisiologia vegetal, agroindústria, tecnologia de pescado, etimologia e controle biológico, e sanidade animal e vegetal, entre muitos outros, sendo um exemplo das possibilidades abertas a arranjos territoriais interinstitucionais na Amazônia.

Esses números demonstram que a superação do relativo atraso da Amazônia na corrida científica e tecnológica do país requer um plano ousado e continuado de elevação da capacidade de formação de profissionais em nível de graduação e pós-graduação, associado ao incremento de bolsas e outros estímulos para o desenvolvimento da pesquisa, em larga escala, assim como mecanismos de estímulo à permanência de doutores na região (Monteiro; Albuquerque; Albuquerque, 2024).

Atualmente, contudo, observa-se que as IESs e ICTs poderiam ampliar a articulação e cooperação entre si, articulando seus Planos de Desenvolvimento Institucional (PDIs) com metas conjuntas e fortalecendo estratégias que incentivem a complementariedade entre essas instituições, com mais projetos em rede, principalmente nas formações da pós-graduação e na pesquisa. O que prevalece é uma corrida que não conecta o conhecimento gerado nas universidades e ICTs e os processos sociais relevantes para o desenvolvimento local e regional, tendo como eixo central as necessidades ecossistêmicas e as especificidades territoriais (Monteiro, 2021).

Torna-se fundamental, portanto, que o governo brasileiro dê continuidade ao programa de interiorização das instituições de ensino e pesquisa na Amazônia, ainda muito concentradas nas maiores cidades da região, com grande potencial para se tornarem cada vez mais capilarizadas. Além de uma expansão coordenada, os desafios profundos das realidades e diversidades amazônicas carecem de estímulo contínuo para a cooperação interna entre as instituições. Seus profissionais formados podem amplificar o impacto da produção de conhecimento e da Extensão aos processos produtivos, iniciativas sociais inovativas e à eficiência na implementação das políticas públicas emanadas dos governos estaduais e nacionais.

A rede de áreas protegidas da Amazônia, incluindo Terras Indígenas e Unidades de Conservação (UCs) de uso sustentável e proteção integral nas três esferas de governo, compreende 198 milhões de hectares, o equivalente a 47% do território do bioma (MMA, 2023). Cerca de 28% são UCs e 72%, ou 115 milhões de hectares, correspondem à extensão das Terras Indígenas. Por outro lado, as populações que habitam as zonas urbanas da Amazônia correspondem a 28 milhões de habitantes (IBGE, 2021), numa rede de cidades que cresce sem infraestrutura e com baixa conectividade física e de telecomunicações com as demais regiões do país.

As formas de ocupação e o uso do solo na Amazônia são determinantes para o desenho da estratégia territorial que se pretende desenvolver. Uma estratégia de indução de boas práticas produtivas e de proteção de povos e ecossistemas pode ser bem-sucedida se começar por segmentos socioeconômicos vinculados aos territórios dos assentamentos da reforma agrária, reservas extrativistas, territórios quilombolas, Terras Indígenas e povos ribeirinhos da Amazônia. Elevar a eficiência produtiva e social desses territórios é fundamental para proteger as áreas que ainda detêm florestas (cerca de 50% da Amazônia) e estimular outros segmentos a escolher sistemas de produção sustentáveis, assim como a agregar valor aos recursos naturais desperdiçados ou exportados como *commodities*, o que prevalece na atual matriz econômica da Amazônia.

Para se ter uma ideia do tamanho do desafio, o número de Reservas Extrativistas (Resex) existentes no Brasil, no período de 1990 a 2019, alcançou 95 unidades, correspondendo a uma área de 15,5 milhões de hectares, sendo 29 estaduais (30,53%) e 66 federais (69,47%), com uma população superior a 60 mil pessoas (Brasil, 2020). Destas, 72 são Resex continentais e 23 Resex marinhas, correspondendo, respectivamente, a 1,38% do território e 0,17% da área costeira nacionais. No bioma Amazônia estão 80% das Resex, representando 95% da área total dessas UCs (Euler; Silva; Almeida*, 2021)*.

A Figura 2 evidencia o avanço da fronteira agrícola sobre a Amazônia e a localização das IESs e ICTs que poderiam ser mobilizadas para o desenvolvimento de pesquisas com forte identidade com as necessidades dos territórios, considerando os impactos já consolidados, os em curso e aqueles projetados em médio e longo prazo.

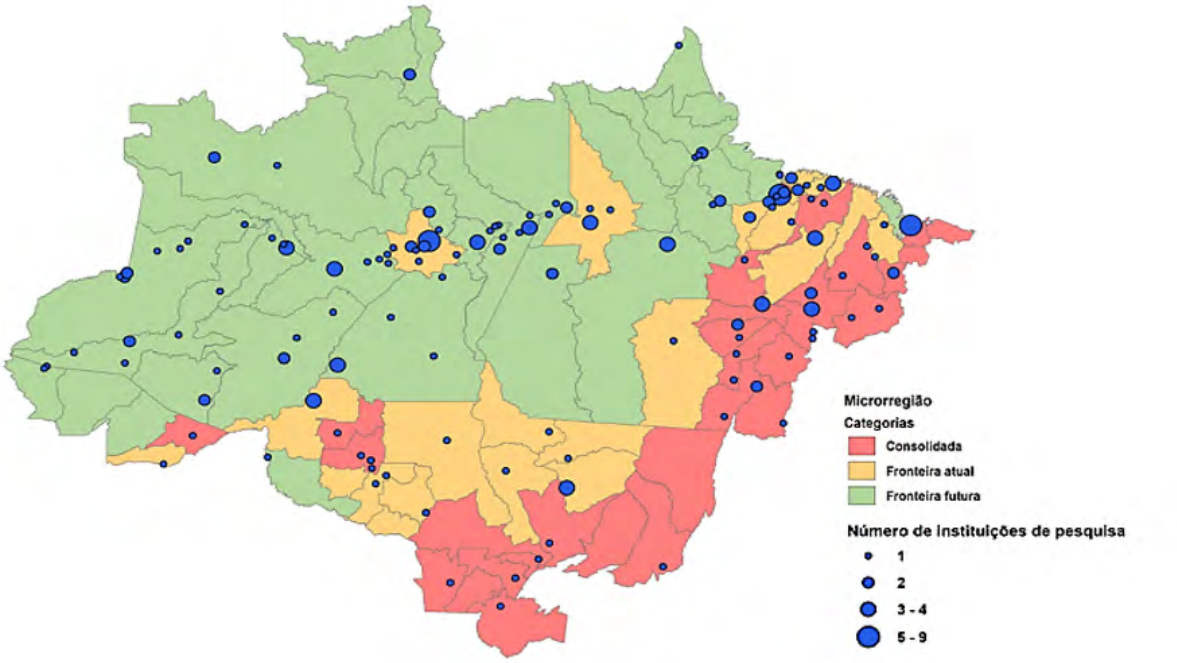

Figura 2 – Número de instituições de ensino e pesquisa nas microrregiões – avanço da fronteira agrícola

Elaboração: José Maria Cardoso da Silva e Ima Vieira (Dados inéditos).

O bioma Amazônia possui 85 microrregiões em diferentes estágios de avanço da fronteira econômica, considerando a porcentagem de vegetação nativa da seguinte forma: abaixo de 50% – consolidada; entre 50%-80% – fronteira atual e maior de 80% – fronteira futura. Tais regiões atendem a um modelo de ocupação baseado na exploração de recursos naturais e conversão de florestas, o que implica impacto na perda de biodiversidade em escala (Vieira *et al.*, 2005; Vieira; Silva, 2024). Uma abordagem de bioeconomia como solução para garantir a "floresta em pé" exige uma forte governança, articulação e integração com vários setores e participação social. Isso inclui valorizar o capital humano e social regionais, bem como os conhecimentos enraizados nas comunidades locais (Vieira, 2023).

5 DESAFIOS PARA A MOBILIZAÇÃO DAS INSTITUIÇÕES CIENTÍFICAS PARA O DESENVOLVIMENTO REGIONAL

O contingente atual de professores e pesquisadores qualificados nas mais diversas áreas do conhecimento, como, por exemplo, Engenharias, Botânica, Sociologia, Saúde, Direito, Economia, Biotecnologia, entre dezenas de outras formações, aguardam serem convocados para participarem, como cidadãos, políticos e profissionais, da batalha por respeito aos direitos, ambientes e à diversidade que hoje se trava na Amazônia (Candotti, 2023b).

As IESs e ICTs na Amazônia mobilizam inteligências e conhecimentos que ocupam territórios próximos aos campos onde a batalha do desenvolvimento, do conhecimento e da conservação está sendo travada. Os quadros humanos qualificados dessas instituições podem e têm interesse em contribuir na definição dos modos de implementação das políticas sociais, econômicas, científicas e ambientais determinadas pelo governo. Essa mobilização de forças pode ser acompanhada por outra, que ofereça um programa de formação dos povos da floresta, nos centros comunitários e nos *campi* das

universidades e Institutos Federais instalados no interior, que lhes permita participar e obter renda nos esforços de bom aproveitamento dos produtos naturais, de reflorestamento, de coleta de produtos florestais e manejo das unidades de conservação. Enfim, participar dos programas de reconhecimento do valor da diversidade botânica e social da floresta.

O professor Ennio Candotti propunha como diretriz "fortalecer os centros comunitários e *campi* das universidades públicas do interior da Amazônia" com o objetivo de mobilizar cidadãos e jovens do interior. Além disso, ampliar a capacidade regional das Ciências e da execução das políticas para a região e fora dela e enfrentar o desafio da permanência de jovens qualificados no interior da Amazônia, permitindo que as políticas públicas fossem pautadas por cidadãos que vivem na região, na terra, nas urbes, nas várzeas e nos rios pelo desenvolvimento, científico, cultural e econômico sustentável.

> Observo que das sementes plantadas em 2005 estamos recolhendo frutos importantes para o desenvolvimento do interior da Amazônia que hoje podem auxiliar a equacionar os desafios postos pelas devastações dos últimos anos: nos últimos 20 anos, os campi das universidades federais e estaduais, da Embrapa, e de outros Institutos, instalados nos municípios do interior da Amazônia, se multiplicaram (Candotti, 2023b, p.1).

Ennio Candotti formulou uma proposta, encaminhada ao Conselho de Desenvolvimento Econômico Social Sustentável – CDESS, onde era conselheiro representando a Amazônia, para um programa de bolsas que garanta um processo formativo contínuo nas pós-graduações, tendo como contrapartida a prestação de serviços para órgãos públicos federais, estaduais e municipais comprometidos com as concertações locais pelo desenvolvimento territorial sustentável.

Nesse sentido, deveria ser criado um Sistema de Ciência, Tecnologia e Inovação na Amazônia assessorado por uma conferência regional, para, entre outras coisas, apontar a agenda de pesquisas orientada às necessidades locais, bem como definir os campos do conhecimento estratégicos e com potencial inovador para o desenvolvimento regional inclusivo e sustentável.

A estratégia proposta para a mobilização das capacidades de C,T&I instaladas no interior da Amazônia e sua articulação com a territorialização dos segmentos prioritários para o desenvolvimento aqui proposto, como agricultores familiares, povos indígenas, populações das periferias sociais e econômicas urbanas, quilombolas, extrativistas e pescadores, entre outros povos tradicionais da região, pode ser viabilizada por um *mix* de bolsas de pesquisa, extensão e formação continuada, e por ações, programas e projetos governamentais voltados para impulsionar soluções sustentáveis para a Amazônia.

A ideia é territorializar a infraestrutura de C,T&I, tendo como agentes principais da ação os egressos das instituições de ensino e pesquisa formados na primeira onda de investimentos em educação superior no interior da Amazônia durante os governos Lula e Dilma. Do ponto de vista da inovação, menciona-se aqui o sentido de integração sistêmica aos processos sociais, culturais e de modernização produtiva contínua (Cassiolato; Lastres, 2005). Os autores convergem para o entendimento deste artigo em relação ao estímulo à criatividade local e multiescalar.

> [...] é reforçada a relevância das inovações incrementais e radicais e a complementaridade entre elas, assim como entre as inovações organizacionais e técnicas e suas distintas fontes internas e externas [...]. Esta, por sua vez, é vista como uma organização inserida em ambientes socioeconômicos e políticos que refletem trajetórias específicas. Assim, cada caso deve ser entendido de acordo com suas peculiaridades, sua posição e seu papel nos contextos nacional e internacional, para que se avalie qual deve ser a estratégia mais apropriada a seu desenvolvimento (Cassiolato; Lastres, 2005, p. 37).

O enunciado a seguir, proferido pelo professor Ennio Candotti em seus esforços para ser escutado na profusão de soluções para a Amazônia, apresentadas no contexto atual por múltiplos agentes do cenário nacional e internacional, é mencionado aqui como uma recomendação geral:

> A floresta amazônica, seus ecossistemas e povos diversos atraem a atenção mundial, ecológica, cultural e climática. Seu conhecimento, documentado e consolidado, não pode ser negligenciado. As comunidades e associações que vivem no interior devem participar ativamente desta missão de monitoramento e pesquisa (Candotti *et al.*, 2023, p.3).

A seguir, reproduzimos na íntegra as propostas enviadas por Ennio Candotti como apontamentos para discussão na Cúpula da Amazônia.

> **Carta de Agosto (sugestões de Ennio Candotti do Museu da Amazônia)**
>
> Ao tratar da Integração Regional, entre os temas recorrentes é o desafio de como promover um programa educacional empenhado em formar e fixar jovens – e jovens dos povos da floresta – na região, habilitando-os na arte de conhecer e explorar, de modo sustentável, com ciência, tecnologia, experiência e conhecimentos tradicionais, a floresta, a bio e geodiversidade dos lagos, das águas de superfície e subterrâneas da Amazônia.
>
> Aos objetivos de intensificar a formação dos jovens deve-se acrescentar a educação e formação profissional de agricultores e pescadores, que vivem no interior da Amazônia, que lhes permita dominar as técnicas agroflorestais, de coleta de sementes, de recomposição de pastagens, reflorestamento e monitoramento ambiental, além do manejo e aproveitamento dos recursos pesqueiros.
>
> No Brasil nos propomos formar jovens e agricultores não apenas nos grandes centros urbanos, mas principalmente no interior da Amazônia, nos municípios e territórios imersos nos laboratórios naturais, nos numerosos campi dos institutos e universidades públicas que lá se encontram e oferecer a eles qualidade de vida, condições econômicas e culturais para lá permanecer, próximos aos teatros de batalha da defesa da floresta e das águas, dos direitos humanos, indígenas e comunitários [...].
>
> O grande desafio que encontramos na institucionalização dos centros, estações ou institutos do interior é habilitá-los com investimentos, competências e infraestrutura de modo que possam contribuir para o desenvolvimento de sistemas produtivos locais, particularmente nas áreas agrícolas, pesqueiras, extrativistas, de manipulação ou indústria da bioeconomia [...]. Perguntamos em que condições os polos de desenvolvimento podem prosperar (explorando os ecossistemas naturais e a bioeconomia)?
>
> Em resposta mencionamos itens que exigem atenção das Políticas Públicas para sanar as deficiências em: qualidade da educação básica, atendimento e prevenção em saúde, estabilidade da energia e internet, acesso a água potável e saneamento básico, velocidade no transporte da produção e também a ausência de instrumentos básicos do Sistema Judiciário, como, por exemplo, a Defensoria Pública (há apenas dois Defensores Públicos na região ocupada por São Gabriel da Cachoeira, Santa Isabel e Barcelos no Amazonas, uma área de aproximadamente 50.000 km^2 – equivalente a uma Paraíba).
>
> O desenho de políticas públicas capazes de promover a educação superior, a formação profissional e o desenvolvimento desejado deveria inicialmente observar quais investimentos estão sendo feitos pela União e Estados, em cada município sede de *campi* das instituições públicas de educação e dimensionar os custos das intervenções recomendadas para promover a fixação dos jovens formados, médicos, engenheiros, antropólogos etc. [...]. No entanto, os recursos para custeio e capital são insuficientes para operar e aproveitar a infraestrutura de recursos humanos instalada, mesmo que precariamente.
>
> Como então financiar o equipamento dos *campi* e melhorar a infraestrutura urbana desses municípios? Sugerimos integrar os institutos e seus *campi* (e os investimentos realizados em salários, etc.) em um projeto de desenvolvimento que contemple fortalecer não apenas a educação superior no interior, mas também os institutos de saúde, meio ambiente e educação, as fontes de energia, a rede de telecomunicações e buscar recursos novos para financiá-los nos fundos próprios dessas áreas ou de C&T como o FNDCT[6], de Meio Ambiente, como o Fundo Amazônia, ou dos incentivos para P&D na Suframa

> do MDIC, do Fust, das telecomunicações, do BNDES, Sudam e Fapes dos estados da Amazônia [...]. Está sendo proposta pelos institutos do Pará e Amapá a criação de um Instituto da Foz do Amazonas (com *campi* em diferentes estados como Amapá e Pará) dedicado à pesquisa e ao monitoramento dos ambientes costeiros e marinhos, da transição da vida entre meios aquáticos de águas doces (do Rio Amazonas) e salgadas (oceânicas) (Candotti, 2023).

Às propostas vocalizadas acima acrescenta-se a necessidade de vinculação das estratégias nacionais às metas da Carta de Belém, da Cúpula da Amazônia e aos esforços interfederativos para a redução de emissões de dióxido de carbono (CO_2), por meio do uso sustentável dos recursos naturais, e a inserção da Amazônia nos esforços da nova industrialização do Brasil. Traduções amazônicas para as políticas de fomento produtivo e de produção e engajamento territorial do conhecimento científico e saberes locais são necessárias.

Conforme Bourg (2002 *apud* Freitas, 2023, p.213), os "princípios político-institucionais que legitimam a implantação de programas de educação, ciência, tecnologia e arte aos modelos de desenvolvimento são exigências sociais e políticas". No caso da Amazônia, o autor complementa que os princípios que devem orientar a implementação de políticas e programas de educação científicos e tecnológicos devem se orientar pelo pressuposto do "compromisso político de instrumentalizá-lo para combater a pobreza e a desigualdade social [...], construindo as bases sustentáveis para o ciclo de desenvolvimento duradouro para o Brasil" (Freitas, 2023, p. 213).

O planejamento do desenvolvimento regional em bases territorializadas e ecossistêmicas se apresenta como imperativo, visto que são nos territórios que acontecem os problemas e as chances das soluções mais eficazes a partir do envolvimento das inteligências locais. A interação da ação humana nas paisagens amazônicas interliga processos produtivos, culturas e dinâmicas ambientais contextualizadas (Vieira, 2023) e esses são aspectos importantes para uma agenda científica interdisciplinar para a região.

A ideia de integração ecossistêmica que ocorre nos quadros de degradação ambiental e humana, quando aplicada às soluções para o desenvolvimento em bases territoriais sustentáveis, potencializa a incorporação dos fatores locais, destacadamente os conhecimentos e os esforços dos seus profissionais qualificados.

6 CONCLUSÕES

A promoção das políticas de sustentabilidade na Amazônia depende de conhecimento territorialmente referenciado, com amplo engajamento das IESs e ICTs, atuando em estratégias cooperadas e orientadas para resultados em curto, médio e longo prazo. É urgente a superação de desigualdades nos investimentos em Ciência, Tecnologia e Inovação, assim como em estímulos à pesquisa, contextualizada nos problemas locais a serem enfrentados para que a região ingresse num ciclo de economia verde, de forma ampla, multiescalar e inclusiva.

As ideias e propostas apresentadas aqui sugerem ser necessária e urgente a formulação de uma estratégia que viabilize a integração dos egressos das instituições amazônicas de ensino e pesquisa diretamente no assessoramento dos processos produtivos e por meio de um processo formativo contínuo, que tenha como contrapartida a prestação de serviços para órgãos públicos federais, estaduais e municipais, em programas voltados para o desenvolvimento territorial sustentável.

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de educação, ciência e tecnologia. As contribuições acadêmicas e a liderança do professor Ennio na comunidade científica brasileira e na Amazônia deixaram testemunho de que a integração do conhecimento às demandas territoriais resulta em melhorias consistentes nas práticas e visões coletivas que são essenciais para a mudança de paradigmas de desenvolvimento.

Gostaríamos de expressar nossa gratidão ao apoio do CNPq (INCT Nexus 406516/2022-7) e agradecer ao Dr. José Maria Cardoso pela troca de ideias sobre Ciência na Amazônia e à Dra. Fabiana Pereira pelo seu apoio durante a revisão deste artigo. Este se beneficiou pela revisão cuidadosa de avaliadores anônimos, aos quais também agradecemos.

NOTAS

1 | Centros de educação integral que visam ao fortalecimento dos conhecimentos dos indígenas, quilombolas, povos de terreiros, benzedeiras, pescadores, entre outros.

2 | Os dados da Capes são para a Região Norte e não para a Amazônia Legal.

3 | Áreas que englobam Astronomia, Física, Matemática, Estatística, Ciência da Computação, Geociências e Química.

4 | Universidade Federal do Oeste do Pará (Ufopa) e Universidade Federal do Sul e Sudeste do Pará (Unifesspa).

5 | Disponível em *https://reuni.mec.gov.br/*. Acesso em: 2 fev. 2024.

6 | Fundo Nacional de Desenvolvimento Científico e Tecnológico (FNDCT); Ministério da Indústria e Comércio (MDIC); Fundo de Universalização dos Serviços de Telecomunicações (Fust).

REFERÊNCIAS

ALMEIDA, A. W. B. *et al.* **Projeto Universidades, Institutos de Pesquisa e Museus na Amazônia**, citado por CANDOTTI, E. Grupo de Trabalho Amazônia, CDESS/SRI, Presidência da República, 2023.

BACELAR, T. Nordeste: desenvolvimento recente e perspectivas. *In:* GUIMARÃES, P. F. *et al.* (org.). **Um olhar territorial para o desenvolvimento**: Nordeste. Rio de Janeiro: Banco Nacional de Desenvolvimento Econômico e Social, 2014. p. 540-560. Available in: http://web.bndes.gov.br/bib/jspui/handle/1408/14600. Acessed in: 10 abr. 2024.

BECKER, B.; STENNER, C. **Um futuro para a Amazônia**. São Paulo: Oficina de Textos, 2008. 152 p.

BECKER, B. K. Novas territorialidades na Amazônia: desafio às políticas públicas. **Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas**, v. 5, n. 1, p. 17–23, jan. - abr. 2010. DOI: https://doi.org/10.1590/S1981-1222010000100003.

BOURG, D. Les fondements du développement durable: la limite et les fins. *In:* DUCROUX, A. M. **Les nouveaux utopistes du développement durable**. Éditions Autrement - Collection Mutations, France, 2002.

BRASIL. Ministério da Educação. Capes. **Plataforma Sucupira**. Available in: https://sucupira.capes.gov.br/sucupira/. Acessed in: 08 fev. 2024.

BRASIL. Ministério da Fazenda. **Transformação Ecológica**: exemplos de ações em andamento. Ministério da Fazenda, 2023. 11p. Available in: https://www.gov.br /fazenda/pt-br/acesso-a-informacao/acoes-e-programas/transformacaoecologica/ apresentacoes/transformacao-ecologica.pdf. Acessed in: 10 abr. 2024.

BRASIL. Ministério do Planejamento e Orçamento. IBGE. SIDRA. **População por grupos de idade**. Available in: https://sidra.ibge.gov.br/tabela/1209#resultado. Acessed in: 14 fev. 2024.

CANDOTTI, E. *et al.* **Amazônia em 14 tempos. Jornal da Ciência**, SBPC, 19 jul. 2023. Available in: https://www.jornaldaciencia.org.br/amazonia-em-14-tempos/. Acessed in: 28 fev. 2024.

CANDOTTI, E. **Amazônia Sustentável, contribuições das ciências sociais, do multilateralismo e da sociedade civil**. 5 de agosto de 2023a. Apresentação em Power Point. Belém (PA), Seminário Flacso e Fundação Alexandre Gusmão.

CANDOTTI, E. **Carta Aberta ao Presidente Luís Inácio Lula da Silva**, manuscrito, Manaus, 2023b.

CASSIOLATO, J. E.; LASTRES, H. M. M. Sistemas de inovação e desenvolvimento: as implicações de política. **São Paulo em Perspectiva**, v. 19, n. 1, p. 34–45, mar. 2005. DOI: https://doi.org/10.1590/S0102-88392005000100003.

CASTRO, E. **Amazônia na encruzilhada**: saque colonial e lutas de resistência. São Paulo (SP): Globo, 2010. p. 105 -122.

EULER, A. M. C.; SILVA, J. E. C. DA; ALMEIDA, H. S. Reservas extrativistas. *In:* CRESTANA, S.; CASTELLANO, E. G.; ROSSI, A. (ed.). **Espaços especialmente protegidos e o Direito Ambiental**. Brasília, DF: Embrapa, 2021. cap. 13, p. 755-770. (Direito Ambiental, v. 4).

FAULHABER, P. A história dos institutos de pesquisa na Amazônia. **Estudos Avançados**, v. 19, n. 54, p. 241–257, ago. 2005. DOI: https://doi.org/10.1590/S0103-40142005000200014

FURTADO, C. A Operação Nordeste. *In:* D'AGUIAR, R. F. (org.). **Essencial Celso Furtado**. São Paulo: Penguin Classics. Companhia das Letras, 2013a, p. 337-361.

FURTADO, C. Metamorfoses do capitalismo. *In:* D'AGUIAR, R. F. (org.). **Essencial Celso Furtado**. São Paulo: Penguin Classics. Companhia das Letras, 2013b, p. 450-457.

GONÇALVES, C. W. P. **Amazônia, Amazônias**. São Paulo: Editora Contexto, 2015. 178p.

MONTEIRO, M. DE A. A institucionalidade da ciência, tecnologia e inovação na Amazônia e a conformação de trajetórias e paradigmas tecnológicos. **Novos Cadernos NAEA**, v. 13, n. 2, p. 235-260, 2010. DOI: http://dx.doi.org/10.5801/ncn.v13i2.480.

MONTEIRO, M. DE A. Meio século de mineração industrial na Amazônia e suas implicações para o desenvolvimento regional. **Estudos Avançados**, v. 19, n. 53, p. 187–207, abr. 2005. DOI: https://doi.org/10.1590/S0103-40142005000100012

MONTEIRO, R. **Amazônia**: espaço-estoque, a negação da vida e esperanças teimosas. Belém: Editora Dalcídio Jurandir, 2021.

MONTEIRO, R.; ALBUQUERQUE, E.; ALBUQUERQUE, I. A Bioeconomia como oportunidade e desafio para o desenvolvimento industrial, a preservação da vida e do bem-estar na Amazônia. *In:* **Tensões e Vivências Afirmativas na Amazônia Brasileira**. Espanha: Edições Universidade de Salamanca, 2024.

NONATO, J. M. D.; PEREIRA, N. M. Histórico da ciência na Região Norte do Brasil: a ciência em ação na Amazônia brasileira. **Perspectivas: Revista de Ciências Sociais**, v. 44, p. 93-124, 2013.

SATHLER, D.; MONTE-MÓR, R. L.; CARVALHO, J. A. M. DE. As redes para além dos rios: urbanização e desequilíbrios na Amazônia brasileira. **Nova Economia**, v. 19, n. 1, p. 11–39, 2009. DOI: https://doi.org/10.1590/S0103-63512009000100002

SCHWARTZMAN, S. Pesquisa e Pós-Graduação no Brasil: duas faces da mesma moeda? **Estudos Avançados**, v. 36, n. 104, p. 227–254, abr. 2022. DOI: https://doi.org/10.1590/s0103-4014.2022.36104.011.

SILVA, M. C. DA. **Metamorfoses da Amazônia**. Manaus: Editora da Universidade do Amazonas, 1999. 309 p.

STEGMANN, L. F. *et al.* Brazilian public funding for biodiversity research in the Amazon. **Perspectives in Ecology and Conservation**, v. 22, n. 1, p.1-7, 17 jan. 2024. DOI: https://doi.org/10.1016/j.pecon.2024.01.003

SUDAM. **Sistematização da produção bibliográfica do programa de polos agropecuários e agrominerais da Amazônia – Polamazônia**. Belém: SUDAM, 2019. 64p.

THEODORO, M. Entrevista com o professor Celso Furtado. *In:* QUINTELA *et al.* (org.). **Celso Furtado**: os combates de um economista. São Paulo: Fundação Perseu Abramo: Expressão Popular, 2020, p. 29-51.

VIEIRA, I. C. G. Desafios para o enfrentamento da crise ambiental da Amazônia. **Revista Ciência & Cultura**, 2023. Available in: https://revistacienciaecultura.org.br/?artigos=desafios-para-o-enfrentamento-da-crise-ambiental-da-amazonia. Acessed in: 20 fev. 2024.

VIEIRA, I. C. G.; SILVA, J. M. C. DA. Zero deforestation and degradation in the Brazilian Amazon. **Trends in Ecology & Evolution**, 28 mar. 2024. DOI: https://doi.org/10.1016/j.tree.2024.03.004

VIEIRA, I. C. G.; SILVA, J. M. C. DA; TOLEDO, P. M. DE. Estratégias para evitar a perda de biodiversidade na Amazônia. **Estudos Avançados**, v. 19, n. 54, p. 153–164, ago. 2005. DOI: https://doi.org/10.1590/S0103-40142005000200009

YAMAMOTO, E. USP é a universidade que mais publica artigos científicos sobre a Amazônia. **Jornal da USP**. 05 nov. 2023. Available in: https://jornal.usp.br/institucional/usp-e-a-universidade-que-mais-publica-artigos-cientificos-sobre-a-amazonia/. Acessed in: 20 fev. 2024

Environmental perception, pro-environmental behaviours and quality of life of residents of Perequê Beach

Avaliação de percepção ambiental, comportamentos pró-ecológicos e qualidade de vida de moradores da Praia do Perequê

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ABSTRACT

Praia do Perequê is located in the city of Guarujá (SP) and presents a situation of severe socio-environmental impacts directly linked to tourism and navigation activities. This research aimed to assess environmental perception, pro-environmental behaviours and quality of life of the *caiçara* community living in this region. Adult and elderly residents of Perequê Beach responded to the Environmental Perception Questionnaire – Beach; Ecological Behaviour Scale, WHOQOL-bref and Brazil Economic Classification Criteria in public places. Results indicated elements of positive environmental perception interacting with socioeconomic difficulties perception (in transportation and public health care), waste disposal behaviours carried out by residents and problems in the environmental domain of quality of life. This initiative will guide the actions to be undertaken by the municipal management of Guarujá.

Keywords: Environmental perception. Pro-environmental behaviours. Quality of life. Caiçara. Baixada Santista.

RESUMO

A Praia do Perequê fica situada na cidade de Guarujá (SP) e apresenta uma situação de graves impactos socioambientais ligados diretamente às atividades de turismo e navegação. O objetivo da pesquisa foi avaliar percepção ambiental, comportamentos pró-ecológicos e qualidade de vida da comunidade de caiçaras daquela região. Moradores adultos e idosos da Praia do Perequê responderam ao Questionário de Percepção Ambiental – Praia; Escala de Comportamento Ecológico, WHOQOL-bref e Critério de Classificação Econômica Brasil, em locais públicos. Resultados indicaram elementos de percepção ambiental positiva interagindo com percepção das dificuldades (em transporte e atendimento em saúde pública), comportamentos dos moradores em relação ao descarte de lixo e problemas no domínio ambiental da qualidade de vida. Essa iniciativa permitirá a orientação de ações a serem empreendidas pela gestão municipal de Guarujá.

Palavras-chave: *Percepção ambiental. Comportamentos pró-ecológicos. Qualidade de vida. Caiçara. Baixada Santista.*

1 INTRODUCTION

Coastal zones, using several ecosystem services, such as fishing, concentrate a large part of the world's population. These high urbanisation levels along the coast may cause damages to marine ecosystems, potentially leading to socio-environmental conflicts linked to the loss of essential ecosystem services. According to the National Environmental Policy in Brazil (Brasil, 1981), local, regional or national public authorities must implement monitoring assessments and remediation strategies for impacted areas. Measures adopted by such decision-makers should simultaneously mediate conflicts, ensure the conservation of natural resources, the improvement and recovery of environmental quality, seeking to ensure conditions for socioeconomic development, the interests of national security and the protection of human life. Socio-environmental impacts are related to the effects that human activities may pose on the natural environments and human communities. Indeed, this term has been used to describe both positive and negative impacts resulting from people, organisations or projects on the environment and society (International Association for Impact Assessment, 1994). Socio-environmental impacts may also include ecosystem change and pollution leading to biodiversity loss, as well as social damages such as community displacement, social inequalities and job losses.

Perequê Beach, located east of Guarujá City, in the state of São Paulo (Figure 1), is under serious socio-environmental impacts directly linked to tourism and navigation activities (Castro; Perina; Fillmann, 2012; Castro; Westphal; Fillmann, 2011). Such a situation can be mediated through interventions by public authorities, which, in turn, require precise assessments to guide the actions to be undertaken.

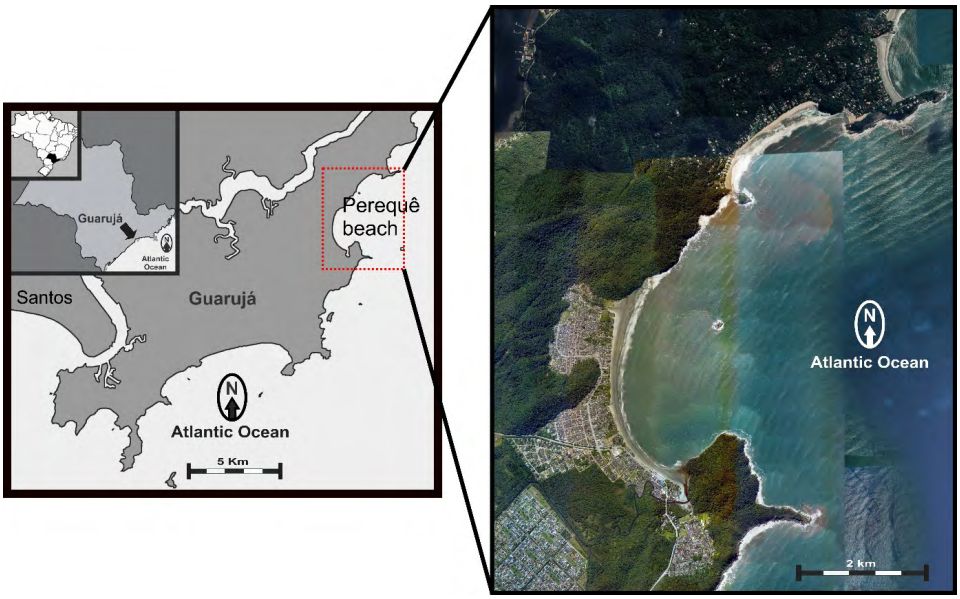

Figure 1 – Location of Perequê Beach (Guarujá/SP**)**

Source: Prepared by the authors based on images from Google Earth.

Based on the presented scenario, this study aims to evaluate the psychosocial dimensions of the local community living in Perequê Beach in terms of environmental perception, pro-ecological behaviours and quality of life.

1.1 ON THE ENVIRONMENTAL PERCEPTION

According to the program *Man and Biosphere*, created in 1971 by the United Nations Educational, Scientific and Cultural Organization (Unesco, 1971), environmental perception is understood as an awareness and understanding by humans of the environment in the broadest sense, involving more than an individual sensory perception, such as vision or hearing (Whyte, 1978). In a framework under the perspective of environmental movements, environmental perception is also considered as an awareness of issues linked to the environment, linked to cultural aspects of everyone (Dorigo; Lamano-Ferreira, 2015). These perceptions emerge from interactions with different environmental systems, from the closest (such as family and school systems) to the most distant (for instance, cultural and ideological systems) (Bronfenbrenner, 2011; Pereira; Reis, 2016). Therefore, perception is a response from the different senses (sight, hearing, touch, smell and taste) to external stimuli unique to the environment or widespread in culture, as well as a selective activity through which some phenomena are registered while others do not (Tuan, 2012). This last characteristic is related to interactions between perception and elements associated with motivations present in human values.

Since the 1960s, academic studies on perception have been produced from the perspective of the environmental area, particularly in humanist research linked to urbanism and human geography (Rodrigues *et al.*, 2012). Especially from the 1970s, when ecological movements emerged, studies on the perception were expanded to Environmental Psychology. Since then, different definitions of environmental perception have been proposed under different conceptual foundations. Thus, assessments of environmental perception are often challenging. Such studies are commonly performed by using interviews or questionnaires including closed and/or open questions. In this regard, many authors create their own questionnaires seeking to evaluate environmental perception.

According to Oliveira-Monteiro and Silva (2018), based on Lucena and Freire (2014), environmental perception encompasses domains of perception (informative and sensory elements; relationship and

knowledge of the environment), attitudes (experiences, opinions and actions related to environmental conservation) and values (affective and leisure values attributed to the environment). The informative and sensorial elements of environmental perception refer to the knowledge accumulated on different aspects of the environment. In this sense, the environment is understood as the core set of physical, chemical, and biological conditions, laws, influences, and interactions that operate on the Earth and affect human life. In fact, this was defined in 1972 by the United Nations (UN) and confirmed by the Stockholm Convention on the Human Environment, the first international declaration on this matter (United Nations Environment Programme, 1972).

Attitudinal elements related to the environment are associated with personal and social worldviews and lifestyles. These attitudes can be based on positive values permeated by an emotional identification with the environment. In this sense, the "topophilia" concept is worth remembering, a construct referring to the affective link between society and the environment. Such links may be enriched by knowledge of local history, which is directly related to components of the environment based on perceptions of beauty and the importance of the place (Tuan, 2012). In turn, the evaluative elements of environmental perception include individual ideals and principles (Pato, 2011). Thus, environmental values seek the equilibrium and sustainability of relationships between ecosystems or environments that are directly related to beliefs, attitudes, and behaviours that are ecologically responsible. Such behaviours may expand the capacity to use available natural resources on Earth, generating low impact on natural environments (Pato; Campos, 2011).

1.2 ON THE PRO-ECOLOGICAL BEHAVIORS

Pro-ecological behaviours are also called pro-environmental, ecological or environmental behaviours. This class of behaviours has been studied in association with environmental movements and is often related to moral values, personal beliefs, social norms and ethics (Becker; Félonneau, 2011; Corral-Verdugo; Pinheiro, 1999; Pinheiro *et al.*, 2014). These different nominations tend to incorporate aspects related to pro-environmental conduct, highlighting motivations leading individuals to defend the environment or minimise harmful effects. Moreover, environmental concern has also been considered as a determining factor, although indirect, in these environmental behaviours (Pereira; Pato, 2015).

According to Pato and Tamayo (2006), the expression "ecological behaviours" refers to pro-environment behaviours towards sustainable use of natural resources. They are part of people's behavioural repertoire, intentionally or unconsciously, actions learned and internalised. Underlying these ecological behaviours (also called pro-ecological behaviours), ethics, values and motivations by acting in defence of the environment, based on sustainability principles and recognition between human relations and the environment, are also considered. Therefore, the links with values portray a complex facet of ecological behaviours since values formation not only depends on pedagogical actions (such as environmental education) but is also linked to other socio-environmental contexts integrating individuals, such as familial, religious and political.

1.3 ON QUALITY OF LIFE

In 1995, the World Health Organization (WHO), through the WHOQOL Group, advocated the first standardised concept of Quality of Life, "as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (Whoqol Group, 1995). Thus, quality of life was defined as a multidimensional concept, providing different elements of the living conditions of the people. Although there are several explanatory aspects for Quality of Life, based on the WHO definition, it began to be understood in a comprehensive way in interactions among different systems, including individual, sociocultural or historical issues. The study of Quality of Life is international and involves a wide variety of target

groups, using different research methods and many types of assessments (Haraldstad *et al.*, 2019). The WHOQOL proposed instruments to assess the quality of life based on four different domains: 1) physical (related to comfort, discomfort, and pain), 2) psychological (positive and negative feelings, body image and appearance, self-esteem, memory, concentration and ability to learn and think), 3) social (personal relationships, social support, and sexual activity), and 4) environment (safety, home environment, financial resources, health and social care, opportunity and ability to acquire information, leisure, pollution, noise, traffic, climate and transport).

The Federal Constitution of Brazil (FC), enacted in 1988, mentions Quality of Life in its article 225, relating to the rights as an ecologically balanced environment (Brasil, 1988). In addition, several provisions ensure the right to quality of life throughout the FC. Thus, quality of life is associated with fundamental rights and guarantees, the economic order, and the right to an ecologically balanced environment.

2 METHODS

Cross-sectional quantitative research aims to describe environmental behaviours and perceptions without direct intervention by the researcher in the environment (Field; Miles; Field, 2012).

2.1 PARTICIPANTS

Residents (adults and elderly) living in the Perequê neighbourhood for at least one year were interviewed. The sample composition's homogeneity regarding sex (men and women) and age groups (young adult, middle-aged and elderly) was sought. However, the sampling considered convenience and accessibility criteria for the researchers, inviting people who passed through the study site (Hulley *et al.*, 2014).

2.2 INSTRUMENTS

Sample data such as participant gender and age were collected using the instruments (questionnaires) listed below.

2.2.1 ENVIRONMENTAL PERCEPTION QUESTIONNAIRE - BEACH (EPQB)

The assessment of environmental perception was performed through the *EPQB*, an adaptation of the instrument used by Oliveira-Monteiro and Silva (2018) to evaluate mangrove environments. The original questionnaire was, therefore, adapted to coastal environments, replacing the word "mangrove" with "beach". The *EPQB* was based on 11 closed-ended questions focused on three domains: 1) perceptual (information/knowledge about the environment and sensory/relationship), 2) values (affective and leisure values attributed to the environment), and 3) attitudes (experiences, opinions and actions related to environmental conservation). From the perspective of environmental perception, such domains are often articulated and integrated. For instance, values are constructed from information and sensory perception, which may lead to positive or negative environmental attitudes. The used instrument also includes three open-ended questions regarding personal descriptions of the local landscape, requiring the respondents to point out the main problem of living in the neighbourhood. On the other hand, the interviewees were also asked about what would be "the best" in the neighbourhood.

2.2.2 ECOLOGICAL BEHAVIOR SCALE (EBE)

To assess pro-ecological behaviours, EBE was used, which was previously developed and validated in Brazil by Pato e Tamayo (2006). This instrument is based on 27 questions related to individual pro-environmental actions. Using a five-point Likert scale, the respondent indicated the degree of agreement with the sentences presented.

2.2.3 WHOQOL-BREF

The quality of life of respondents was assessed using the WHOQOL-bref (Fleck *et al.*, 2005). The Whoqol-bref is an abbreviated version of Whoqol-100 for quality-of-life assessment. This tool was developed by the Quality-of-Life Group of the Mental Health Division of the WHO and translated in Brazil by the Department of Psychiatry and Forensic Medicine at the Federal University of Rio Grande do Sul using 26 questions presenting the best psychometric performances extracted from Whoqol-100. As previously mentioned, the domains evaluated are: 1) physical (pain and discomfort), 2) psychological (positive and negative feelings, body image and appearance, self-esteem, memory, concentration and ability to learn and think), 3) social relationships (personal relationships, social support and sexual activity) and 4) environment (security, home environment, financial resources, health and social care, opportunity and ability to acquire information, leisure, pollution, noise, traffic, climate and transportation).

2.2.4 BRAZILIAN CRITERIA OF ECONOMIC CLASSIFICATION (BCEC)

The economic characterisation of the sample was based on BCEC, from the Brazilian Association of Research Companies (ABEP, 2022). This instrument comprises family comfort items, access to basic sanitation, street paving and the education of the head of the family (understood as the person who contributes most of the family income).

2.3 ETHICAL PROCEDURES FOR RESEARCH USING HUMAN BEINGS

The research protocols were previously submitted through Plataforma Brasil for evaluation by the Unifesp Research Ethics Committee, and the approval decision was received (No. 5090212). For agreement and signature, an Informed Consent Form (ICF) was presented to all participants. Signed copies of these ICFs are filed at LADH/Unifesp.

2.4 DATA COLLECTION PROCEDURES

After an initial foray onto Perequê beach, data was collected in person, with ecological insertion of researchers (Prati *et al.*, 2008), in public places, commercial establishments, on the beach, in a family health Unit, and a neighbourhood residence. For that, local leaders and the health equipment coordination carried out a prior intermediation. Despite these collaborations, in compliance with ethical procedures, explanations on the investigation objectives and presentations of the informed consent form signed, there were several refusals. Some expressions of refusal were related to issues related to previous surveys, which, as claimed, led to losses by fishermen. In other cases, participants seemed to be afraid of scams or breaches of confidentiality. In this regard, the temporal overlap of data collection with the pre-election period of 2022 and the demographic census carried out by the Brazilian Institute of Geography and Statistics (IBGE) may have led to a lower willingness and availability of people invited to participate. After invitations and acceptance, under ethical procedures, the ICF was presented, proper explanations were provided, and signatures were collected. The individual

data collection took place over 10 visits to the neighbourhood (dates: 06/30/2022, 07/20/2022, 08/03/2022, 09/16/2022, 09/21/2022, 12/01/2023, 03/29/2023, 04/25/2023, 04/26/2023 e 04/27/2023). During the interviews, the data collection team was adequately identified as university members using badges and lab coats. At some points during the collection, the researchers used face masks per the university's fieldwork guidelines and state measures to contain the Covid-19 pandemic.

2.5 DATA ANALYSIS PROCEDURES

The QPAP (Environmental Perception) data were analysed by the frequencies of responses to the 11 closed-ended questions. The content analysis model (Bardin, 2010) was used to analyse the responses to open-ended questions, including reading and organisation of relevant aspects of the text communicated by the interviewees and selecting units of analysis and classification of data into categories. The PEB (Pro-Ecological Behaviors) results were tabulated according to instrumental standards. Similarly, the WHOQOL-bref (Quality of Life) results were calculated according to standards (Fleck *et al.*, 2005), considering the physical, psychological, social and environmental domains. The CCEB scores were calculated according to Abep (2022) based on economic subclasses A, B, C and D/E. The numerical data presented in the present study were analysed using descriptive statistics (means, standard deviation and frequencies. All analyses were performed using the software Jasp (0.14.1) and Excel (2016).

3 RESULTS AND DISCUSSION

A total of 86 adult individuals participated in the investigation, of which 52 (60.46%) were women, and 34 were men (Figure 2a). Regarding economic classification, most of the sample (46.51%) belonged to class C, 26% to class B and 16% to class D (Figure 2b). The ages ranged from 18 to 75 years (mean = 38.9 years; SD = 5.4 years), with a predominance of younger people under 33 years old (Figure 2c). Most respondents have lived in the Perequê neighbourhood since 2000, suggesting a good sense of belonging and territorial Identity.

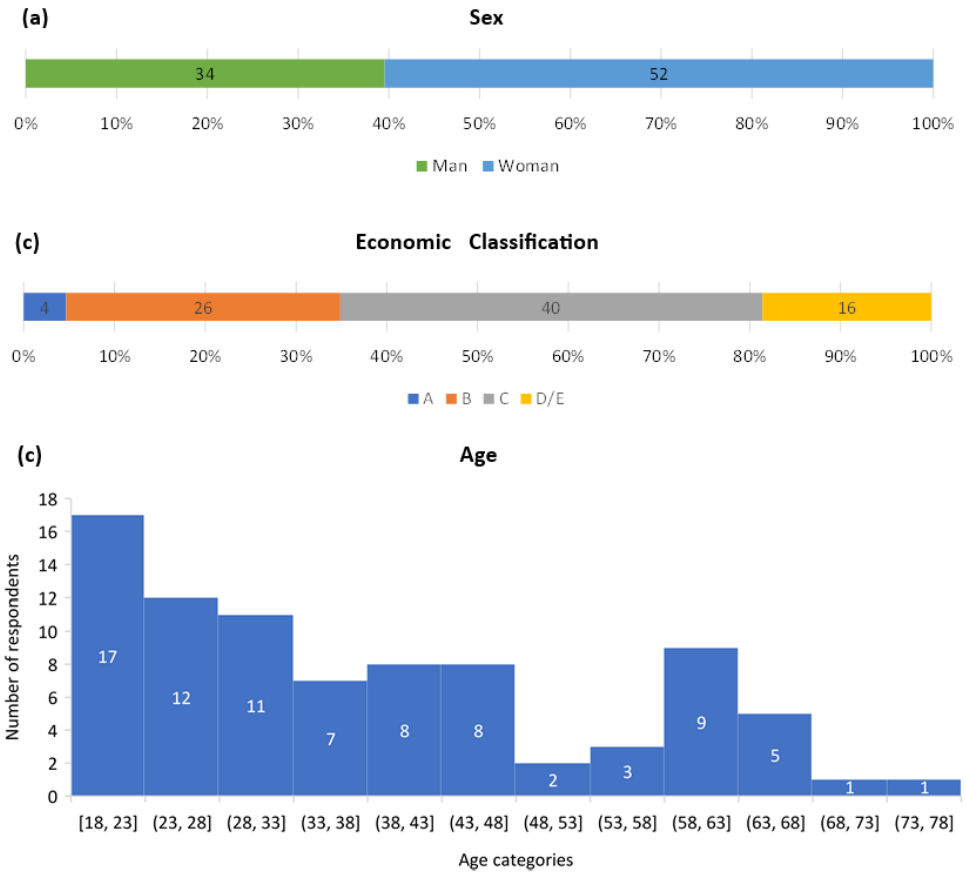

Figure 2 – Gender (a), economic classification (b) and age distribution (c) of respondents

Source: Prepared by the authors.

3.1 RESULTS ON ENVIRONMENTAL PERCEPTION

According to the QPAP tool, the obtained results were presented following the domains of environmental perception: 1) perception (relationship and knowledge about the environment, encompassing informative and sensory elements), 2) attitudes (experiences and opinions regarding environmental conservation), and 3) values (affective and leisure values attributed to the environment). The responses collected by each question group, across its three domains, allowed to elucidate meanings on which the participants based their opinions.

3.1.1 PERCEPTION DOMAIN

Informative elements (Figure 3) of environmental perceptions were present by most of the respondents (84.88%), indicating references to the knowledge of animals living in the coastal region alongside mentions of domestic animals (dogs and cats). Thus, in the present study, species of marine animals were mentioned, such as fish (catfish, mullet, shark and sea bass), crustaceans (crab, crab, shrimp and guava) and mammals (whale and dolphin).

In this regard, a study performed by Oliveira-Monteiro and Silva (2018), assessing perceptions of residents of Baixada Santista living in irregular occupations close to a mangrove forest, obtained similar results (80%). Additionally, the participants mentioned other species of mammals (such as capybara, saruê, squirrel, fox, jaguar, armadillo, among others). Most participants broadly recognised animals from the Perequê beach (Figure 3a). This universe of references, including animals, demonstrates a

close interaction with fauna living on the beach and in the Atlantic Forest region in the vicinities of the neighbourhood. However, a low frequency of respondents (38.37%) reported using fish as food (Figure 3b).

On the other hand, as presented in Figures 3c and 3d, the results on knowledge of plants indicated a lower identification with local flora (45.34% denied knowledge about plants, while 54.65% claimed to know them, citing mainly *embaúba*, bromeliad, orchid, coconut tree, *chapéu de sol*, *boldo*, *manacá-da-serra* and fern). Such observation may be associated with higher familiarity with marine animals since fishing is a relevant subsistence activity in that neighbourhood. As stated by Diegues (2019), this specific knowledge may be linked to traditional fields, including information about marine fauna from residents of coastal regions.

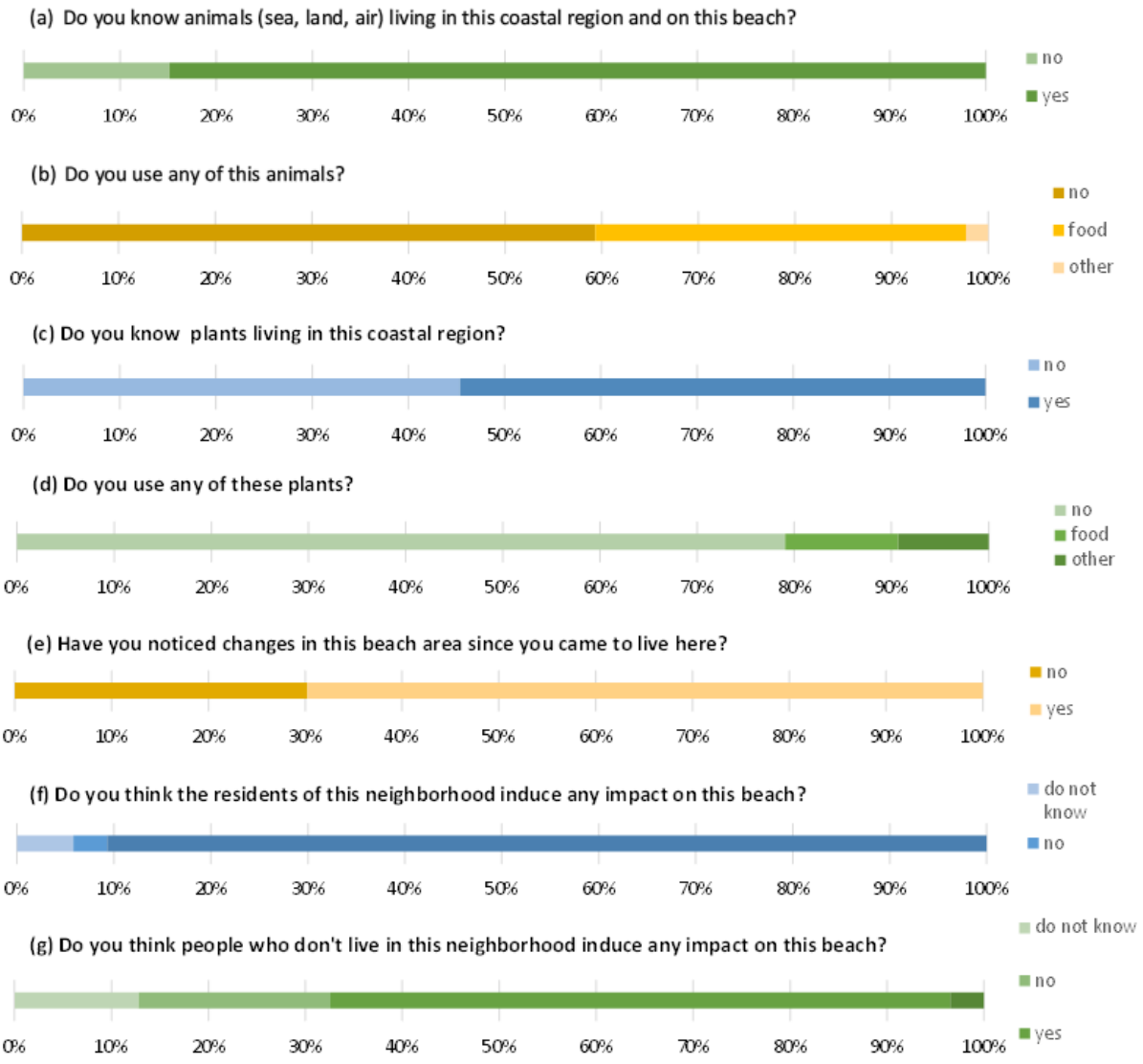

Figure 3 – Percentage of responses to the Environmental Perception questionnaire – Beach within the perception domain

Source: Prepared by the authors.

The sensory elements of environmental perception were related to possible changes in the coastal zone during the period in which they lived in the neighbourhood. Thus, 20.93% of the respondents claimed to have lived in Perequê Beach between 2000 and 2004, and 19.77% had lived there since before

the 1990s. Most participants (69.77%) stated that there had been changes since they started living in the neighbourhood (Figure 3e). Alongside positive changes, such as improvements in public lighting, paving, and increased commerce, negative alterations were mentioned, mainly pollution increase and invasions of protected areas. Furthermore, most respondents considered that both residents and non-residents had an impact on the beach, with negative impacts always associated with inadequate waste disposal. However, the mentions of impacts caused by non-residents were less recurrent (63.95%; Figure 3f) than those pointing out neighbourhood residents (90.69%; Figure 3g).

Thus, contrary to the results obtained by Oliveira-Monteiro and Silva (2018) using the same instrument with residents of mangrove regions, the participants of the present study mostly included themselves as potential inducers of environmental impacts in Perequê Beach. In addition to pollution aspects, the construction of irregular housing was also highlighted as impact-causing by residents. Furthermore, seven participants (8.14%) stated that such impacts are related to a lack of awareness about the importance of environmental conservation. Moreover, the lack of sanitation and the release of waste and sewage into the Peixe River, which passes through the neighbourhood and flows into the sea, was cited 11 times by respondents (12.79%).

According to several statements, the main issues of living in Perequê Beach were the distance from the city centre of Guarujá (probably suggesting limited public transport) and the lack of basic sanitation, infrastructure and public security. Further, the lack and/or absence of doctors at the neighbourhood Family Health Unit was also mentioned. When asked about the best attributes of Perequê Beach, the most common responses were associated with aspects of restorative environments (Gressler; Günther, 2013), especially the proximity to the seacoast (Danovaro *et al.*, 2021). References to nature, tranquillity, peace, beach, peace and security were common. In contrast to complaints regarding security, nine residents stated that there was no violence or robberies in the neighbourhood, while a few people suggested that local drug dealers provide security, indicating parallel actions apart from public authorities.

3.1.2 ATITUDES DOMAIN

Environmental attitudes are considered predictors of pro-environmental behaviours (Shafiei; Maleksaeidi, 2020). Results regarding the attitudinal field (Figure 4) indicated a higher frequency (90.86%) of confirmatory manifestations associated with interest in taking care of the region.

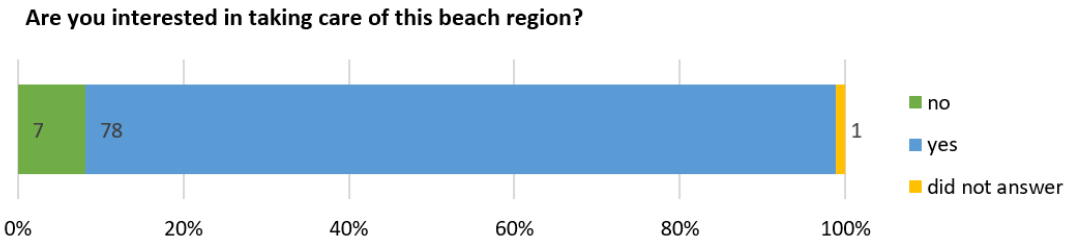

Figure 4 – Percentage of responses to the Environmental Perception questionnaire – Beach within the domain of attitudes

Source: Prepared by the authors.

Responses indicating strong feelings of territoriality were often perceived, probably associated with identification and long periods of living in the neighbourhood. The confirmatory manifestations of the desire to conserve the region - through explicit citations referring to the need for care for future generations - may be related to disseminating information about sustainability issues, probably conveyed by the media. Most respondents mentioned aspects indicating a positive valuation of the local environment (91.86%) and the affirmation of enjoying living in Perequê Beach. Such positive valuation,

as well as affective territoriality, were expressively pointed out as qualifications indicative of connection with nature (Mackay; Schmitt, 2019) by using expressions such as wonderful, light, magnificent, calm, splendid and unique place - also characteristics of restorative environments close to the sea (Danovaro *et al.*, 2021). Although not very frequently, a few residents defined the territory as dirty, unpleasant and polluted, citing the sewage that flows onto the beach and invasions. However, these negative references were never directly associated with the nature of that environment, suggesting anthropic actions.

3.1.3 VALUES DOMAIN

In the domain of values, when asked about the importance of the beach area, most respondents expressed themselves positively (Figure 5). In this case, reasons linked to territoriality, leisure provided by the beach, work opportunities with fishing, maintenance of environmental beauty, and values of a sentimental nature were again explained.

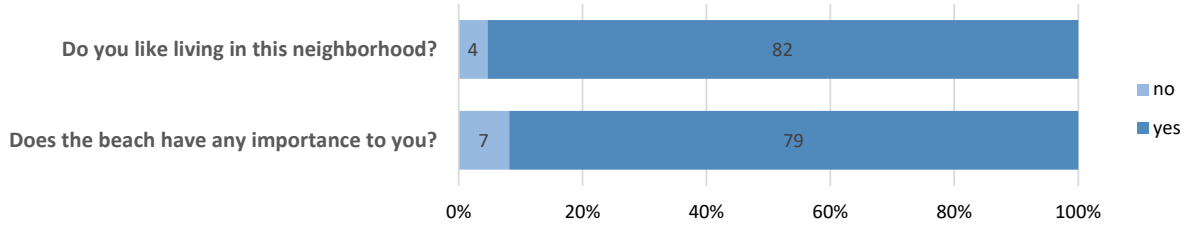

Figure 5 – Percentage of responses to the Environmental Perception questionnaire – Beach within the domain of values

Source: Prepared by the authors.

When asked if they liked living in the neighbourhood, most respondents also said yes (Figure 5), indicating the tranquillity, nature and identification with the place. Participants described the beach as magnificent, beautiful, perfect, calm, and wonderful, among other positive adjectives. As already mentioned, and reaching the field of values, negative descriptions were related to pollution, dirt, and a weak, unpleasant region, suggesting negative valuations associated with human interventions in the territory.

Mackay *et al.* (2019) stated that nature does not always need to be seen as positive or beneficial for human beings, as nature identification does not require that all experienced aspects be always pleasurable from a human perspective. Although some respondents have attributed negative descriptions to the studied environment, they still expressed respect for nature, emphasising the personal importance of the beach (91.86%).

3.2 PRO-ECOLOGICAL BEHAVIORS

Results related to Pro-ecological behaviours are presented in Figure 6. The most frequently mentioned pro-ecological behaviours were related to saving costs, such as “I turn off the lights when I leave empty spaces” (average = 5.56) or “I avoid wasting energy” (mean = 5.48). The behaviour “I keep the paper I no longer want in my bag when I can’t find a trash can nearby” (average = 5.44) was also frequently mentioned. These results may be related to local national regulations relating to these behaviours, such as the National Policy on Climate Change (Brasil, 2009), the National Solid Waste Policy (Brasil, 2010) and the new Brazilian Forest Code (Brasil, 2012).

Ecological behaviours related to saving water and energy (probably related to saving financial expenses) and urban cleaning stood out as references for those investigated, in line with the results

of Beuron *et al.* (2012). Furthermore, although these pro-ecological behaviours, presenting higher averages among respondents, are considered pro-environmental social changes, it is important to highlight that Batson and Thompson (2001) warn about "moral hypocrisy". According to these authors, such behaviour may lead research participants to provide socially expected answers to the questions presented, being more frequent in non-experimental studies that include some association with moral behaviours.

On the other hand, according to the evaluated residents of Perequê Beach, the least practised behaviour was associated with: "when I don't find trash cans nearby, I throw empty cans on the ground" (average = 1.41). Indeed, such a statement should be inverted, as it represents the opposite objectives of the instrument, which was proposed to verify pro-environmental behaviours.

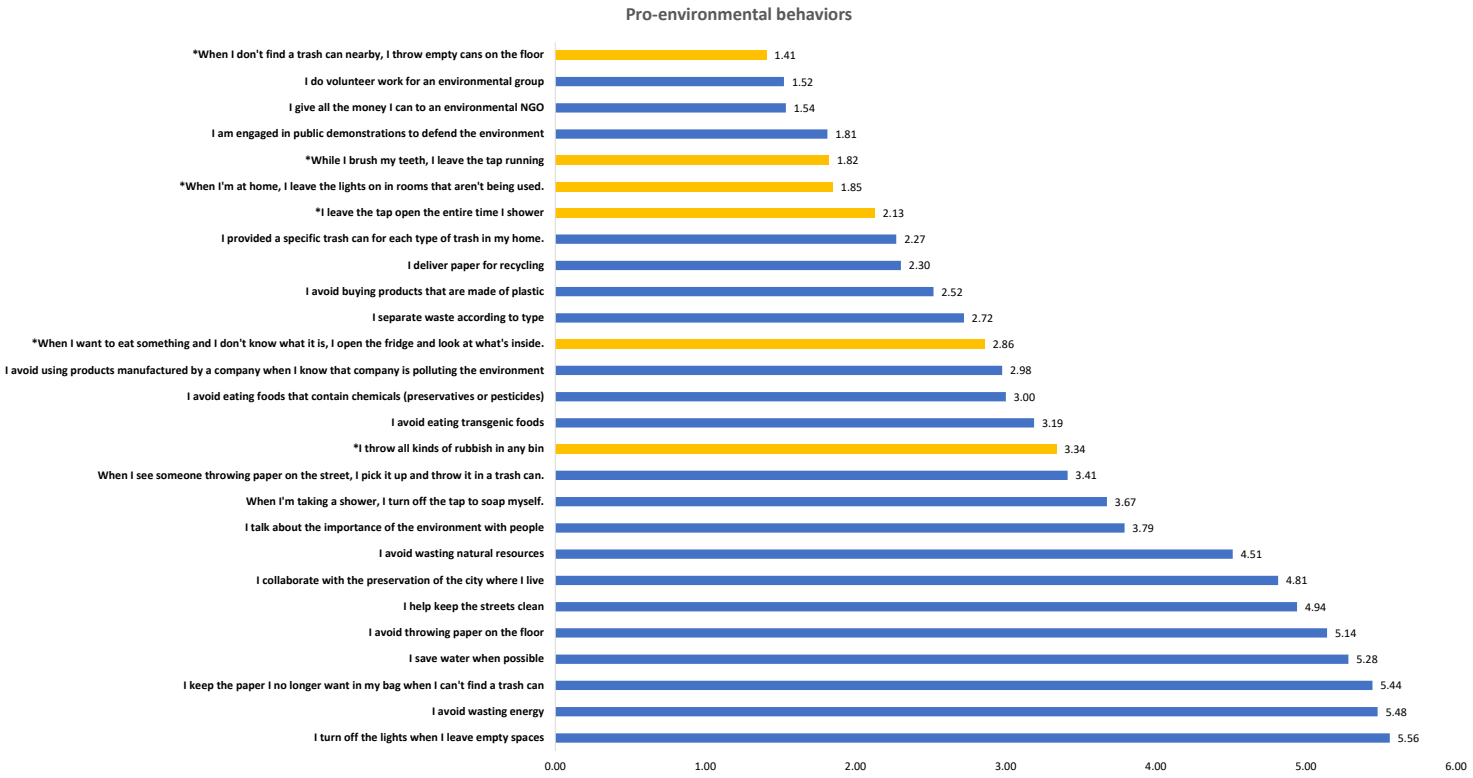

Figure 6 – Results of the assessment using the Ecological Behavior Scale

Source: Prepared by the authors.

*Note: * behaviours to be inverted on the scale, as it represents the opposite objectives of the instrument, which was proposed to verify pro-environmental behaviours.*

The questions, "I do voluntary work for an environmental group" (average = 1.52) and "I give all the money I have to an environmental NGO" (average = 1.54), also among the lowest averages in the sample, are part of the list of behaviours called "social desirability", according to Pato and Tamayo (2006). Such questions were included in the scale to serve as parameters of "the most ecological possible". However, it was expected to have low valuations for these questions. Interestingly, ecological behaviours presenting the lowest values were those related to the proper disposal and recycling of garbage, which was described as annoying in the environmental perception questionnaire.

3.3 QUALITY OF LIFE PERCEPTION

Results of the WHOQOL-bref, including domains psychological, social, environmental and physical, are presented in Figure 7. Quality of life had the highest average value (average = 4.10) in the psychological

domain, which includes questions about positive feelings about life, in addition to questions about self-esteem, body image and appearance, negative feelings, memory and concentration (Fleck *et al.*, 2005). These positive psychological conditions can be associated with connection, proximity and insertion in the local environment, providing clear restorative conditions (Danovaro *et al.*, 2021) - not only the beach but also green spaces - areas of Atlantic Forest still present in the region.

There is a consensus that interactions with natural environments provide physical and mental health to people (White *et al.*, 2016). The environmental mechanisms linked to health promotion are stress reduction, encouragement of physical activities and social interactions (Hartig *et al.*, 2014). Still, according to White *et al.* (2016), individuals living close to the coast were healthier and happier than those who lived inland, especially in the case of poorer populations. Indeed, coastal areas can offer greater leisure and health promotion spaces free of charge.

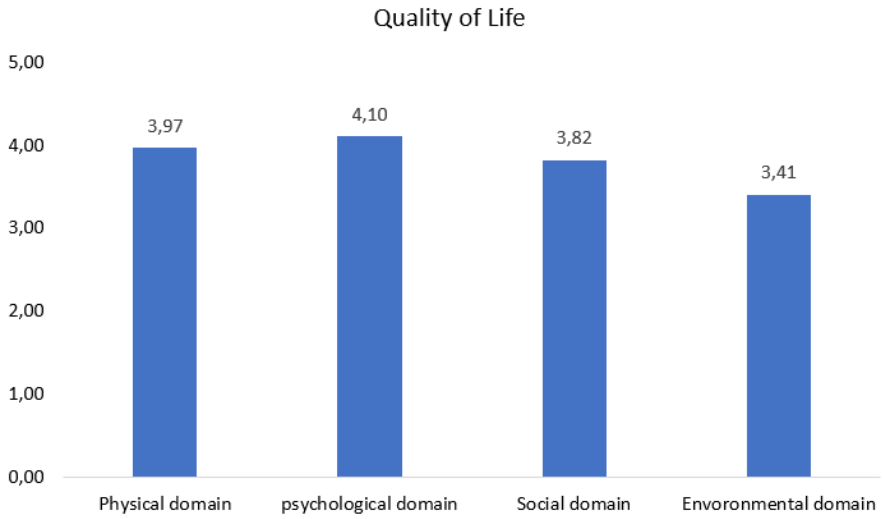

Figure 7 – Results of the quality-of-life assessment using the WHOQOL-bref in its psychological, social, environmental and physical domains

Source: Prepared by the authors.

On the other hand, the lowest average of the four evaluated domains was related to the environmental domain (average = 3.41). This domain includes issues related to physical safety, home environment, financial resources, availability and quality of health and social care, opportunity to acquire new information and skills, leisure opportunities, transportation and physical environment (Fleck *et al.*, 2005). Oliveira-Monteiro and Silva (2018) assessed mangrove residents using WHOQOL-bref and reported positive results in three of the four domains. Similarly to the present study, the environmental domain related to mangroves reached the lowest valuation (average = 3.24), even lower than the average for residents of Perequê Beach (average = 3.41).

Figure 8 – Results of the quality-of-life assessment using the WHOQOL-bref, detailing assessed items

Source: Prepared by the authors.

Although most of the respondents have considered the neighbourhood a restorative environment (according to the results of the environmental perception questionnaire), the lower valuation achieved in the environmental domain of Quality of Life may also be related to the predominance of economic class C in the sample. This pattern was already highlighted by Gordia *et al.* (2009), which found positive correlations between less affluent economic classes and lower quality of life (measured in the environmental domain of the WHOQOL-Bref).

Many housing areas in the Perequê neighbourhood are considered irregular, including those in "invasion areas", a fact reported by some participants. According to Sales *et al.* (2006), residents of irregular occupations may have a lower quality of life due to the lack of access to adequate infrastructure.

The items of the Quality-of-Life instrument reaching the lowest averages were related to financial resources to satisfy needs, opportunity to carry out leisure activities and satisfaction with access to health services (Figure 8). These results may indicate that, although residents were satisfied with some conditions associated with restorative environmental conditions in the place where they lived, they did not consider the financial resources they had sufficient to meet their needs. In addition to economic difficulties, the residents of Perequê Beach were not satisfied with access to available health services, which was also manifested in the environmental perception questionnaire, with some residents reporting the lack of doctors at the neighbourhood health unit.

In research on parks, Camargo *et al.* (2017) suggest an interaction between personal and environmental characteristics, subjective and objective, related to urban park regions, health conditions and physical activity contributing to the perception of quality of life. Parks are characterised as *green spaces* that promote well-being with green nature (Foley; Kistemann, 2015). In turn, the present research evaluated individuals living in blue spaces, places close to water bodies (such as beaches, lakes and rivers) (Foley; Kistemann, 2015; White *et al.*, 2020).

As mentioned above, the item on the opportunity to carry out leisure activities reached one of the lowest averages (3.09) in the WHOQOL-bref (Figure 8). This finding points out the need for leisure

activities and places for that population. It is also worth mentioning that living close to water bodies on the beach is very conducive to physical activities and leisure, promoting human well-being (Foley; Kistemann, 2015).

4 CONCLUSIONS

This investigation assessed self-references on environmental perceptions, pro-ecological behaviours and quality of life among residents of Perequê Beach. The obtained results are limited to the participants ' perceptions within the scope of the method used (cross-sectional, self-report quantitative research, with a convenience sample). Investigations of self-references of this nature, inserted in socio-environmental scenarios such as the one considered in the study, have not been presented in the literature. This lack of similar studies did not favour a broader discussion of the data in a comparative sphere. This constitutes a limitation of the study and, simultaneously, indicates the need for additional research along the same lines.

The positive environmental perception mentioned by respondents was related to experiences in interactions with green space environments - the hills close to the neighbourhood - in addition to the constant interactions with blue spaces on the beach and rivers of the region. Therefore, this environmental positivity coexisted with self-references of difficulties in that environment.

Issues on urban mobility, such as deficient transport services, difficulties in obtaining public health care, and inadequate waste disposal, contributed to the negative perceptions found in the environmental domain when evaluating the quality of life. This set of circumstances suggests that public policies aiming to implement environmental education strategies simultaneously targeting residents and occasional visitors, improving transport and safety in the neighbourhood, supplying public health equipment and promoting public leisure activities should be adopted.

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REFERENCES

ARAÚJO, F. R.; SCACHETTI, R. E.; OLIVEIRA-MONTEIRO, N. R. Autopercepção de qualidade de vida em adultos de uma região litorânea do estado de São Paulo. **Unisanta Law and Social Science**, v. 12, n. 1, p. 269-284, 2023. Available in: https://periodicos.unisanta.br/index.php/lss/article/view/3556. Access in: 20 jan. 2024.

ARAÚJO, F. R. et al. Percepções e condutas de universitários frente ao ambiente. **Brazilian Journal of Development**, v. 6, n. 9, p. 73141-73156, 2020. Available in: https://doi.org/10.34117/bjdv6n9-682. Access in: 20 jan. 2024.

ASSOCIAÇÃO BRASILEIRA DE EMPRESAS DE PESQUISAS (ABEP). **Critério de Classificação Econômica Brasil**, 2022. Available in: https://www.abep.org/criterio-brasil. Access in: 20 jan. 2024.

BARDIN, L. **Análise de conteúdo**. São Paulo: Edições 70, 2011.

BATSON, C. D.; THOMPSON, E. R. Why don't Moral People Act Morally? Motivational considerations. **Current Directions in Psychological Science**, v. 10, n. 2, p.54-57, 2001. Available in: https://doi.org/10.1111/1467-8721.00114. Access in: 20 jan. 2023.

BECKER, M.; FÉLONNEAU, M. L. Pourquoi être pro-environnemental? Une approche socionormative des liens entre valeurs et «pro-environnementalisme». **Pratiques psychologiques**, v. 17, n. 3, p. 237-250, 2011.

BEURON, T. A. *et al.* Relações entre os valores pessoais e os comportamentos ecológicos no contexto da sustentabilidade. **Revista ibero-americana de Ciências Ambientais**, v. 3, n. 2, p. 6-22, 2012.

BRASIL. **Lei nº 6.938, de 31 de agosto de 1981**. Dispõe sobre a Política Nacional do Meio Ambiente, seus fins e mecanismos de formulação e aplicação, e dá outras providências. Available in: https://www.planalto.gov.br/ccivil_03/leis/l6938.htm. Access in: 20 jan. 2024.

BRASIL. **Constituição da República Federativa do Brasil de 1988**. Brasília: Presidência da República, 1988. Available in: http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm

BRASIL. **Lei nº 12.187, de 29 de dezembro de 2009**. Institui a Política Nacional sobre Mudança do Clima – PNMC e dá outras providências. Available in: http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Lei/L12187.htm. Access in: 20 jan. 2024.

BRASIL. **Lei nº 12.305, de 2 de agosto de 2010**. Institui a Política Nacional de Resíduos Sólidos; altera a Lei no. 9.605, de 12 de fevereiro de 1998, e dá outras providências. Available in: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm. Access in: 20 jan. 2024.

BRASIL. **Lei nº 12.651, de 25 de maio de 2012**. Dispõe sobre a proteção da vegetação nativa; altera as Leis nº 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis nº 4.771, de 15 de setembro de 1965, e 7.754, de 14 de abril de 1989, e a Medida Provisória nº 2.166-67, de 24 de agosto de 2001, e dá outras providências.

BRONFENBRENNER, U. **Bioecologia do desenvolvimento humano**: tornando os seres humanos mais humanos. Artmed Editora, 2011.

CAMARGO, D. M.; RAMÍREZ, P. C.; FERMINO, R. C. Individual and environmental correlates to quality of life in park users in Colombia. **International Journal of Environmental Research and Public Health**, v. 14, n. 10, p. 1250, 2017. Available in: https://doi.org/10.3390/ijerph14101250. Access in: 20 jan. 2024.

CASTRO, I. B.; PERINA, F.; FILLMANN, G. Organotin contamination in South American coastal areas. **Environmental Monitoring and Assessment**, v. 184, p. 1781–1799, 2012. Available in: https://doi.org/10.1007/s10661-011-2078-7. Access in: 24 mar. 2024.

CASTRO, I. B.; WESTPHAL, E.; FILLMANN, G. Tintas anti-incrustantes de terceira geração: novos biocidas no ambiente aquático. **Química Nova**, v. 34, p. 1021–1031, 2011. Available in: https://www.scielo.br/j/qn/a/cxZqL77Vv9MYpY6YBRcFVcL/. Access in: 24 mar. 2024.

CORRAL-VERDUGO, V.; PINHEIRO, J. Q. Condições para o estudo do comportamento pró-ambiental. **Estudos de Psicologia**, v. 4, p. 7-22, 1999.

DANOVARO, R. *et al.* Marine ecosystem restoration in a changing ocean. **Restoration Ecology**, v. 29, e13432, 2021.

DIEGUES, A. C. Conhecimentos, práticas tradicionais e a etnoconservação da natureza. **Desenvolvimento e meio ambiente**, v. 50, 2019.

DORIGO, T. A.; LAMANO-FERREIRA, A. P. N. Contribuições da percepção ambiental de frequentadores sobre praças e parques no Brasil (2009-2013): revisão bibliográfica. **Revista de Gestão Ambiental e Sustentabilidade**, v. 4, n. 3, p. 31-45, 2015.

FIELD, A.; MILES, J.; FIELD, Z. **Discovering statistics using R**. Los Angeles: Sage Publications, 2012.

FLECK, M. P. A. *et al.* Aplicação da versão em português do instrumento abreviado de avaliação da qualidade de vida "WHOQOL-bref". **Revista de Saúde Pública**, v. 34, n. 2, p. 178-183, 2000.

FOLEY, R.; KISTEMANN, T. Blue space geographies: enabling health in place. **Health & Place**, v. 35, p. 157-165, 2015.

GORDIA, A. P.; QUADROS, T. M. B. D.; CAMPOS, W. D. Variáveis sociodemográficas como determinantes do domínio meio ambiente da qualidade de vida de adolescentes. **Ciência & Saúde Coletiva**, v. 14, p. 2261-2268, 2009.

GRESSLER, S. C.; GÜNTHER, I. D. A. Ambientes restauradores: definição, histórico, abordagens e pesquisas. **Estudos de Psicologia**, v. 18, p. 487-495, 2013.

HARALDSTAD, K. *et al.* A systematic review of quality of life research in medicine and health sciences. **Quality of life Research**, v. 28, p. 2641-2650, 2019.

HARTIG, T. *et al.* Nature and health. **Annual review of public health**, v. 35, p. 207-228, 2014.

HULLEY, S. B. **Delineando a pesquisa clínica**. 4. ed. São Paulo: Artmed, 2014.

INTERNATIONAL ASSOCIATION FOR IMPACT ASSESSMENT. **Guidelines and Principles for Social Impact Assessment**. Washington: The Interorganizational Committee on Guidelines and Principles for Social Impact Assessment, 1994. Available in: https://www.iaia.org/pdf/IAIAMemberDocuments/Publications/Guidelines_Principles/SIA%20Guide.PDF. Access in: 23 mar. 2024.

LIU, P.; TENG, M.; HAN, C. How does environmental knowledge translate into pro-environmental behaviors?: the mediating role of environmental attitudes and behavioral intentions. **Science of the total environment**, v. 728, p. 138126, 2020.

LUCENA, M. M.; FREIRE, E. M. Percepção ambiental como instrumento de participação social na proposição de área prioritária no semiárido. **Revista Internacional Interdisciplinar INTERthesis**, v. 11, n. 1, p. 147-171, 2014.

MACKAY, C. M.; SCHMITT, M. T. Do people who feel connected to nature do more to protect it? A meta-analysis. **Journal of Environmental Psychology**, v. 65, 101323, 2019.

OLIVEIRA-MONTEIRO, N. R.; SILVA, D. S. Percepções do ambiente, condições psicológicas e de qualidade de vida em habitantes de ocupações irregulares de área de manguezais na Baixada Santista, SP, Brasil. **Sustainability in Debate**, v. 9, n. 3, p. 13-27, 2018.

ORGANIZAÇÃO DAS NAÇÕES UNIDAS PARA A EDUCAÇÃO, A CIÊNCIA E A CULTURA. **1st International co-ordinating council of the programme on man and the biosphere (MAB)**. Paris: MAB Report Series, 1971. Available in: http://npshistory.com/publications/mab/unesco-mab-report/1.pdf. Access in: 20 jan. 2024.

ORGANIZAÇÃO DAS NAÇÕES UNIDAS PARA O MEIO AMBIENTE. **Declaração sobre o meio ambiente humano**, junho de 1972. Available in: http://portal.iphan.gov.br/uploads/ckfinder/arquivos/Declaracao%20de%20Estocolmo%201972.pdf. Access in: 20 jan. 2024.

PATO, C. M. L. Valores ecológicos. *In:* CAVALCANTE, S.; ELALI, G. E. **Temas básicos em psicologia ambiental**. São Paulo: Vozes, 2011.

PATO, C. M. L.; CAMPOS, C. B. D. Comportamento ecológico. *In*: CAVALCANTE, S.; ELALI, G. E. **Temas básicos em psicologia ambiental**. São Paulo: Vozes, 2011.

PATO, C. M. L.; TAMAYO, Á. A escala de comportamento ecológico: desenvolvimento e validação de um instrumento de medida. **Estudos de Psicologia**, v. 11, p. 289-296, 2006. Available in: https://www.scielo.br/j/epsic/a/GS4KQWFrQ8YFhrdDLKQ3kGf/abstract/?lang=pt. Access in: 20 jan. 2024.

PEREIRA, D. A.; PATO, C. Valores e comportamento ecológico: dimensões para Educação Ambiental em Parques Urbanos. **Ambiente & Educação**, v. 20, n. 2, p. 81-101, 2015.

PEREIRA, S. D. O.; REIS, L. P. C. Contextos de interação e sua inter-relação com o comportamento ecológico. **Revista Internacional Interdisciplinar INTERthesis**, v. 14, n. 1, 2017. Available in: https://doi.org/10.5007/1807-1384.2017v14n1p117. Access in: 20 jan. 2024.

PINHEIRO, L. V. S. *et al.* Comportamento, crenças e valores ambientais: uma análise dos fatores que podem influenciar atitudes pró-ambientais de futuros administradores. **Revista de Gestão Social e Ambiental**, v. 8, n. 1, p. 89-104, 2014.

PRATI, L. E. *et al.* Revisando a inserção ecológica: uma proposta de sistematização. **Psicologia: reflexão e crítica**, v. 21, p. 160-169, 2008.

RODRIGUES, M. L. *et al*. A percepção ambiental como instrumento de apoio na gestão e na formulação de políticas públicas ambientais. **Saúde e Sociedade**, v. 21, p. 96-110, 2012.

SALES, L. G. L.; SILVA, R. M. M.; CLEMENTINO, M. L. M. **Da natureza natural à natureza social**: os caminhos da relação entre sociedade e mangue de Bayeux – PB. III ENCONTRO DA ANPPAS, Brasília, 3, 2006. Available in: http://www.anppas.org.br/encontro_anual/encontro3/arquivos/TA209-04032006-024459.DOC. Access in: 20 jan. 2024.

SHAFIEI, A.; MALEKSAEIDI, H. Pro-environmental behavior of university students: application of protection motivation theory. **Global Ecology and Conservation**, v. 22, e00908, 2020.

TUAN, Y. F. Topofilia: um estudo da percepção, atitudes e valores do meio ambiente. **SciELO-EDUEL**, 2012.

WHITE, M. P. *et al.* The 'Blue Gym': What can blue space do for you and what can you do for blue space? **Journal of the Marine Biological Association of the United Kingdom**, v. 96, n. 1, p. 5-12, 2016.

WHITE, M. P. *et al.* Blue space, health and well-being: a narrative overview and synthesis of potential benefits. **Environmental Research**, v. 191, p. 110169, 2020.

WHOQOL GROUP. The World Health Organization quality of life assessment (WHOQOL): position paper from the World Health Organization. **Social science & medicine**, v. 41, n. 10, p. 1403-1409, 1995.

WHYTE, A. V. **La perception de l'énvironnement**: lignes directrices méthodologiques pour les études sur le terrain. Unesco, 1978.

Avaliação de percepção ambiental, comportamentos pró-ecológicos e qualidade de vida de moradores da Praia do Perequê

Environmental perception, pro-environmental behaviours and quality of life of residents of Perequê Beach

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ARTICLE-VARIA

RESUMO

A Praia do Perequê fica situada na cidade de Guarujá (SP) e apresenta uma situação de graves impactos socioambientais ligados diretamente às atividades de turismo e navegação. O objetivo da pesquisa foi avaliar percepção ambiental, comportamentos pró-ecológicos e qualidade de vida da comunidade de caiçaras daquela região. Moradores adultos e idosos da Praia do Perequê responderam ao Questionário de Percepção Ambiental – Praia; Escala de Comportamento Ecológico, WHOQOL-bref e Critério de Classificação Econômica Brasil, em locais públicos. Resultados indicaram elementos de percepção ambiental positiva interagindo com percepção das dificuldades (em transporte e atendimento em saúde pública), comportamentos dos moradores em relação ao descarte de lixo e problemas no domínio ambiental da qualidade de vida. Essa iniciativa permitirá a orientação de ações a serem empreendidas pela gestão municipal de Guarujá.

Palavras-chave: Percepção ambiental. Comportamentos pró-ecológicos. Qualidade de vida. Caiçara. Baixada Santista.

ABSTRACT

Praia do Perequê is located in the city of Guarujá (SP) and presents a situation of severe socio-environmental impacts directly linked to tourism and navigation activities. This research aimed to assess environmental perception, pro-environmental behaviours and quality of life of the caiçara community living in this region. Adult and elderly residents of Perequê Beach responded to the Environmental Perception Questionnaire – Beach; Ecological Behaviour Scale, WHOQOL-bref and Brazil Economic Classification Criteria in public places. Results indicated elements of positive environmental perception interacting with socioeconomic difficulties perception (in transportation and public health care), waste disposal behaviours carried out by residents and problems in the environmental domain of quality of life. This initiative will guide the actions to be undertaken by the municipal management of Guarujá.

Keywords: *Environmental perception. Pro-environmental behaviours. Quality of life. Caiçara. Baixada Santista.*

1 INTRODUÇÃO

As zonas costeiras são regiões que concentram boa parte da população do mundo que faz uso de inúmeros serviços ecossistêmicos, como a pesca. Essa concentração populacional, próxima ao mar, causa danos aos ecossistemas marinhos, podendo fazer surgir conflitos socioambientais ligados à perda desses serviços ecossistêmicos essenciais. Nesse aspecto, cabe ao poder público, em suas diferentes esferas, e como preconizado pela Política Nacional de Meio Ambiente (Brasil, 1981), implementar estratégias de avaliação, monitoramento e remediação de zonas impactadas visando mediar conflitos e garantir a preservação, melhoria e recuperação da qualidade ambiental propícia à vida, objetivando também assegurar, no país, condições para o desenvolvimento socioeconômico, os interesses da segurança nacional e a proteção da dignidade da vida humana.

Os impactos socioambientais que podem ocorrer referem-se aos efeitos que as atividades humanas têm sobre o ambiente natural e sobre as comunidades humanas. Esse termo é usado para descrever tanto os impactos positivos quanto os negativos que resultam das ações das pessoas, organizações ou projetos em relação ao meio ambiente e à sociedade. Os impactos socioambientais podem incluir mudanças nos ecossistemas, perda de biodiversidade, poluição do ar, água e solo, bem como impactos sociais, como deslocamento de comunidades, desigualdades sociais, perda de empregos, entre outros (International Association for Impact Assessment, 1994).

Nesse contexto, a Praia do Perequê, situada a leste da cidade de Guarujá, no estado de São Paulo (Figura 1), apresenta uma situação de graves impactos socioambientais ligados diretamente às atividades de turismo e navegação (Castro; Perina; Fillmann, 2012; Castro; Westphal; Fillmann, 2011). Tal situação pode ser mediada por meio de intervenções do poder público que, por sua vez, necessita de avaliações precisas que orientem as ações a serem empreendidas.

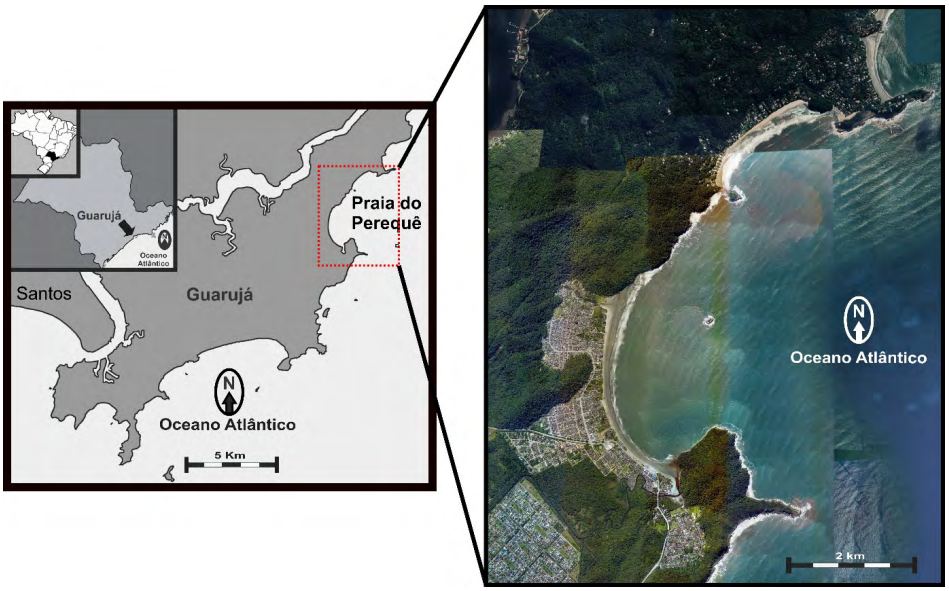

Figura 1 – Localização da Praia do Perequê (Guarujá/SP)

Fonte: Elaborada pelos autores a partir de imagens do Google Earth.

Considerando esse cenário, o presente artigo visa avaliar dimensões psicossociais da comunidade local em termos de percepção ambiental, comportamentos pró-ecológicos e qualidade de vida.

1.1 SOBRE PERCEPÇÃO AMBIENTAL

Segundo o programa Homem e Biosfera – MAB (*Man and Biosphere*), criado em 1971 pela Organização das Nações Unidas para a Educação, a Ciência e a Cultura (Unesco, 1971), a percepção ambiental é entendida como uma tomada de consciência e a compreensão pelo ser humano do ambiente no sentido mais amplo, envolvendo mais do que uma percepção sensorial individual, como a visão ou a audição (Whyte, 1978). Num enquadre mais alinhado com posições de movimentos ecológico-ambientais, a percepção ambiental é também considerada uma tomada de consciência das problemáticas ligadas ao ambiente, interagindo com aspectos culturais de cada indivíduo (Dorigo; Lamano-Ferreira, 2015). Das interações com diferentes sistemas ambientais, dos mais próximos (como os familiares e escolares) aos mais distantes (por exemplo, os culturais e ideológicos), emergem essas percepções (Bronfenbrenner, 2011; Pereira; Reis, 2016).

Assim, a percepção é tanto uma resposta dos diferentes sentidos (visão, audição, tato, olfato e paladar) a estímulos externos, singulares no ambiente ou espargidos na cultura, como também uma atividade seletiva, através da qual alguns fenômenos são registrados, e outros não (Tuan, 2012). Essa última característica é decorrente da interação da percepção com elementos associados às motivações presentes nos valores humanos.

Desde os anos de 1960, estudos sobre percepção apareceram na área ambiental, particularmente em pesquisas humanistas ligadas ao urbanismo e à geografia humana (Rodrigues *et al.*, 2012). Especialmente a partir da década de 1970, com a eclosão dos movimentos ecológicos, ampliaram-se estudos sobre o tema na área da Psicologia Ambiental. Desde então, encontram-se diferentes definições de percepção ambiental, dependendo do fundamento conceitual de que ela parte – por isso, sua avaliação é desafiadora. A avaliação da percepção ambiental é frequentemente feita por meio de entrevistas, ou questionários com perguntas fechadas e/ou abertas, e são diversos os autores que criam seus próprios questionários com o intuito de avaliação da percepção ambiental.

Segundo Oliveira-Monteiro e Silva (2018), com base em Lucena e Freire (2014), a percepção ambiental engloba os domínios de: percepção (elementos informativos e sensoriais; relacionamento e conhecimento acerca do ambiente), atitudes (experiências, opiniões e ações em relação à conservação do ambiente) e valores (valores afetivos e de lazer atribuídos ao ambiente). Os elementos informativos e sensoriais da percepção ambiental referem-se aos conhecimentos que as pessoas têm dos diferentes aspectos do ambiente. O ambiente é aqui entendido como o conjunto de condições, leis, influências e interações de ordem física, química e biológica que operam na Terra e que influencia e determina a vida humana. Assim é, conforme definido, em 1972, pela Organização das Nações Unidas (ONU), e confirmado pela Declaração de Estocolmo sobre o Meio Ambiente Humano, a primeira declaração internacional sobre o meio ambiente (Organização das Nações Unidas para o Meio Ambiente, 1972).

Já os elementos atitudinais em relação ao meio ambiente associam-se à sua visão de mundo e ao estilo de vida que a pessoa e/ou seu grupo social possuem. Essas atitudes podem ser baseadas em valores positivos, aqueles que são permeados por uma identificação emocional com o ambiente. Nesse sentido, vale lembrar o conceito de "topofilia", constructo que se refere ao elo afetivo entre a sociedade e o meio ambiente. Esse laço é enriquecido por conhecimentos da história local, com uma relação mais direta com os componentes do ambiente, e com a percepção da beleza e da importância do lugar (Tuan, 2012). Por sua vez, os elementos valorativos da percepção ambiental referem-se a ideais e princípios que cada indivíduo apresenta em relação ao ambiente (Pato, 2011). Os valores ambientais visam ao equilíbrio e à sustentabilidade das relações entre os ecossistemas ou ambientes e estão diretamente relacionados a crenças, atitudes e comportamentos ecologicamente responsáveis, condutas que expandem a capacidade de utilização dos recursos naturais disponíveis no planeta Terra, com menor nível de impacto ao meio ambiente (Pato; Campos, 2011).

1.2 SOBRE COMPORTAMENTOS PRÓ-ECOLÓGICOS

Denominados de diversas maneiras, como comportamentos pró-ecológicos, condutas pró-ambientais, ou mesmo comportamentos ecológicos ou ambientais, essa classe de condutas vem sendo estudada de forma associada aos movimentos ambientalistas, e muitas vezes relacionada a valores morais, crenças pessoais, normas sociais e à ética (Becker; Félonneau, 2011; Corral-Verdugo; Pinheiro, 1999; Pinheiro *et al.*, 2014). Essas diferentes nomeações tendem a aceitar que os aspectos relacionados às condutas pró-ambientais evidenciam motivações que levam o indivíduo a agir em defesa do meio ambiente ou de maneira não prejudicial a ele, e também que a preocupação ambiental pode ser considerada um fator determinante, embora indireto, desses comportamentos ambientais (Pereira; Pato, 2015).

Em Pato e Tamayo (2006), a denominação "comportamentos ecológicos" refere-se a condutas em favor do meio ambiente que refletem a utilização dos recursos de maneira sustentável, sendo parte do repertório comportamental das pessoas, de forma intencional, ou mesmo não consciente, ações que podem ser aprendidas e internalizadas. Subjacentes a esses comportamentos ecológicos, também nomeados pelos autores como comportamentos pró-ecológicos, pode-se considerar a ética, os valores e as motivações que se afirmam, em seu conjunto, pelo agir em defesa do ambiente, baseados em princípios de sustentabilidade e no reconhecimento entre relações humanas e a sustentabilidade ambiental. Essa vinculação com valores mostra uma faceta complexa dos comportamentos ecológicos, já que a formação de valores não depende somente de ações pedagógicas, como as de educação ambiental, por exemplo, mas está também ligada a outros contextos socioambientais que interagem com os indivíduos, como o familiar, o religioso e o político.

1.3 SOBRE QUALIDADE DE VIDA

Em 1995, a Organização Mundial da Saúde (OMS), por meio do projeto *The WHOQOL Group*, preconizou o primeiro conceito padronizado de Qualidade de Vida, definindo-a como a percepção do indivíduo de

sua inserção na vida, no contexto da cultura e sistemas de valores nos quais ele vive e em relação aos seus objetivos, expectativas, padrões e preocupações (Whoqol Group, 1995). Dessa forma, a qualidade de vida foi definida como um conceito multidimensional, conferindo-lhe diferentes elementos das condições de vida das pessoas.

Embora sejam diversas as vertentes explicativas para Qualidade de Vida, com essa definição da OMS ela passou a ser entendida de forma abrangente, na interação com diferentes sistemas, sejam eles individuais, socioculturais e históricos. O estudo da Qualidade de Vida é internacional e envolve grande variedade de grupos-alvo, usando diferentes métodos de pesquisa e muitos tipos de medidas para sua avaliação (Haraldstad *et al.*, 2019).

O *Whoqol Group* da OMS criou instrumentos para avaliação da qualidade de vida, subdividindo-a em quatro domínios: 1) físico (relacionado a conforto e desconforto, e dor), 2) psicológico (sentimentos positivos e negativos, imagem corporal e aparência, autoestima, memória, concentração e capacidade de aprender e pensar), 3) relações sociais (relações pessoais, apoio social e atividade sexual), e 4) meio ambiente (segurança, ambiente no lar, recursos financeiros, cuidados com saúde e sociais, oportunidade e habilidade de adquirir informações, lazer, poluição, ruído, trânsito, clima e transporte).

A Constituição Federal do Brasil (CF), de 1988, menciona a Qualidade de Vida em seu artigo 225, relacionando-a com o direito ao meio ambiente ecologicamente equilibrado (Brasil, 1988). Porém, ao longo da CF, irradiam disposições que asseguram o direito à Qualidade de Vida. Nesse enquadramento, ela está associada não só aos direitos e garantias fundamentais, como também à ordem econômica e ao já mencionado direito ao meio ambiente ecologicamente equilibrado.

2 MÉTODO

Pesquisa quantitativa transversal que visa descrever como se manifestam determinados comportamentos e percepções, sem intervenção direta do pesquisador no ambiente (Field; Miles; Field, 2012).

2.1 PARTICIPANTES

Foram avaliados moradores (adultos e idosos) residentes no bairro Perequê há pelo menos um ano. Buscou-se tendência de homogeneidade na composição da amostra quanto a: sexo (homem e mulher) e faixas de idade (adulto jovem, meia idade e idoso). A amostra foi constituída por critérios de conveniência e acessibilidade dos pesquisadores – o que quer dizer que foram convidadas as pessoas que transitavam nos locais de coleta (Hulley *et al.*, 2014).

2.2 INSTRUMENTOS

Dados de característica da amostra, como sexo e idade do participante, foram coletados. Além desses, foram utilizados os instrumentos (questionários) elencados a seguir.

2.2.1 QUESTIONÁRIO DE PERCEPÇÃO AMBIENTAL – PRAIA (QPAP)

A avaliação de percepção ambiental foi levantada através do QPAP, adaptação do instrumento utilizado por Oliveira-Monteiro e Silva (2018), utilizado em pesquisas realizadas no LADH/Unifesp. O questionário original foi construído para pesquisa realizada em ambiente de manguezal e aqui adaptado para o ambiente costeiro (onde estava escrito “mangue” foi substituído por “praia”). O QPAP contém 11 perguntas fechadas voltadas a três domínios: 1) perceptivo (de informação/conhecimentos sobre o

ambiente e sensorial/relação com o ambiente); 2) de valores (valores afetivos e de lazer atribuídos ao ambiente) e 3) de atitudes (experiências, opiniões e ações em relação à conservação do ambiente). Na percepção ambiental, esses domínios articulam-se e integram-se. Dessa maneira, por exemplo, os valores são construídos a partir das informações e da percepção sensorial, podendo a presença de valores conduzir a atitudes positivas ou negativas a respeito do meio ambiente.

Esse instrumento também abarca três questões abertas que dizem respeito a: descrição pessoal da paisagem do local, principal problema de morar no bairro e o que seria "o melhor" daquele bairro.

2.2.2 ESCALA DE COMPORTAMENTO ECOLÓGICO (ECE)

Para verificação de comportamentos pró-ecológicos, foi utilizada a Escala de Comportamento Ecológico (ECE), desenvolvida e validada no Brasil por Pato e Tamayo (2006), um instrumento que contém 27 questões relacionadas a ações individuais em favor do meio ambiente. Em uma escala do tipo *Likert* de cinco pontos, o respondente assinala o grau de concordância com as sentenças apresentadas.

2.2.3 WHOQOL-BREF

A avaliação da qualidade de vida dos participantes foi feita a partir do WHOQOL-bref (Fleck *et al.*, 2005). O Whoqol-bref é uma versão abreviada do Whoqol-100 para avaliação de qualidade de vida desenvolvida pelo Grupo de Qualidade de Vida da Divisão de Saúde Mental da OMS e traduzida no Brasil pelo Departamento de Psiquiatria e Medicina Legal da Universidade Federal do Rio Grande do Sul, com as 26 questões que obtiveram os melhores desempenhos psicométricos extraídas do Whoqol-100.

Como citado anteriormente, os domínios avaliados são: 1) físico (dor e desconforto), 2) psicológico (sentimentos positivos e negativos, imagem corporal e aparência, autoestima, memória, concentração e capacidade de aprender e pensar), 3) relações sociais (relações pessoais, apoio social e atividade sexual) e 4) meio ambiente (segurança, ambiente no lar, recursos financeiros, cuidados com saúde e sociais, oportunidade e habilidade de adquirir informações, lazer, poluição, ruído, trânsito, clima e transporte).

2.2.4 CRITÉRIO DE CLASSIFICAÇÃO ECONÔMICA BRASIL (CCEB)

Para caracterização econômica da amostra, foi utilizado o Critério de Classificação Econômica Brasil (CCEB), da Associação Brasileira de Empresas de Pesquisa (Abep) (2022). O instrumento compreende itens de conforto da família, acesso a saneamento básico, pavimentação da rua e a escolaridade do chefe da família (compreendido como quem contribui com a maior parte da renda familiar).

2.3 PROCEDIMENTOS ÉTICOS DE PESQUISA COM SERES HUMANOS

A pesquisa realizada foi submetida, através da Plataforma Brasil, à avaliação do Comitê de Ética em Pesquisa da Unifesp, tendo recebido Parecer de Aprovação Nº 5.090.212. Um Termo de Consentimento Livre e Esclarecido (TCLE) foi apresentado aos participantes para concordância e assinatura. Cópias assinadas desses TCLE encontram-se arquivadas no LADH/Unifesp.

2.4 PROCEDIMENTOS DE COLETA DE DADOS

Após uma visita ao campo para primeira exploração do ambiente, as coletas de dados foram realizadas de forma presencial, com inserção ecológica (Prati *et al.*, 2008) dos pesquisadores, em locais públicos, em comércios, na faixa de praia, em uma Unidade de Saúde da Família, e em uma residência do bairro. Para tanto, lideranças locais e a coordenação do equipamento de saúde realizaram intermediações prévias.

A despeito dessas colaborações e do cumprimento de procedimentos éticos, explicando os objetivos da investigação e apresentação do TCLE assinado pela pesquisadora responsável, ocorreram várias recusas por parte dos convidados para participar da pesquisa. Algumas manifestações de recusa foram relacionadas a problemas com levantamentos (pesquisas) anteriores que, segundo mencionado, acabaram por trazer prejuízos aos pescadores. Em outros casos, outros participantes pareceram indicar medo de golpes e temor de quebra de sigilo. Nesse aspecto, a coincidência da coleta de dados com o período pré-eleitoral de 2022 e com a realização do censo demográfico do Instituto Brasileiro de Geografia e Estatística (IBGE) pode ter motivado uma menor disposição e disponibilidade dos convidados à participação.

Após convites e aceites, de acordo com os procedimentos éticos, foi apresentado o TCLE com as informações sobre a pesquisa para as devidas explicações e assinaturas. A coleta de dados com esses participantes aconteceu em 10 visitas ao bairro (datas: 30/06/2022, 20/07/2022, 03/08/2022, 16/09/2022, 21/09/2022, 01/12/2023, 29/03/2023, 25/04/2023, 26/04/2023 e 27/04/2023). A equipe de coleta de dados foi devidamente identificada como membros da universidade, com crachá e jaleco. Em alguns momentos da coleta, os pesquisadores utilizaram máscaras faciais, em conformidade às diretrizes para trabalhos de campo da universidade, bem como as medidas estaduais para contenção da pandemia da Covid-19.

2.5 PROCEDIMENTOS DE ANÁLISE DOS DADOS

Os dados do QPAP (Percepção Ambiental) foram analisados pelas frequências das respostas às 11 questões fechadas. O modelo de Análise de Conteúdo (Bardin, 2010) foi utilizado para análise das respostas às questões abertas, com leitura e organização dos aspectos importantes do texto comunicado pelos entrevistados, seleção das unidades de análise e classificação dos dados em categorias.

Os resultados da ECE (Comportamentos Pró-Ecológicos) foram tabulados segundo normas do instrumento. Os resultados do WHOQOL-bref (Qualidade de Vida) foram calculados segundo normas do próprio instrumento (Fleck *et al.*, 2005), considerados nos domínios físico, psicológico, social e ambiental. Os escores do CCEB foram calculados segundo normas da Abep (2022) e considerados nas subclasses econômicas A, B, C e D/E.

Os dados numéricos apresentados neste relatório foram analisados por estatística descritiva (médias, desvio-padrão e frequências). Foram utilizados os programas Jasp (0.14.1) e Excel (2016).

3 RESULTADOS E DISCUSSÃO

Participaram da investigação 86 adultos, dos quais 52 (60,46%) mulheres e 34 homens (Figura 2a). Quanto à classificação econômica, a maior parte da amostra (46,51%) pertencia à classe C, 26% à classe B e 16% à classe D (Figura 2b). As idades dos participantes variaram de 18 a 75 anos (média = 38,9 anos; DP = 5,4 anos), com predominância de pessoas mais jovens, abaixo dos 33 anos (Figura 2c). A maioria desses participantes morava no bairro do Perequê desde o ano 2000, sugerindo boa familiaridade com a região e sentimento de pertencimento ao território.

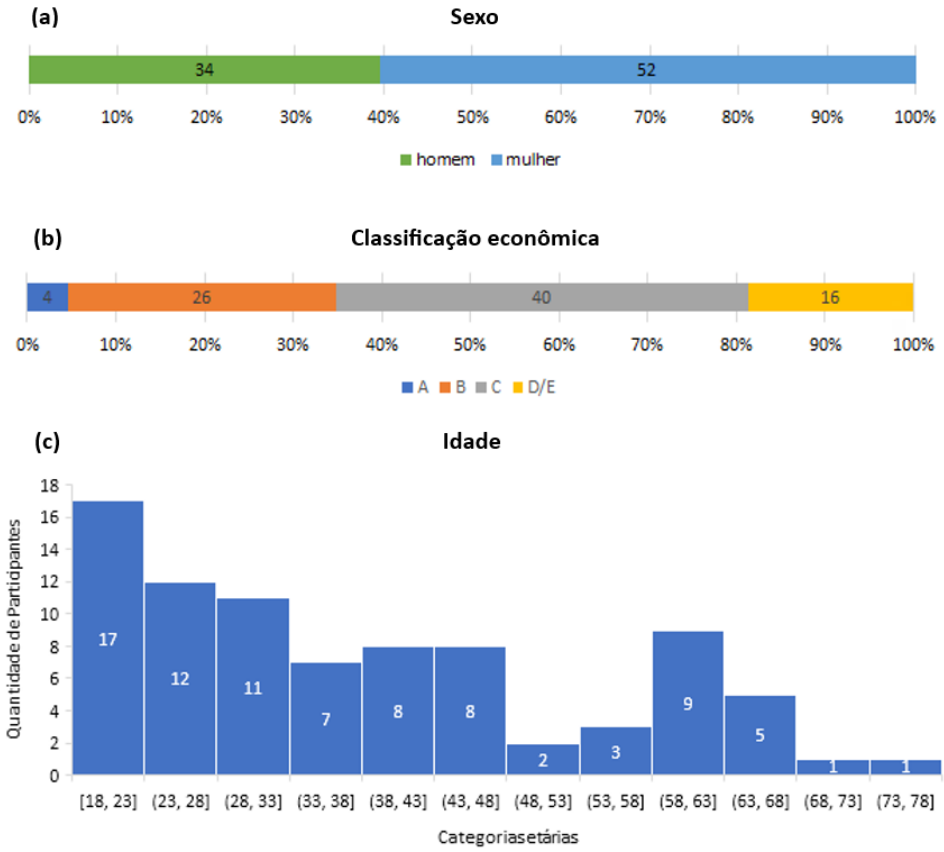

Figura 2 – Caracterização da amostra de participantes segundo sexo (a), classificação econômica (b) e distribuição etária (c)

Fonte: Elaborada pelos autores

3.1 RESULTADOS DE PERCEPÇÃO AMBIENTAL

De acordo com o potencial do instrumento utilizado, os resultados do QPAP estão apresentados para os seguintes domínios da percepção ambiental: 1) percepção (relacionamento e conhecimento acerca do ambiente, abarcando elementos informativos e sensoriais), 2) atitudes (experiências e opiniões em relação à conservação do ambiente), e 3) valores (valores afetivos e de lazer atribuídos ao ambiente). As respostas da amostra acerca de cada agrupamento das perguntas do instrumento, pelos seus três domínios, permitiram elucidar significados a partir dos quais os participantes basearam suas opiniões.

3.1.1 DOMÍNIO DE PERCEPÇÃO

Elementos informativos (Figura 3) da percepção ambiental estiveram presentes na maior parte da amostra (84,88%) indicando referências de conhecimento de animais da região costeira ao lado de citações a animais domésticos (cães e gatos). Nesse sentido, no presente estudo, foram mencionadas espécies de animais marinhos, como peixes (peixe-bagre, tainha, tubarão e robalo), crustáceos (caranguejo, siri, camarão e guaiamum) e mamíferos (baleia e golfinho).

O estudo conduzido por Oliveira-Monteiro e Silva (2018), avaliando percepções de moradores da Baixada Santista vivendo em ocupações irregulares nas proximidades de um manguezal, obteve resultados semelhantes (80%). Adicionalmente, outras espécies de mamíferos (tais como, capivara, saruê, esquilo, raposa, onça, tatu entre outras) foram mencionadas como conhecidas pelos participantes. Em sua maioria, as pessoas que participaram da pesquisa apresentaram amplo reconhecimento acerca de

animais da região (Figura 3a). Esse universo de referências a animais forneceu indícios de interação próxima com a fauna daquela praia e da região da Mata Atlântica presente no bairro. Não houve expressiva frequência (38,37%) da referência de utilização de peixes para a alimentação (Figura 3b).

Por outro lado, como indicado nas Figuras 3c e 3d, os resultados sobre o conhecimento de plantas indicaram uma menor identificação com a flora (45,34% negaram conhecimento sobre plantas, enquanto 54,65% afirmaram conhecê-las, citando principalmente embaúba, bromélia, orquídea, coqueiro, chapéu-de-sol, boldo, manacá-da-serra e samambaia). Essa observação pode estar associada a uma maior familiaridade dos moradores com animais marinhos, uma vez que a pesca é uma atividade de subsistência muito relevante naquele bairro. Como em Diegues (2019), esses saberes específicos estavam ligados a um conhecimento e a saberes tradicionais de campos particulares: informações de moradores de regiões costeiras sobre fauna marinha.

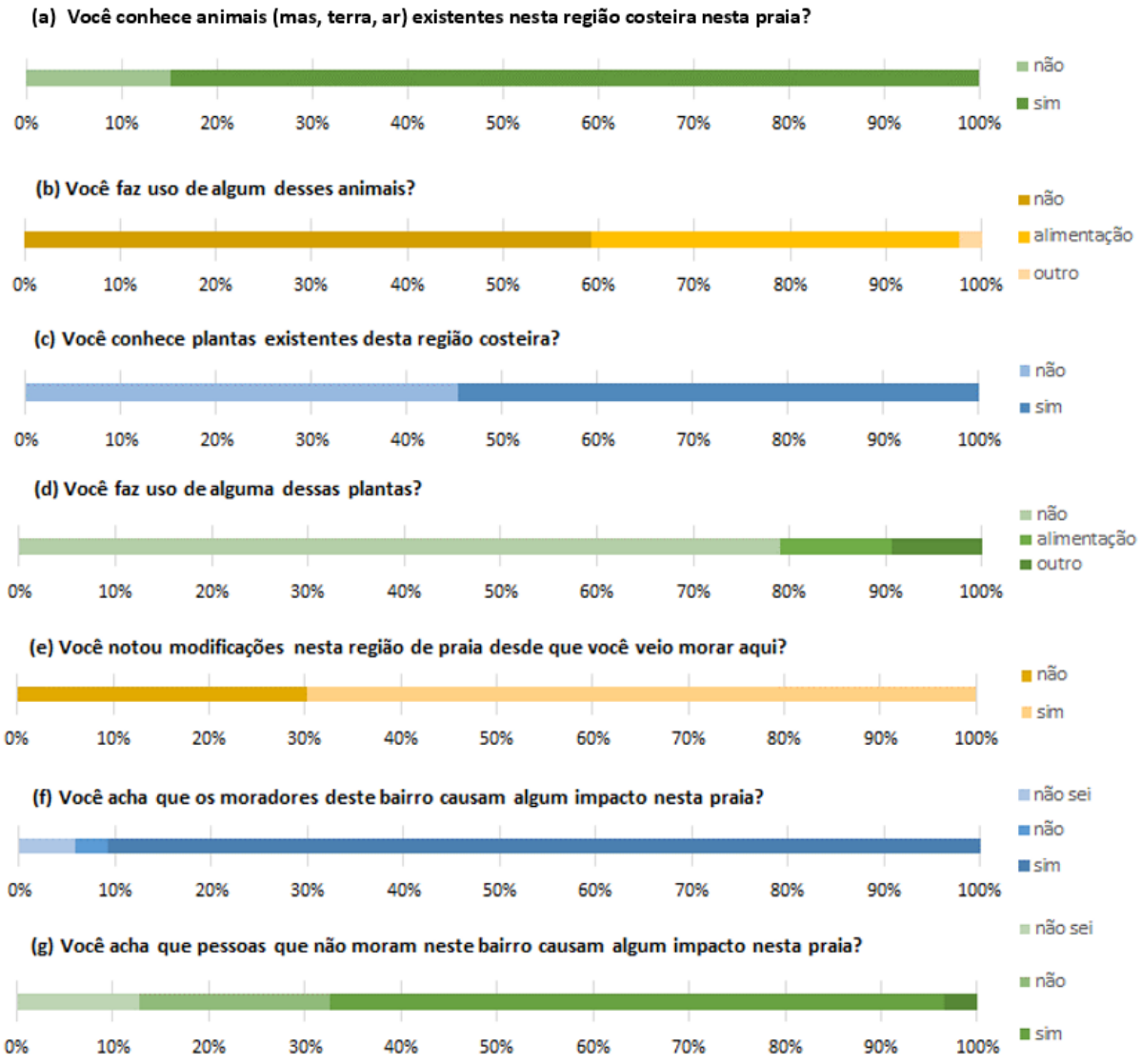

Figura 3 – Percentual de respostas ao questionário de Percepção Ambiental – Praia dentro do domínio percepção

Fonte: Elaborada pelos autores

Os elementos sensoriais da percepção ambiental foram relacionados a possíveis modificações ocorridas na região costeira durante o período em que residiram no bairro, sendo que 20,93% da amostra afirmou

lá residir no período de 2000 a 2004 e 19,77% desde antes dos anos 1990. A maioria dos participantes (69,77%) afirmou que houve modificações desde que começaram a residir no bairro (Figura 3e). Ao lado de modificações positivas, com destaque para a melhoria na iluminação, na pavimentação e aumento do comércio, foram referidas alterações negativas, principalmente o aumento da poluição e a invasão de áreas preservadas. Além disso, a maioria dos participantes considerou que tanto moradores quanto não moradores traziam impactos para a praia, sendo os impactos negativos sempre associados ao descarte inadequado de lixo. As referências aos impactos causados por não moradores foram menos recorrentes (63,95%; Figura 3f) do que aqueles referentes aos moradores do bairro (90,69%; Figura 3g).

Dessa forma, ao contrário dos resultados obtidos pelo citado estudo de Oliveira-Monteiro e Silva (2018), que usou o mesmo instrumento na pesquisa com moradores de regiões de manguezais, os participantes da presente pesquisa majoritariamente se incluíram na condição de causadores de impactos ambientais no bairro. Nesse aspecto, além de referências à poluição, a construção de moradias irregulares no bairro foi também apontada como geradora de impactos pelos residentes. Ainda, sete participantes (8,14%) afirmaram que os impactos causados pelos moradores estavam relacionados à falta de conscientização acerca da importância da preservação ambiental. Mais além, a falta de saneamento e o despejo de lixo e esgoto no Rio do Peixe, que passa pelo bairro e deságua no mar, foram citados 11 vezes pelos participantes (12,79%).

Os principais problemas de residir no bairro, segundo a manifestação dos participantes, eram a distância do centro da cidade de Guarujá (provavelmente sugerindo problemas de transporte), a falta de saneamento básico e de infraestrutura, pouca segurança, e carência e/ou ausência de médicos na Unidade de Saúde da Família do bairro. Quando questionados sobre os melhores atributos do bairro, as respostas mais comuns foram associadas a características de ambientes restauradores (Gressler; Günther, 2013), especialmente os próximos às praias e costas marítimas (Danovaro *et al.*, 2021), com referências à natureza, tranquilidade, sossego, praia, paz e segurança. Em contraste com queixas relativas à segurança, nove moradores afirmaram que não havia violência e roubos no bairro. Alguns poucos investigados sugeriram que traficantes locais davam segurança aos moradores do bairro, com indicativos de ações paralelas ao poder público.

3.1.2 DOMÍNIO DE ATITUDES

Lembrando que atitudes ambientais são tidas como preditoras de comportamentos pró-ambientais (Shafiei; Maleksaeidi, 2020), os resultados pertinentes ao campo atitudinal (Figura 4), um dos domínios avaliados na percepção ambiental dos investigados, indicaram maior frequência (90,86%) de manifestações confirmatórias de atitudes associadas a interesse em cuidar da região.

Figura 4 – *Percentual de respostas ao questionário de Percepção Ambiental – Praia dentro do domínio de atitudes*

Fonte: Elaborada pelos autores

Frequentemente, foram percebidas características de forte sentimento de territorialidade, provavelmente associadas à identificação com o bairro e tempo de moradia naquele local. As manifestações confirmatórias de desejo de preservação da região – com citações explícitas referentes à necessidade de cuidado para as gerações futuras – podem ser efeito de disseminação de informações sobre problemas à sustentabilidade, provavelmente veiculadas pela mídia. Aspectos de valoração positiva do ambiente estiveram presentes na maioria da amostra (91,86%), assim como a afirmação de gostar de morar no bairro. Tal valoração positiva, bem como uma identificação afetiva com o território, foi expressivamente colocada em qualificações indicativas de conexão com a natureza (Mackay; Schmitt, 2019), com uso de expressões como: um local maravilhoso, leve, magnífico, calmo, esplêndido e único – também características de ambientes restauradores próximos ao mar (Danovaro *et al.*, 2021). Entretanto, embora não muito frequente, alguns poucos moradores definiram o território como sujo, pouco agradável e poluído, citando o esgoto que deságua na praia e invasões, mas essas referências negativas nunca foram associadas diretamente à natureza daquele ambiente, sugerindo ações antrópicas.

3.1.3 DOMÍNIO DE VALORES

No domínio de valores, quando questionados sobre a importância da região de praia para eles, a maioria dos investigados manifestou-se positivamente (Figura 5). Nesse caso, foram novamente explicitadas razões ligadas a territorialidade, ao lazer que a praia proporcionava, oportunidades de trabalho com a pesca, manutenção da beleza do ambiente, além de valores de natureza sentimental.

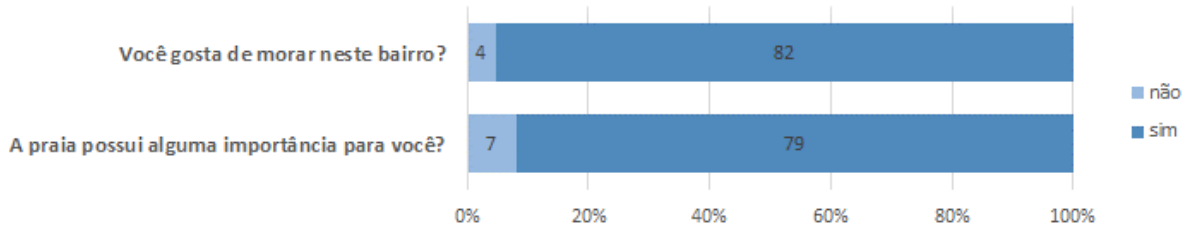

Figura 5 – Percentual de respostas ao questionário de Percepção Ambiental – Praia dentro do domínio de valores

Fonte: Elaborada pelos autores

Quando questionados se gostavam de residir no bairro, a maioria também afirmou que sim (Figura 5), indicando a tranquilidade, natureza e a identificação com o local. Os participantes descreveram a praia como magnífica, bonita, perfeita, calma, maravilhosa, entre outros adjetivos positivos. Como já citado, e atingindo o campo de valores, apareceram as descrições negativas daquele ambiente como região poluída, suja, fraca, pouco agradável, sugerindo valorações negativas associadas à ação humana no território.

Mackay *et al.* (2019) sustentam que a natureza não precisa ser vista sempre como positiva ou benéfica para os seres humanos sentirem conexão com ela, já que a identificação com a natureza não requer que tudo nela seja sempre prazeroso a partir de uma perspectiva humana. Portanto, embora uma parte dos participantes tenha atribuído descrições negativas àquele ambiente, ainda apresentam respeito pela natureza quando afirmam que a praia possui importância para eles (91,86%).

3.2 RESULTADOS DE COMPORTAMENTOS PRÓ-ECOLÓGICOS

Resultados da ECE estão apresentados na Figura 6. Os comportamentos pró-ecológicos mais frequentemente colocados foram relacionados à economia de gastos, como "apago as luzes quando saio de lugares vazios" (média = 5,56), "evito desperdício de energia" (média = 5,48); e o comportamento "guardo o papel que não quero mais na bolsa, quando não encontro uma lixeira por perto" (média = 5,44) também foi bastante mencionado. Esse resultado pode ter relação com a criação de leis relativas a esses comportamentos, como a Política Nacional sobre Mudança do Clima (Brasil, 2009), a Política Nacional de Resíduos Sólidos (Brasil, 2010) e o novo Código Florestal Brasileiro (Brasil, 2012).

Os comportamentos ecológicos referentes à economia de água e energia (provavelmente relacionados à economia de gastos financeiros), e limpeza urbana, destacaram-se como referências daqueles investigados, ao encontro de resultados de Beuron *et al.* (2012). Outrossim, embora se considere que esses comportamentos pró-ecológicos com maiores médias sejam resultado de alterações sociais pró-ambientais, é importante ressaltar que Batson e Thompson (2001) alertam sobre o que nomearam "hipocrisia moral". Segundo esses autores, tal comportamento leva participantes de pesquisas a fornecerem respostas socialmente esperadas diante das perguntas apresentadas, sendo mais frequentes em estudos não experimentais que incluam alguma associação com comportamentos morais.

Por outro lado, o comportamento menos praticado, segundo os moradores avaliados da Praia do Perequê, foi associado a: "quando não encontro lixeiras por perto, jogo latas vazias no chão" (média = 1,41) – uma das afirmativas presentes no instrumento que precisa ser invertida, pois representa o oposto do desejado com o instrumento, que é verificar comportamentos em favor do ambiente. Ou seja, é um comportamento que se espera que seja pouco frequente na população porque não é voltado para a preservação ambiental.

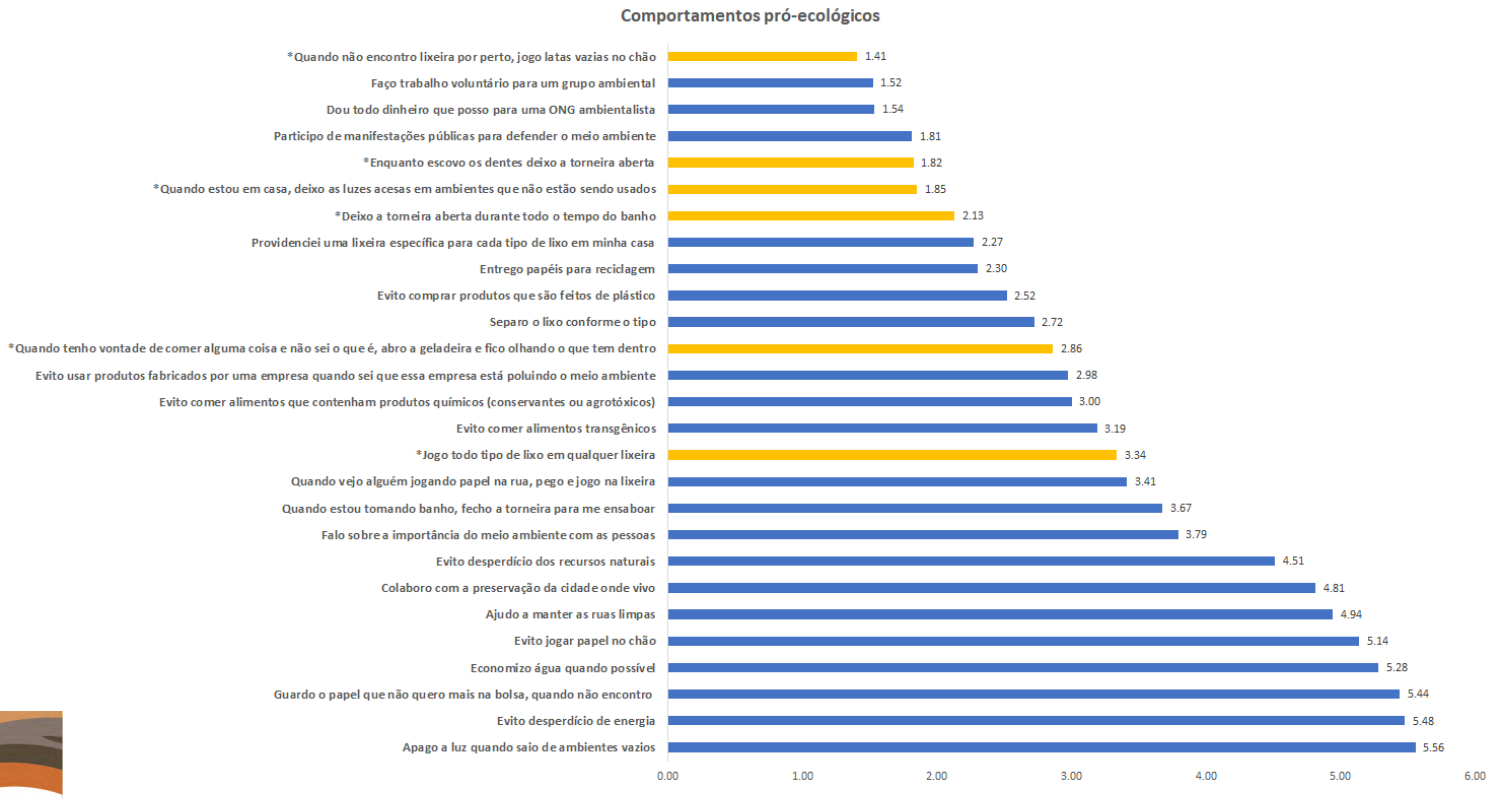

Figura 6 – Resultados da avaliação empregando a Escala de Comportamento Ecológico

Fonte: Elaborada pelos autores.

*Nota: *Comportamentos para serem invertidos na escala representam o oposto do desejado, que é o comportamento voltado para preservação do meio ambiente.*

Já os itens "faço trabalho voluntário para um grupo ambiental" (média = 1,52) e "dou todo dinheiro que possuo para uma ONG ambientalista" (média = 1,54), também entre as menores médias da amostra, fazem parte do rol de comportamentos denominados como "desejabilidade social", de acordo com Pato e Tamayo (2006). Os autores os incluíram na escala para servirem como parâmetros do que seria o "mais ecológico possível", mas mesmo eles esperavam que as valorações para esses fossem mais baixas. Curioso notar que, entre os comportamentos ecológicos com valores mais baixos para a amostra, estão aqueles relacionados ao descarte adequado e à reciclagem de lixo – o mesmo lixo que os participantes referenciaram incomodá-los no questionário de percepção ambiental, mas que assumiram não serem descartados adequadamente.

3.3 PERCEPÇÃO DE QUALIDADE DE VIDA

Resultados do WHOQOL-bref, nos seus domínios psicológico, social, ambiental e físico, estão apresentados na Figura 7. A Qualidade de Vida teve o maior valor médio (média = 4,10) no domínio psicológico, que inclui questões sobre sentimentos positivos acerca da vida, além de questões sobre autoestima, imagem corporal e aparência, sentimentos negativos, memória e concentração (Fleck *et al.*, 2005). Essas condições psicológicas positivas podem ser associadas à conexão, proximidade e inserção no ambiente daquele bairro, com claras condições restauradoras (Danovaro *et al.,* 2021) – não só a Praia do Perequê, como também espaços verdes – áreas de Mata Atlântica ainda presentes na região.

É consenso que o ambiente interage com a saúde física e mental das pessoas (White *et al.*, 2016). Os mecanismos ambientais ligados à promoção da saúde são a redução do estresse, incentivo a atividades físicas e interações sociais e a qualidade ambiental (Hartig *et al.*, 2014). O estudo de White *et al.* (2016) indicou que indivíduos que viviam perto da costa eram mais saudáveis e mais felizes do que aqueles que viviam no interior, principalmente no caso de populações mais pobres, já que a zona costeira pode oferecer maiores espaços de lazer e de promoção da saúde, de forma gratuita.

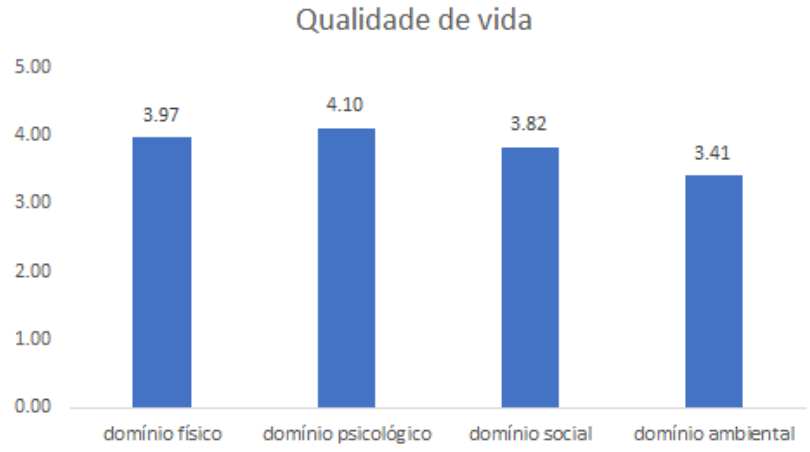

Figura 7 – Resultados da avaliação sobre qualidade de vida empregando o WHOQOL-bref, nos seus domínios psicológico, social, ambiental e físico

Fonte: Elaborada pelos autores

Por outro lado, a menor média dos quatro domínios avaliados para a Qualidade de Vida dos moradores da Praia do Perequê foi referente ao domínio ambiental (média = 3,41). Esse domínio inclui questões relacionadas à segurança física, ambiente no lar, recursos financeiros, disponibilidade e qualidade de cuidados com saúde e sociais, oportunidade de adquirir novas informações e habilidades, oportunidades de lazer, transporte e ambiente físico (Fleck *et al.*, 2005). No estudo de Oliveira-Monteiro e Silva (2018)

com moradores de manguezais e que também usou o WHOQOL-bref, houve resultados positivos em três dos quatro domínios do instrumento. De forma semelhante aos resultados do presente estudo, foi o domínio ambiental daqueles de manguezais que recebeu a menor valoração (média = 3,24), menor ainda do que a média dos moradores da Praia do Perequê (média = 3,41).

Figura 8 – Resultados da avaliação sobre qualidade de vida empregando o WHOQOL-bref, detalhando os itens avaliados

Fonte: Elaborada pelos autores

Embora a maioria dos investigados tenha indicado que considerava aquele bairro com características de um ambiente restaurador (conforme resultados do questionário de percepção ambiental), essa menor valoração alcançada no domínio ambiental da Qualidade de Vida também pode estar relacionada à predominância de classe econômica C na amostra. Esse padrão foi também apontado nos resultados do estudo de Gordia *et al.* (2009), em que houve correlações positivas entre classe econômica menos abastada e menor qualidade de vida (medida no domínio ambiental do WHOQOL-bref).

Muitas áreas de moradia no bairro do Perequê são consideradas irregulares, inclusive as que se encontram em "áreas de invasão", fato relatado por alguns dos participantes. Segundo Sales *et al.* (2006), moradores de ocupações irregulares podem ter uma menor qualidade de vida devido à falta de acesso à infraestrutura adequada.

Os itens do instrumento de Qualidade de Vida que obtiveram as menores médias com os moradores da Praia do Perequê foram sobre recursos financeiros para satisfazer necessidades, oportunidade de realizar

atividades de lazer e satisfação com o acesso aos serviços de saúde (Figura 8). Esses resultados podem indicar que, embora aqueles moradores estivessem satisfeitos com algumas condições associadas à natureza do local onde viviam, e o considerassem com características de ambiente restaurador, não consideravam os recursos financeiros que possuíam suficientes para suprir suas necessidades. Para além de dificuldades econômicas, os moradores da Praia do Perequê não estavam satisfeitos com o acesso aos serviços de saúde disponíveis, o que também se manifestou no questionário de percepção ambiental, com alguns moradores relatando a falta de médicos na unidade de saúde do bairro.

Em pesquisa sobre parques, Camargo *et al.* (2017) sugerem que há uma interação entre características pessoais e ambientais, subjetivas e objetivas, relacionadas a regiões urbanas de parques, condições de saúde e prática de atividade física que contribuem para a percepção de qualidade de vida. Parques são caracterizados como *green spaces*, locais que promovem bem-estar com natureza normalmente verde (Foley; Kistemann, 2015). Por sua vez, a presente pesquisa avaliou indivíduos localizados em *blue spaces*, que são locais com água em sua extensão (como praias, lagos e rios) (Foley; Kistemann, 2015; White et al., 2020).

Como apresentado anteriormente, o item sobre oportunidade de realizar atividades de lazer obteve uma das menores médias (3,09) no WHOQOL-bref, para a amostra do bairro do Perequê (Figura 8). Esse achado aponta para a necessidade de oportunizar publicamente atividades e locais de lazer para aquela população. Cabe ainda mencionar que o fato de habitar perto da água, na praia, é bastante propício para atividades físicas e lazer, o que, por si só, é potencial para promoção do bem-estar humano (Foley; Kistemann, 2015).

4 CONCLUSÕES

Voltada para avaliação de condições psicossocioambientais de moradores de um bairro de periferia sociogeográfica de um município de zona costeira paulista que sofre impactos socioambientais pelo turismo e navegação, esta investigação procurou analisar suas autorreferências de percepções ambientais, comportamentos pró-ecológicos e qualidade de vida.

Dentro do recorte do método empregado (pesquisa quantitativa transversal, de autorrelato, com amostra constituída por conveniência), os resultados encontrados circunscrevem-se à percepção dos participantes e ao que eles responderam no momento da coleta. Investigações de autorreferências dessa natureza, em cenários socioambientais como o considerado no estudo, não têm sido apresentadas na literatura, situação que não favoreceu uma discussão mais ampla dos dados numa esfera comparativa. Isso constitui uma limitação do trabalho e, ao mesmo tempo, aponta uma sugestão de realização de outras pesquisas nessa mesma linha.

A percepção ambiental positiva referida pelos investigados relacionou-se às experiências de interação com ambientes de espaços verdes – dos montes próximos ao bairro –, além da interação constante, e praticamente cotidiana, com espaços azuis da praia e dos rios da região. Essa positividade ambiental coexistia com autorreferências de dificuldades daquele ambiente.

Problemas de mobilidade urbana, com transporte deficitário, dificuldades nos atendimentos em saúde pública, convívio com descarte inadequado de lixo são dificuldades que podem ter contribuído para os dados encontrados de negatividade no domínio ambiental na avaliação da qualidade de vida daqueles investigados. Esse conjunto de circunstâncias pode indicar e sugerir políticas públicas voltadas à implementação de estratégias de educação ambiental visando simultaneamente moradores e frequentadores ocasionais, melhoria de transporte e segurança no bairro, melhoria da oferta em equipamentos de saúde e favorecimento de atividades públicas de lazer.

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REFERÊNCIAS

ARAÚJO, F. R.; SCACHETTI, R. E.; OLIVEIRA-MONTEIRO, N. R. Autopercepção de qualidade de vida em adultos de uma região litorânea do estado de São Paulo. **Unisanta Law and Social Science**, v. 12, n. 1, p. 269-284, 2023. Disponível em: https://periodicos.unisanta.br/index.php/lss/article/view/3556. Acesso em: 20 jan. 2024.

ARAÚJO, F. R. *et al.* Percepções e condutas de universitários frente ao ambiente. **Brazilian Journal of Development**, v. 6, n. 9, p. 73141-73156, 2020. Disponível em: https://doi.org/10.34117/bjdv6n9-682. Acesso em: 20 jan. 2024.

ASSOCIAÇÃO BRASILEIRA DE EMPRESAS DE PESQUISAS (ABEP). **Critério de Classificação Econômica Brasil**, 2022. Disponível em: https://www.abep.org/criterio-brasil. Acesso em: 20 jan. 2024.

BARDIN, L. **Análise de conteúdo**. São Paulo: Edições 70, 2011.

BATSON, C. D.; THOMPSON, E. R. Why don't Moral People Act Morally? Motivational considerations. **Current Directions in Psychological Science**, v. 10, n. 2, p.54-57, 2001. Disponível em: https://doi.org/10.1111/1467-8721.00114. Acesso em: 20 jan. 2023.

BECKER, M.; FÉLONNEAU, M. L. Pourquoi être pro-environnemental? Une approche socionormative des liens entre valeurs et «pro-environnementalisme». **Pratiques psychologiques**, v. 17, n. 3, p. 237-250, 2011.

BEURON, T. A. *et al.* Relações entre os valores pessoais e os comportamentos ecológicos no contexto da sustentabilidade. **Revista ibero-americana de Ciências Ambientais**, v. 3, n. 2, p. 6-22, 2012.

BRASIL. **Lei nº 6.938, de 31 de agosto de 1981**. Dispõe sobre a Política Nacional do Meio Ambiente, seus fins e mecanismos de formulação e aplicação, e dá outras providências. Disponível em: https://www.planalto.gov.br/ccivil_03/leis/l6938.htm. Acesso em: 20 jan. 2024.

BRASIL. **Constituição da República Federativa do Brasil de 1988**. Brasília: Presidência da República, 1988. Disponível em: http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm

BRASIL. **Lei nº 12.187, de 29 de dezembro de 2009**. Institui a Política Nacional sobre Mudança do Clima – PNMC e dá outras providências. Disponível em: http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Lei/L12187.htm. Acesso em: 20 jan. 2024.

BRASIL. **Lei nº 12.305, de 2 de agosto de 2010**. Institui a Política Nacional de Resíduos Sólidos; altera a Lei no. 9.605, de 12 de fevereiro de 1998, e dá outras providências. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm. Acesso em: 20 jan. 2024.

BRASIL. **Lei nº 12.651, de 25 de maio de 2012**. Dispõe sobre a proteção da vegetação nativa; altera as Leis nº 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis nº 4.771, de 15 de setembro de 1965, e 7.754, de 14 de abril de 1989, e a Medida Provisória nº 2.166-67, de 24 de agosto de 2001, e dá outras providências.

BRONFENBRENNER, U. **Bioecologia do desenvolvimento humano**: tornando os seres humanos mais humanos. Artmed Editora, 2011.

CAMARGO, D. M.; RAMÍREZ, P. C.; FERMINO, R. C. Individual and environmental correlates to quality of life in park users in Colombia. **International Journal of Environmental Research and Public Health**, v. 14, n. 10, p. 1250, 2017. Disponível em: https://doi.org/10.3390/ijerph14101250. Acesso em: 20 jan. 2024.

CASTRO, I. B.; PERINA, F.; FILLMANN, G. Organotin contamination in South American coastal areas. **Environmental Monitoring and Assessment**, v. 184, p. 1781–1799, 2012. Disponível em: https://doi.org/10.1007/s10661-011-2078-7. Acesso em: 24 mar. 2024.

CASTRO, I. B.; WESTPHAL, E.; FILLMANN, G. Tintas anti-incrustantes de terceira geração: novos biocidas no ambiente aquático. **Química Nova**, v. 34, p. 1021–1031, 2011. Disponível em: https://www.scielo.br/j/qn/a/cxZqL77Vv9MYpY6YBRcFVcL/. Acesso em: 24 mar. 2024.

CORRAL-VERDUGO, V.; PINHEIRO, J. Q. Condições para o estudo do comportamento pró-ambiental. **Estudos de Psicologia**, v. 4, p. 7-22, 1999.

DANOVARO, R. *et al.* Marine ecosystem restoration in a changing ocean. **Restoration Ecology**, v. 29, e13432, 2021.

DIEGUES, A. C. Conhecimentos, práticas tradicionais e a etnoconservação da natureza. **Desenvolvimento e meio ambiente**, v. 50, 2019.

DORIGO, T. A.; LAMANO-FERREIRA, A. P. N. Contribuições da percepção ambiental de frequentadores sobre praças e parques no Brasil (2009-2013): revisão bibliográfica. **Revista de Gestão Ambiental e Sustentabilidade**, v. 4, n. 3, p. 31-45, 2015.

FIELD, A.; MILES, J.; FIELD, Z. **Discovering statistics using R**. Los Angeles: Sage Publications, 2012.

FLECK, M. P. A. *et al.* Aplicação da versão em português do instrumento abreviado de avaliação da qualidade de vida "WHOQOL-bref". **Revista de Saúde Pública**, v. 34, n. 2, p. 178-183, 2000.

FOLEY, R.; KISTEMANN, T. Blue space geographies: enabling health in place. **Health & Place**, v. 35, p. 157-165, 2015.

GORDIA, A. P.; QUADROS, T. M. B. D.; CAMPOS, W. D. Variáveis sociodemográficas como determinantes do domínio meio ambiente da qualidade de vida de adolescentes. **Ciência & Saúde Coletiva**, v. 14, p. 2261-2268, 2009.

GRESSLER, S. C.; GÜNTHER, I. D. A. Ambientes restauradores: definição, histórico, abordagens e pesquisas. **Estudos de Psicologia**, v. 18, p. 487-495, 2013.

HARALDSTAD, K. *et al.* A systematic review of quality of life research in medicine and health sciences. **Quality of life Research**, v. 28, p. 2641-2650, 2019.

HARTIG, T. *et al.* Nature and health. **Annual review of public health**, v. 35, p. 207-228, 2014.

HULLEY, S. B. **Delineando a pesquisa clínica**. 4. ed. São Paulo: Artmed, 2014.

INTERNATIONAL ASSOCIATION FOR IMPACT ASSESSMENT. **Guidelines and Principles for Social Impact Assessment**. Washington: The Interorganizational Committee on Guidelines and Principles for Social Impact Assessment, 1994. Disponível em: https://www.iaia.org/pdf/IAIAMemberDocuments/Publications/Guidelines_Principles/SIA%20Guide.PDF. Acesso em: 23 mar. 2024.

LIU, P.; TENG, M.; HAN, C. How does environmental knowledge translate into pro-environmental behaviors?: the mediating role of environmental attitudes and behavioral intentions. **Science of the total environment**, v. 728, p. 138126, 2020.

LUCENA, M. M.; FREIRE, E. M. Percepção ambiental como instrumento de participação social na proposição de área prioritária no semiárido. **Revista Internacional Interdisciplinar INTERthesis**, v. 11, n. 1, p. 147-171, 2014.

MACKAY, C. M.; SCHMITT, M. T. Do people who feel connected to nature do more to protect it? A meta-analysis. **Journal of Environmental Psychology**, v. 65, 101323, 2019.

OLIVEIRA-MONTEIRO, N. R.; SILVA, D. S. Percepções do ambiente, condições psicológicas e de qualidade de vida em habitantes de ocupações irregulares de área de manguezais na Baixada Santista, SP, Brasil. **Sustainability in Debate**, v. 9, n. 3, p. 13-27, 2018.

ORGANIZAÇÃO DAS NAÇÕES UNIDAS PARA A EDUCAÇÃO, A CIÊNCIA E A CULTURA. **1st International co-ordinating council of the programme on man and the biosphere (MAB)**. Paris: MAB Report Series, 1971. Disponível em: http://npshistory.com/publications/mab/unesco-mab-report/1.pdf. Acesso em: 20 jan. 2024.

ORGANIZAÇÃO DAS NAÇÕES UNIDAS PARA O MEIO AMBIENTE. **Declaração sobre o meio ambiente humano**, junho de 1972. Disponível em: http://portal.iphan.gov.br/uploads/ckfinder/arquivos/Declaracao%20de%20Estocolmo%201972.pdf. Acesso em: 20 jan. 2024.

PATO, C. M. L. Valores ecológicos. *In:* CAVALCANTE, S.; ELALI, G. E. **Temas básicos em psicologia ambiental**. São Paulo: Vozes, 2011.

PATO, C. M. L.; CAMPOS, C. B. D. Comportamento ecológico. *In:* CAVALCANTE, S.; ELALI, G. E. **Temas básicos em psicologia ambiental**. São Paulo: Vozes, 2011.

PATO, C. M. L.; TAMAYO, Á. A escala de comportamento ecológico: desenvolvimento e validação de um instrumento de medida. **Estudos de Psicologia**, v. 11, p. 289-296, 2006. Disponível em: https://www.scielo.br/j/epsic/a/GS4KQWFrQ8YFhrdDLKQ3kGf/abstract/?lang=pt. Acesso em: 20 jan. 2024.

PEREIRA, D. A.; PATO, C. Valores e comportamento ecológico: dimensões para Educação Ambiental em Parques Urbanos. **Ambiente & Educação**, v. 20, n. 2, p. 81-101, 2015.

PEREIRA, S. D. O.; REIS, L. P. C. Contextos de interação e sua inter-relação com o comportamento ecológico. **Revista Internacional Interdisciplinar INTERthesis**, v. 14, n. 1, 2017. Disponível em: https://doi.org/10.5007/1807-1384.2017v14n1p117. Acesso em: 20 jan. 2024.

PINHEIRO, L. V. S. *et al.* Comportamento, crenças e valores ambientais: uma análise dos fatores que podem influenciar atitudes pró-ambientais de futuros administradores. **Revista de Gestão Social e Ambiental**, v. 8, n. 1, p. 89-104, 2014.

PRATI, L. E. *et al.* Revisando a inserção ecológica: uma proposta de sistematização. **Psicologia: reflexão e crítica**, v. 21, p. 160-169, 2008.

RODRIGUES, M. L. *et al.* A percepção ambiental como instrumento de apoio na gestão e na formulação de políticas públicas ambientais. **Saúde e Sociedade**, v. 21, p. 96-110, 2012.

SALES, L. G. L.; SILVA, R. M. M.; CLEMENTINO, M. L. M. **Da natureza natural à natureza social**: os caminhos da relação entre sociedade e mangue de Bayeux – PB. III ENCONTRO DA ANPPAS, Brasília, 3, 2006. Disponível em: http://www.anppas.org.br/encontro_anual/encontro3/arquivos/TA209-04032006-024459.DOC. Acesso em: 20 jan. 2024.

SHAFIEI, A.; MALEKSAEIDI, H. Pro-environmental behavior of university students: application of protection motivation theory. **Global Ecology and Conservation**, v. 22, e00908, 2020.

TUAN, Y. F. Topofilia: um estudo da percepção, atitudes e valores do meio ambiente. **SciELO-EDUEL**, 2012.

WHITE, M. P. *et al.* The 'Blue Gym': What can blue space do for you and what can you do for blue space? **Journal of the Marine Biological Association of the United Kingdom**, v. 96, n. 1, p. 5-12, 2016.

WHITE, M. P. *et al.* Blue space, health and well-being: a narrative overview and synthesis of potential benefits. **Environmental Research**, v. 191, p. 110169, 2020.

WHOQOL GROUP. The World Health Organization quality of life assessment (WHOQOL): position paper from the World Health Organization. **Social science & medicine**, v. 41, n. 10, p. 1403-1409, 1995.

WHYTE, A. V. **La perception de l'énvironnement**: lignes directrices méthodologiques pour les études sur le terrain. Unesco, 1978.

Urban environment and unequal urban environmental policies: a case study in Argentina

Meio ambiente urbano e políticas ambientais desiguais: um estudo de caso na Argentina

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ARTICLE-VARIA

ABSTRACT

This study analyses different and unequal urban environmental problems in the city of Posadas (Argentina), where there are different social practices of environmental care and management according to neighbourhoods. The aim was to understand and describe the action or lack of action of environmental legislation or policy concerning different urban areas. Based on a quantitative survey, the spatial context of the neighbourhoods was linked to environmental problems and policies, environmental care practices, opinions, attitudes, and social self-management processes in each neighbourhood. It describes how people living in the poorest neighbourhoods are disproportionately exposed to adverse environmental conditions and risks. Neighbourhoods in urban spaces with high environmental quality have more services, resources and government attention, while the most disadvantaged neighbourhoods in the city are also the least favoured by policies and deficient urban structures.

Keywords: Trees. Waste. Pollution. Settlements. Environmental policies.

RESUMO

Este artigo analisa os diferentes problemas urbanos ambientais na cidade de Posadas (Argentina), onde existem diversas práticas sociais de cuidado e gestão do ambiente de acordo com os bairros. O objetivo foi entender e descrever as ações ou omissões da legislação e/ou políticas ambientais em relação às diferentes áreas urbanas. Com base em um levantamento quantitativo, o contexto espacial dos bairros foi vinculado à presença de problemas e políticas ambientais, práticas de proteção ambiental, opiniões, atitudes e processos de autogestão social em cada bairro. O artigo descreve como as pessoas que vivem nos bairros mais pobres estão desproporcionalmente expostas aos riscos e condições ambientais. Os bairros localizados em ambientes urbanos de alta qualidade ambiental têm acesso a mais serviços, recursos e atenção governamental, enquanto os bairros mais desfavorecidos na cidade são, ao mesmo tempo, os menos beneficiados pelas políticas e sofrem com estruturas urbanas deficientes.

Palavras-chave: *Árvores. Resíduos. Poluição. Assentamentos. Políticas ambientais.*

1 INTRODUCTION

Today, urban marketing strategies operate under the slogan of a green and sustainable city. However, the most significant urban environmental interventions occur in distinctive urban and residential areas, increasing their economic value Connolly *et al.* (2023). Different urban spaces express socio-spatial inequalities in the distribution of opportunities and resources (Capdevielle, 2014). Therefore, we analyse here how the unequal distribution of environmental services or their inaccessibility determines the quality of life and the environmental conditions to which residents in different urban areas are exposed.

In the current climate crisis, environmental policies take on an unusual relevance, adopting mechanisms to mitigate new environmental adversities: pollution, emissions, drought, rising temperatures, fires, etc. In this context, the Posadas government agenda has developed urban environmental programmes and policies, accompanied by the discourse of sustainable and resilient cities.

In the city of Posadas, since 2020, the municipality has been carrying out various actions under the slogan "A sustainable, greener, modern and innovative Posadas". Specifically, it has promoted environmental education, differentiated waste collection, the provision of containers, recycling and the circular economy, the construction of cycle paths, urban reforestation, composting and fertilisation programmes, and the use of pruning chips in public spaces, among other actions. On the negative side, however, it has been noted that all these actions are more intense in some sectors and neighbourhoods of the city, as well as the absence of in-depth environmental policies to control vehicle emissions and household incineration, and the weakness of environmental protection legislation (Brites, 2022b).

In addition to pollution and other environmental crises, urban spatiality plays a crucial role in determining the distribution of environmental problems within a city. Some areas may experience more chronic problems than others, leading to inequalities in urban health and health vulnerability. This leads to reconsidering environmental inequalities due to their interaction with other forms of inequality that exacerbate disadvantage and environmental risks.

This article highlights the importance of understanding pollution and risk as environmental inequalities, a category that refers to the adversities of a polluted environment, exposure to risks and various vulnerabilities of the urban environment. It is, therefore, another factor contributing to urban inequalities. As a contribution, the discussion highlights the inequalities created by urban policies that disproportionately affect the quality of life and habitat of low-income sectors. Sustainability policies do not consider the costs associated with pollution and its effects.

2 THEORETICAL APPROACHES

The environmental problems faced by Latin American cities are at the forefront of the sustainability debate. However, the actions taken to address these issues have not been equitable (Fernández *et al.*, 2023; London, 2018). Pollution and socio-environmental vulnerability affect urban ecosystems and directly impact the deterioration of urban quality of life and population health. It is important to remember that a clean, healthy and inclusive environment is demanded by the more equitable approach to environmental justice proposed by Harvey (1996).

Environmental risks in the context of climate change are variable, and their study is at the centre of political agendas and mitigation plans (Zulaica; Vázquez, 2021); on the other hand, the issues of climate change and environmental justice demonstrate the correlations between socio-environmental patterns and conditions of social vulnerability (Travassos *et al.*, 2021).

In recent decades, urban growth and its different functionalities have generated negative environmental impacts unequally distributed among the population, with severe environmental

problems disproportionately affecting lower-income sectors or communities (Krieg; Faber, 2004; Walker; Bulkeley, 2006). A context in which urban and environmental inequalities shape unequal ways of inhabiting space (Suárez, 2021).

The unequal environmental costs and benefits of policies generate differential and unequal impacts. For example, differential access to environmental goods such as clean air, clean water or green spaces (Alves Prates, 2007; Brites, 2022b; Pi Puig, 2021) are indicators of environmental well-being. However, different inequalities (socio-spatial, residential, environmental, etc.) lead to a more repetitive urban landscape in many cities.

Investments in infrastructure and the restructuring of public spaces (boulevards, gardens and parks) are accompanied by new and renovated comfortable buildings for sectors with greater purchasing power (Brites, 2019). On the other hand, waterfronts and green spaces have been identified as landscape resources (Santasusagna Riu; Tort Donada, 2019) and environmental and tourist resources for urban and real estate requalification. A process that reinforces class inequalities and increases dispossession (Casgrain; Janoschka, 2013).

Sustainable urban policies, accompanied by the search for capital gains, create beautified and landscaped urban environments and new peripheries of neglected neighbourhoods with environmental degradation. Areas of extreme poverty and pollution overlap to create hyper-degraded urban areas (Davis, 2006). The advance of real estate dynamics reorganises the city and leads to the creation of areas of high environmental vulnerability, such as poor neighbourhoods and suburban settlements, sometimes "located on rubbish dumps and swamps and with very high levels of pollution" (Curutchet; Grinberg; Gutiérrez, 2012, p.173). Peri-urban or suburban spaces appear as 'hybrids' where rural and urban areas are often difficult to distinguish (Ferraro et al., 2013; Galindo; Delgado, 2006), spaces where environmental legislation often does not reach or is not enforced.

From an ecological point of view, the emergence of poor and vulnerable neighbourhoods refers to the lack of green spaces, lack of zoonosis care, contamination of soil, water and air (internal pollution) or due to proximity to industrial areas or high pollution production (London, 2018). Some studies (Fernandes, 2011; Fernandez *et al.*, 2023) point out that the frequent expansion of informal settlements in urban peripheries has led to the loss and degradation of natural habitats. In addition, governments have allowed urban expansion in areas prone to environmental risks with a lack of infrastructure and services. Many vacant plots of land are vulnerable to uncontrolled waste dumping on the outskirts of the cities, creating environmentally unsustainable areas and waste disposal sites, commonly referred to as "open dumps" (D'hers, 2013, p. 2).

Environmental inequalities can also be analysed from the operational category of Critical Urban Deficit Areas (Barreto *et al.*, 2014), which analyses a highly fragmented part of the periurban residential space where unequal neighbourhoods coexist (in terms of physical and social characteristics), characterised by segregation, disconnected territories and lack of urbanity. As in the periphery, critical urban deficit areas are characterised by deficits in infrastructure, services, facilities and accessibility problems, environmental vulnerability and, in some cases, water risk areas (Alcalá; Rus, 2017).

Flooding and lack of infrastructure works result from the various links between vulnerability and risk hazards: socioeconomic, material, physical and environmental (Biffis *et al.*, 2022). An idea that suggests that the experience of living in degraded urban margins involves environmental suffering, which is expressed in a link between social vulnerability and environmental risk (Scharager, 2017).

Studies have found significant differences in the environment and quality of life according to socioeconomic conditions between households in poor or disadvantaged neighbourhoods and residents of upper-class neighbourhoods (Flacke *et al.*, 2016). Gómez and Velázquez (2018) observed that in the peripheries, there are more unfavourable areas for quality of life, according to a relationship

between the number of inhabitants and the area of public green spaces. This allows us to understand how the characteristics of the social context are reflected in environmental and health inequalities.

For example, air pollution is unevenly distributed within cities, which can lead to urban health inequalities (Pierangeli *et al.*, 2020). Thus, in addition to environmental inequalities, some authors (Garzón-Duque *et al.*, 2016) highlight the social determinants of health, which create huge inequalities in the probability of falling ill and the risk of dying prematurely, that is to say, in a way that is not natural but socially determined, which could and should be avoided.

Beyond the impact of environmental adversity, in a climate crisis scenario, we are talking about socio-environmental vulnerability (Daga *et al.*, 2015; Ortiz Espejel *et al.*, 2015), a phenomenon that has a greater impact on low-income sectors, where the risk of exposure to new and unusual threats is greater, regardless of the characteristics of the environment.

3 METHODOLOGIES

The study area included the city of Posadas in its different urban sectors (city centre and surrounding areas, western, southern, and south-western districts). The main methodological approach was a quantitative and exploratory design, carried out in two stages: the first through an online web form and the second through field surveys. The research collected information from a probabilistic sampling by cluster, involving 322 people living in different neighbourhoods or sectors (clusters), then the selection of cases to make up the sample followed a random criterion within each neighbourhood.

Table 1 – Distribution of analysed cases by cluster

Type of conglomerate	*Sectors or Neighbourhoods*	*Frequency*	*Percentage*
Social housing districts	Villa Cabello, A-4, Yacyretá, Santa Rita, 80 viviendas. 90 viviendas. Chacra 32-33, Cocomarola Oeste. Giovinazzo (autódromo). Itaembé Miní. Itaembé Guazú, Hipotecario (ch.124). Las Orquídeas. Los Jilgueros. Prat, San Isidro, M. Lanús (A-3.2). Nemesio Parma, Sesquicentenario, Papel Misionero (Ch.122), Prosol, 10 de Junio.	72	22%
Settlements or popular neighbourhoods	Santa Rosa, Aeroclub. Chacra 252. El Mangal. Los Lapachitos, Ita Verá (Ch.145). Chacra 178. Los Lapachitos. Los Oleritos, La Tablada. Nestor kirchner. Sol Naciente. San Jorge. San Onofre, San Marcos. Los Paraísos. Villa Flor, Sol de Misiones. Vecinos Unidos. Ch. 127, V. Cariño.	76	24%
Neighbourhood with urban grids, pavements and drains	San Alberto, Alta Gracias. Altos de Bella Vista. Alto de Irupé, Bancario, Congreso, Gazupí. Los Lapachos, Independencia. Las Dolores. Hermoso, El Libertador, Jardín. Latinoamérica, Mini City. Libertador San Martín. La Picada. Rocamora. San Lucas. Santa Lucía. Sur Argentino, Villa Poujade, 25 de Diciembre, 25 de mayo, A. Guacurari Ch.105., Ch.34. Cha. 183.	117	36%
Urban centre and surrounding area	Centro (cuatro Avenidas y microcentro) Tajamar, Apos. El Palomar. Los Aguacates. Villa Sarita, Villa Urquiza, 23 de Sep., Ch.7., Ch. 46., Patoti, Tiro Federal.	57	18%
Total		**322**	**100%**

Source: Author, based on research database.

The survey of cases was carried out between April and November 2023, and the unit of registration was adult residents in the selected clusters. Initially, the online form was distributed to people via mobile phone in a careful and controlled way, and then the survey was carried out in a more targeted way through home visits in the neighbourhoods. In its dimensions, the survey (voluntary and anonymous) explored aspects related to environmental and pollution problems in the neighbourhoods, environmental care practices, and the impact of government policies, among other opinions collected in the form. The quantitative treatment of the data was carried out through a descriptive statistical analysis processed in SPSS software.

The fieldwork phase included observations and notes, as well as photographic and audio-visual surveys in the different areas of the city. On the other hand, in addition to the surveys, 10 semi-structured interviews were carried out to capture the perceptions of neighbours and neighbourhood leaders with local knowledge of the habitat and environment in their neighbourhood or sector of residence. In other words, it was decided to complement the research with a qualitative/compressive analysis to understand the socio-cultural aspects of pollution problems, practices, and risk representations.

For the spatial analysis, the 67 settlements of Posadas were delimited based on different sources, such as the National Register of Popular Neighbourhoods (Registro Nacional de Barrios Populares, 2018) and the NGO Techo (2016). Information from the Provincial Institute for Housing Development (IPRODHA) was used to determine the location of social housing complexes. Official information from the Municipality of Posadas, available on its website, was used to analyse environmental policy plans and programmes.

Regarding environmental inequalities, we have tried to identify and explore the different neighbourhoods or areas (as spatial units) where urban environmental policies have been implemented or not. Although we propose an exploratory study, open to new emerging processes, we propose two hypotheses: a) environmental policies do not reach all neighbourhoods with the same intensity, i.e. there are actions and omissions in the treatment of pollution and the provision of environmental services; b) people living in neighbourhoods of low socioeconomic status (working-class neighbourhoods and settlements) are disproportionately exposed to adverse environmental conditions with potential health impacts.

The final stage of the research involved analysing and producing comparative information between the different neighbourhoods and urban sectors, as well as the production of graphs, tables, and maps with geo-referenced information.

4 THE CITY OF POSADAS: THE URBAN CONTEXT

With a population of around 390,000, Posadas is the largest urban centre in the province of Misiones, and its urban sprawl extends into the neighbouring municipality of Garupá. In recent decades, the city's morphology has changed due to major river treatment works on the banks of the Paraná River, resulting in marked urban, environmental, and socio-spatial inequalities. On the one hand, a new waterfront with public spaces of high environmental quality and, on the other, the emergence of new settlements and popular neighbourhoods, which in many cases hybridise the occupation of the land with social housing complexes.

The settlements (67 in the city), in addition to poverty and informal land occupation, are characterised by deficient habitats and degraded urban environmental conditions, some more adverse than others, depending on their location in the urban space (Brites, 2022a). Despite the adversities inherent to the settlements, their problems are of different magnitudes, such as distance from the urban centre, segregation, lack of infrastructure and services, unpaved roads, environmental pollution, etc.

Another issue affecting the city's environment is how new social housing estates are built. Large areas of grassland, trees, and natural vegetation are indiscriminately bulldozed to make way for massive housing developments, wasting natural resources and creating environmental inequalities.

In the experience of Posadas, the construction of mega-housing estates such as Itaembé Miní and Itaembé Guazú has increased urban sprawl and degraded natural areas through deforestation, land clearing, and landfills, affecting streams and wetlands without adequate environmental treatment. In the transformation process, housing policies have exchanged ecosystem services for a more precarious and unfavourable environment.

5 RESULTS AND DISCUSSIONS

5.1 ENVIRONMENTAL PROBLEMS

The research analysed a series of recurrent environmental problems in many sectors of the city, such as waste accumulation, waste burning, bad smells, smoke, burning of prunings and grassland, wastewater, industrial pollution, etc. It was found that the highest prevalence of pollution is more intense in the settlements and less in the centre of Posadas and the surrounding areas. As shown in Figure 1, poor environmental conditions disproportionately disadvantage impoverished neighbourhoods (although often located in green areas). In other words, there are certain problematic levels of pollution to which residents are exposed depending on the socioeconomic context of the neighbourhoods. This situation also suggests certain inequalities in terms of urban services.

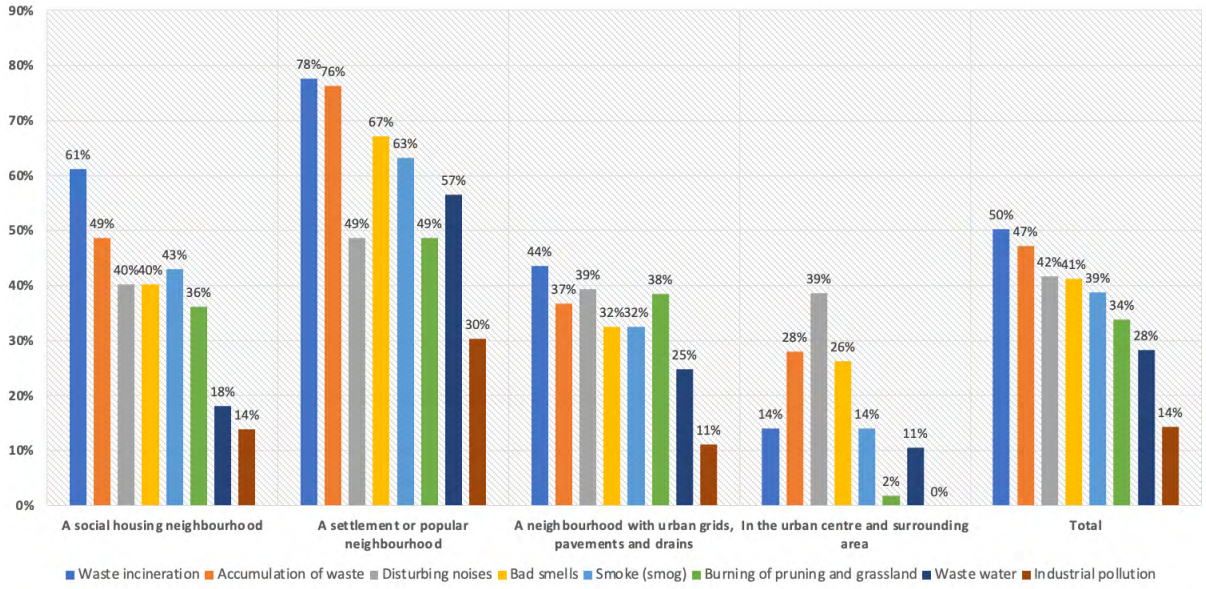

Figure 1 – Main environmental problems by type of neighbourhood

Source: Author, based on research database.

In Posadas, the problem of burning contributes significantly to the city's pollution in terms of prevalence (Brites, 2022b). A phenomenon that, in its different dimensions, such as the burning of garbage or pruning and grassland, increases the presence of smoke and exacerbates the air pollution problem. An analysis of the data by sector or type of neighbourhood (Figure 1) confirms the fact that the settlements are a vivid illustration of the problems of burning: 78% report the presence of waste burning, 49% report the burning of pruning/grass and 63% refer to the problems of smoke (smog) in the neighbourhood.

Apart from burning, pollution in settlements is diverse and often not recognised as a problem by those living in the settlements. There are small open-air rubbish dumps, rubbish dumped in streams, sewage dumped in internal streets and alleyways, construction waste accumulation, rodents in vacant lots, etc. In an interview, one resident mentioned that he often collects pieces of tin, wood, cans, tarpaulins, metals, or other elements that could be useful for the construction of his house.

In the southern outskirts of Posadas, the most remote settlements are plagued by extreme poverty and inadequate housing. The waste management practices in the area are also very lax, which has allowed some families to resort to self-employment strategies, mainly by recovering recyclable materials from waste. This activity is done either for personal consumption or for sale to waste collectors. As a result, the periphery has become a hub for informal settlements, where people eke out a living from the waste they collect. This practice of scavenging is known as “cirujeo” (Schamber; Suárez, 2011).

The prevalence of environmental problems is slightly lower in gridded neighbourhoods than in social housing neighbourhoods, although there are differences in some aspects. For example, social housing estates have fewer problems with wastewater because they have infrastructure such as sewers. In contrast, in other neighbourhoods, such as San Jorge, it was found that houses have sewage outlets that lead to open drains in the Zaimán stream. Environmental issues related to urban vegetation and poor biomass management should also be considered. In the southern neighbourhoods of Posadas, the practice of burning prunings, branches, and grass is more widespread. In the settlements, the situation is critical, as sewage emissions and bad smells are exacerbated by the manipulation of waste through open-air burning, leading to problems of smog and environmental degradation.

On the other hand, on the outskirts of the city, in areas of urban expansion, some factories or industries have been identified in surveys as polluting. These include ‘olerias’ (brick kilns, artisanal brick factories), plastic wrapping industries, car repair shops, material collectors, and companies with inadequate waste management. According to a resident of the Alto de Bella Vista neighbourhood, there is a “chemical smell from the Copaflex industry” in the area, and complaints have been made without any solutions to the problem. Furthermore, a resident of the Itaembé Miní neighbourhood denounces the presence of a brick kiln in a nearby settlement: “The kiln there smokes for days and fills the neighbourhood with the smell of burnt clay” (neighbour interview).

The combination of statistical data and field observations has allowed us to identify more or less delimited areas of environmental degradation and pollution (rubbish dumping, burning, sewage, presence of smoke, etc.). As shown in Figure 2, these areas tend to be located further away from the city centre and its surrounding area.

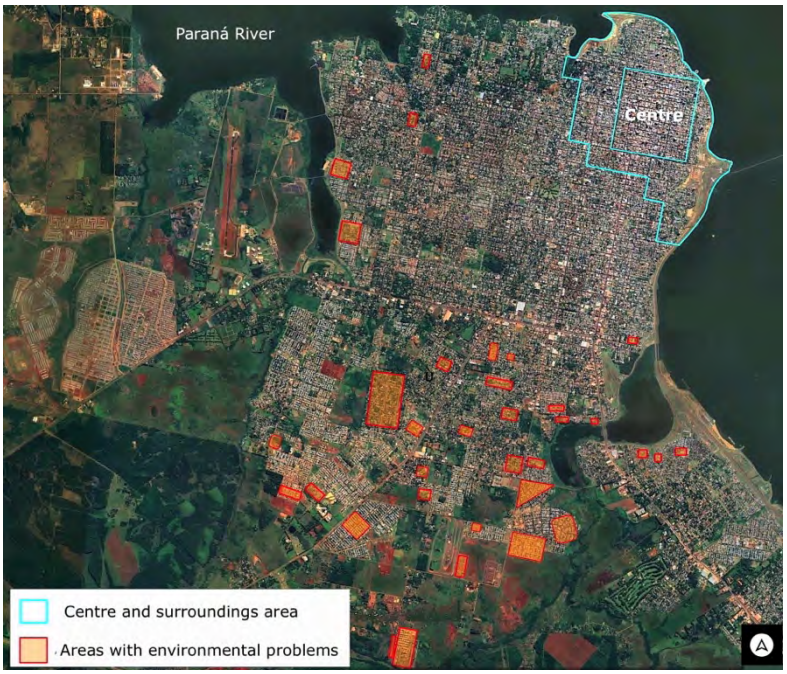

Figure 2 – Delimited areas with environmental deterioration

Source: Author, based on Google Earth.

In general, the greatest pollution problems are found in urban expansion areas. In Posadas, many state-built social housing complexes share urban spaces with self-built popular neighbourhoods and settlements that, despite adversities, are the product of social self-management processes.

5.2 TREES AND GREEN SPACES

Table 2 analyses tree ownership and the presence of green spaces around respondents' homes. In particular, it can be seen that, regardless of the neighbourhood or urban sector in which people live, the availability of trees on pavements is high, with between 72% and 85% of respondents in the different areas stating that they have trees on pavements. However, the question "Has the municipality planted trees in your neighbourhood?" reveals a difference in the answers, in the sense that in the different urban sectors, there is a greater government intervention to the detriment of the popular settlements and their neighbourhoods, where only 13% say that the municipality has planted trees, compared to 38% in the social housing complexes, 34% in other neighbourhoods and 26% in the centre and surrounding areas.

Table 2 – Green spaces and trees by neighbourhood type

	Neighbourhood type				
Arboriculture	*Social Housing NBHD*	*Settlement/ popular NBHD*	*NBHD with urban grids*	*City centre and surroundings*	*Total*
You have trees on your pavement	83%	79%	85%	72%	81%
No trees on your pavement	17%	21%	15%	28%	19%
Planted any trees in the last 2 years	36%	50%	48%	46%	45%

	Neighbourhood type				
Arboriculture	*Social Housing NBHD*	*Settlement/ popular NBHD*	*NBHD with urban grids*	*City centre and surroundings*	*Total*
Not planted a tree in the last 2 years	64%	50%	52%	54%	55%
The municipality has planted trees in the neighbourhood.	38%	13%	34%	26%	29%
The municipality has not planted trees in the neighbourhood.	63%	87%	66%	74%	71%
It has a green space or park	72%	39%	70%	61%	62%
It does not have a green space or park	28%	61%	30%	39%	38%

Source: Author, based on research database.

The distribution of green spaces is also scarce near the poorest neighbourhoods, with 61% of respondents in settlements stating they have no access to them. As can be seen from the map in Figure 3, the largest green spaces are located in different parts of the city, close to the waterfront (shores of the Paraná River). In this regard, it is appropriate to refer to the study by Gómez and Velázquez (2018), which suggests a link between the quality of life and public green spaces (PGS), showing that areas with a high quality of life have more or less defined limits in the city, while in peripheral areas the most "unfavourable" quality of life areas are observed. In central areas, some spaces are more "favourable" for quality of life. On the other hand, although most of the settlements in Posadas are located in the southwest of the city, where urbanisation merges with natural vegetation, green areas should not be confused with environmental quality. In the periphery, lush vegetation coexists with anthropogenic pollution practices such as grass burning, waste disposal, landfills, industrial plants, etc.

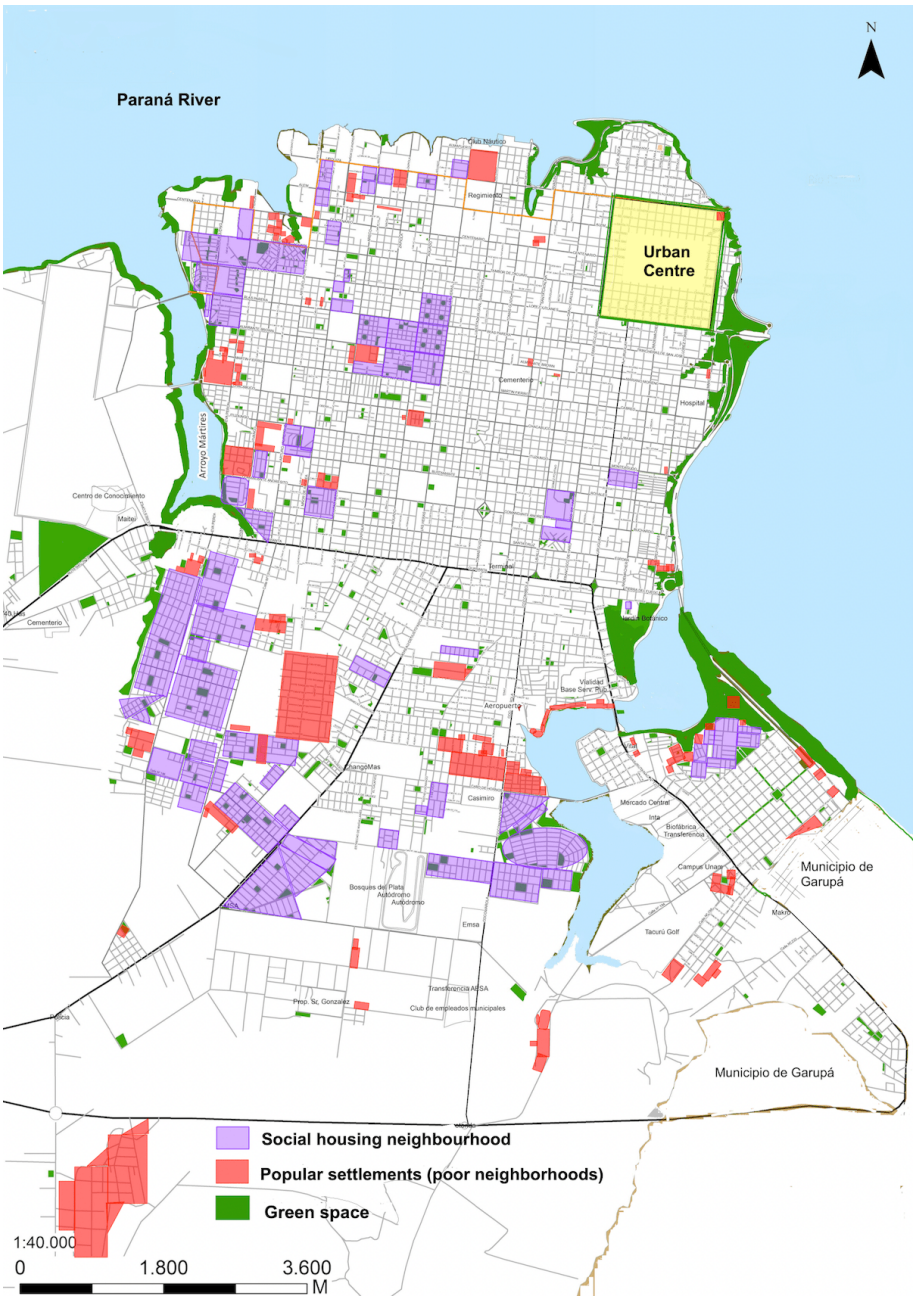

Figure 3 – Posada's city map and location of green spaces

Source: Author, based on RENABAP (2018) and the Municipality of Posadas.

As a more general framework for interpretation, Posadas's proximity to the river and the city's centrality are of crucial interest. Families with greater purchasing power do not always prefer to settle near green areas far from the city centre. Factors such as the presence of settlements, insecurity (both crime-related and traffic-related), proximity to industries (pollution), distance from centrality, etc. are externalities weighted as negative and act as elements that increase socio-spatial distances.

Among the reasons given by those who have not planted trees, some qualitative dimensions emerge, such as: a- lack of space in yards (settlements), b- roots threatening buildings, c- fear during rainy days and storms, d- living in buildings or renting apartments, e- tree leaves litter yards and clog drains, f- other reasons related to cleaning and maintenance.

Specifically, in the words of some neighbours: “The trees are big and need space, their roots will grow and threaten my house”... “They could fall with the rain”... “I don’t like having trees in my garden because they dirty my pool and clog the drains” (neighbour interviews). In short, the negative reasons for growing trees prioritise the representation of something threatening and dirty. This also highlights a problem in people’s relationship with trees.

5.3 BURNING AND AIR POLLUTION

In the most impoverished settlements, such as Lapachitos, Oleritos, N. Kirchner, San Onofre, Los Paraísos, and Aeroclub, burning is a widespread problem, suggesting that air quality is unsafe or inadequate, exposing residents to pollution and making them vulnerable to disease. As shown in Figure 4, data analysis reveals that in settlements and poor neighbourhoods, 54% of respondents reported repeated burning at home, while there were no registered cases in the city centre and surrounding areas. The situation is also noteworthy in social housing complexes, where 33% of respondents reported practising burning.

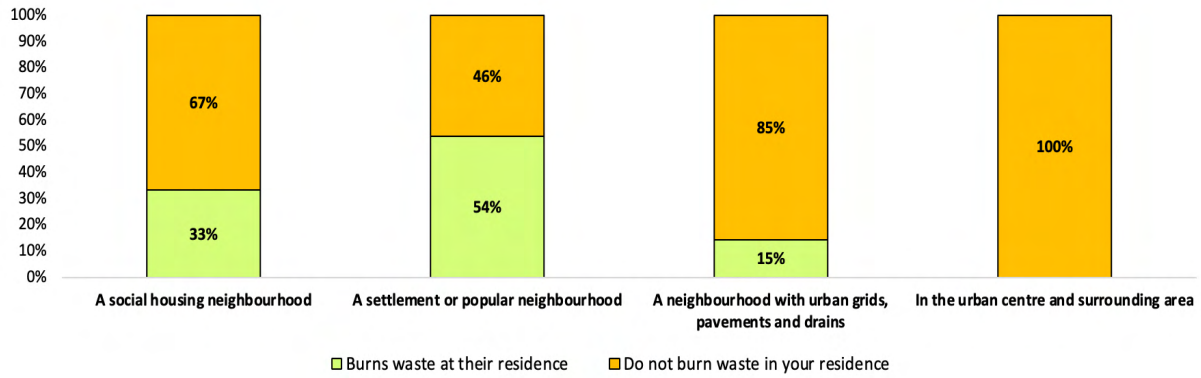

Figure 4 – Waste burning at home by type of neighbourhood or sector

Source: Author, based on research database.

Another strategic and differentiated way of asking about burning was to ask: do you know any neighbours who burn waste? Here, the change of focus shows cases from a different perspective, cases that even appear around the urban centre, where urban legislation is more restrictive. As can be seen in Figure 5, 91% of the people surveyed in settlements know neighbours who usually carry out burning.

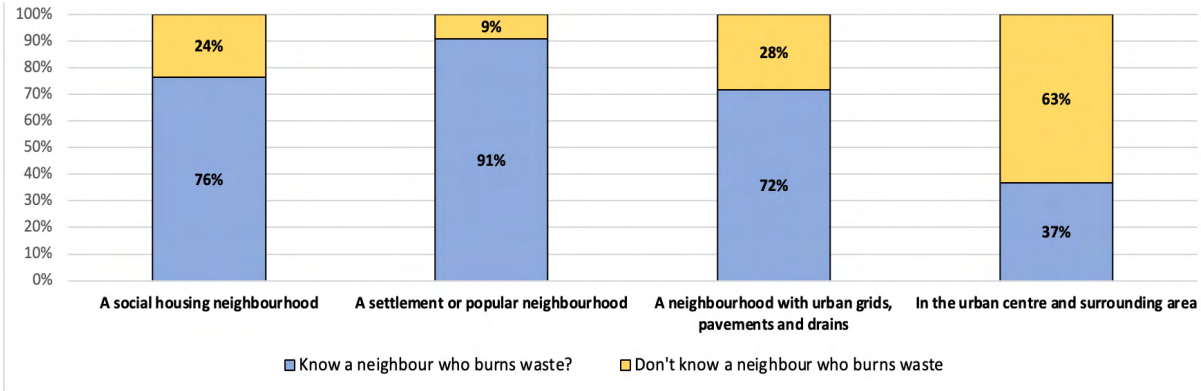

Figure 5 – Knowledge of a neighbour burning by type of neighbourhood or sector

Source: Author, based on research database.

These data corroborate the findings of another study (Brites, 2022b) on the southern periphery of Posadas, where residents carry out burning on pavements, vacant lots, yards, and rarely used streets, a

problem that is not informed, controlled, or regulated. In Posadas, it is known that burning is a problem in settlements where, due to the lack of roads, waste collection vehicles sometimes do not enter, or the service is intermittent. On the other hand, in both social housing estates and other neighbourhoods with optimal urban services, between 76% and 72% of people surveyed claim to know neighbours who burn (Figure 5). This important finding reveals hidden burning practices in private spaces such as backyards.

As in other Argentinean cities, in the urban centre of Posadas and the surrounding areas, there is a more intensive and organised occupation of the land and greater control of urban environmental legislation, with inspections, daily cleaning, and maintenance of green spaces. On the other hand, the constrained location of popular neighbourhoods and settlements, pushed to the edge of the city, often coincides with their proximity to waste dumps, rubbish tips, and improvised landfills, both sanctioned and unsanctioned (authorised and unauthorised), leading to air, soil and water pollution. As D'hers (2013) points out, in the city's suburbs, the existence of informal and illegal networks related to waste makes pollution possible.

From a qualitative approach, through interviews, it has been shown that in some neighbourhoods, there is a certain 'naturalisation' of burning practices, which are seen as a conventional and non-risky way of disposing of waste. In other words, there is evidence to interpret the phenomenon as a cultural practice that is common, shared, and, to some extent, normalised in many neighbourhoods. As a resident of San Lucas explained: "We burn a little every now and then, it's not a big fire... the neighbours tend to burn too"... "It's not a nuisance because it burns at night in the open space there" (interview).

Other field observations enrich the interpretation model of pollution in settlements. The use of firewood as a cheap cooking fuel is common (though not universal). In addition, high land occupation (densification) and construction of masonry and metal sheeting create heat islands with elevated temperatures, contributing to anthropogenic emissions. This becomes a more critical issue in the summer due to the piped water scarcity, leading to greater socio-environmental vulnerability.

Among other issues, it is affirmed that in the south of Posadas, emissions problems are more chronic among the poor population, and besides other sources of pollution outside the neighbourhoods (such as few industries or vehicular traffic), burning is a recurrent practice. Waste disposal by fire generates harmful smoke, which causes severe air pollution and is dispersed by the wind (Bernache Pérez, 2012; NCAIR, 2012). The new paradigm of environmental epidemiology associates this type of pollution with allergies, respiratory diseases, cardiovascular diseases, and even cancer (WHO, 2018). Therefore, it is emphasised here that air pollution in some areas is part of urban inequalities, expressing socio-environmental divergence, with potential costs for quality of life and health.

As will be seen in the next section, the absence or inadequacy of public services, the lack of awareness programmes on the risks and dangers of pollution, etc., facilitate the various practices of burning, rubbish, and biomass waste (leaves and pruning waste).

5.4 THE ENVIRONMENTAL ACTIONS OF THE MUNICIPALITY

In general, the environmental policies of the Municipality of Posadas are far removed from the most recurrent and less visible environmental problems, such as those related to air pollution or the sanitation of urban streams and tributaries. As can be seen in Figure 6, the control of vehicle emissions and waste incineration is practically non-existent; instead, there is concern about dengue fever through cleaning and fumigation operations (62% and 51%, respectively), to the detriment of other equally serious environmental problems. This concern is evidenced by the increase in dengue cases in recent years.

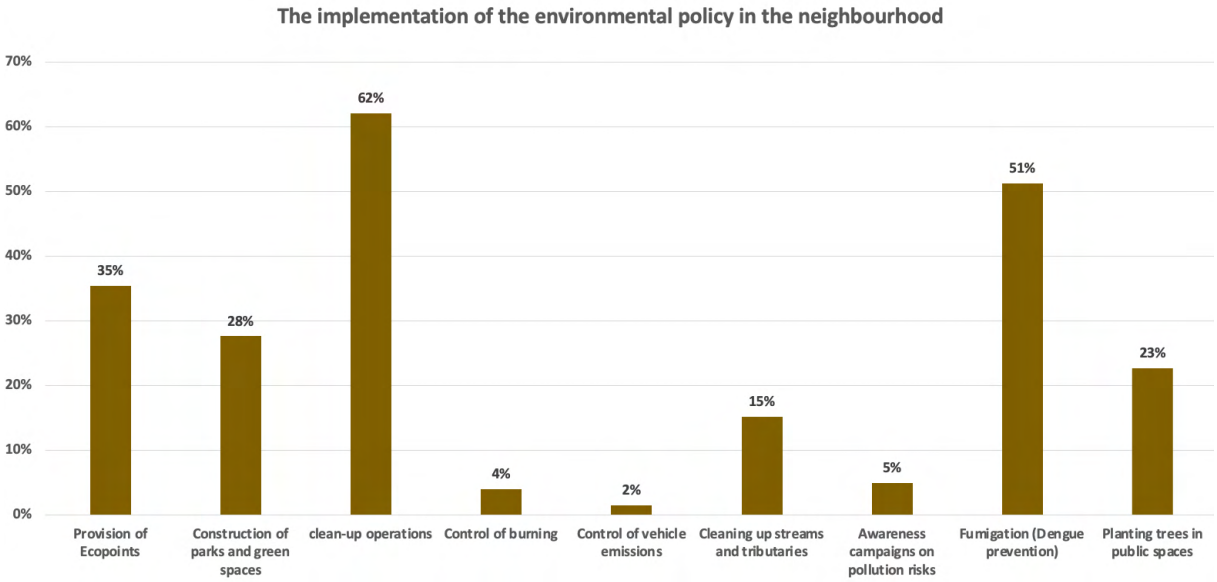

Figure 6 – Implementation of the Environmental Policy of the Municipality of Posadas

Source: Author, based on research database.

On the other hand, when it comes to raising awareness, it is striking that only 5% of respondents (16 cases in non-poor neighbourhoods) said that campaigns to raise awareness of pollution risks reach the neighbourhood. In this aspect, the political agenda, for example, that is related to air pollution issues, is relegated and pending.

In Figure 7 below, we analyse the presence of the municipality concerning the different clusters studied: social housing areas, settlements, neighbourhoods with a grid layout, and the city centre and its surroundings. For instance, we can see that 68% of respondents in settlements and popular neighbourhoods said that the government does not control living conditions or pollution problems in neighbourhoods.

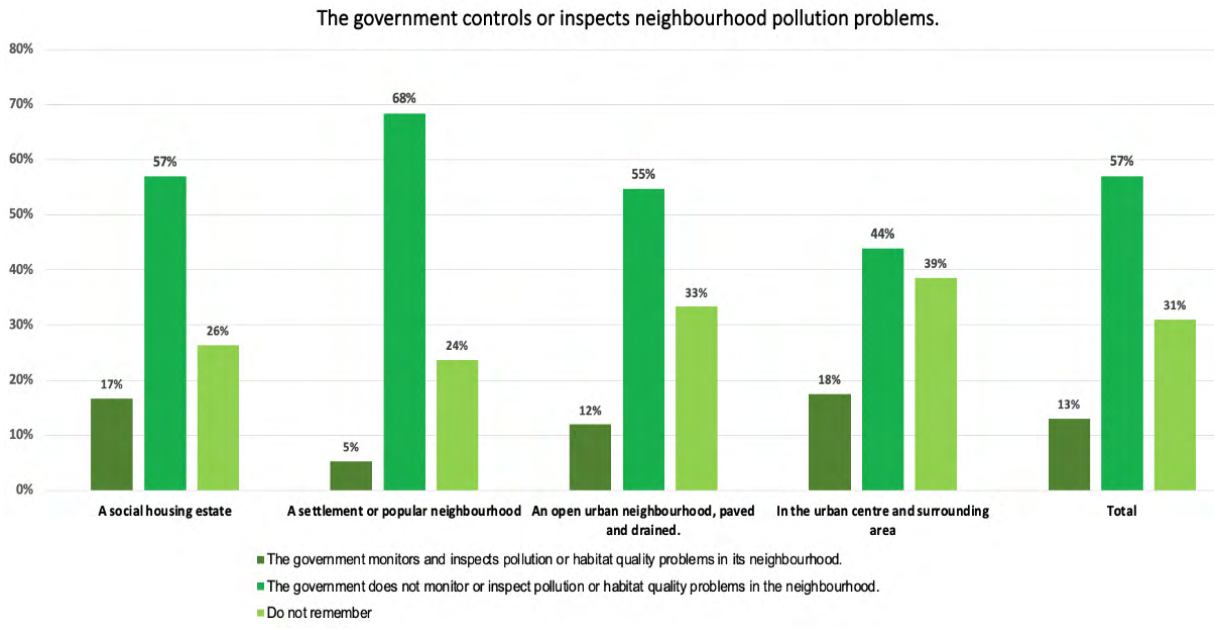

Figure 7 – Government control of pollution problems by type of neighbourhood

Source: Author, based on research database.

The absence of the government is high, considering that a further 24% of respondents could not remember or had no record of campaigns (other than dengue). According to one interviewed person in a poor neighbourhood: "The government comes after a big storm because of the water getting into the houses or to bring goods to the soup kitchen, but they don't come for anything else"... "Anyway, people don't care about the environment here, it's more important to have work and food" (interview with a neighbour).

The research also reveals that pollution monitoring or inspection is poorly developed in other neighbourhoods of Posadas and even in the city centre and surrounding areas, but should be a priority in settlements and poor neighbourhoods where there are multiple situations of socio-environmental vulnerability and pollution. Understanding the impact of pollution on people's health and lives is essential and a pending issue in the city's environmental policies. As London (2018) points out, in many poor neighbourhoods, indoor pollution is not addressed and is rarely part of the political agenda, where urgency prevails over importance; mitigation takes precedence over prevention, habitat management and environmental concerns.

Figure 7 shows that pollution is unevenly distributed in the urban space of Posadas, with little control in the working-class neighbourhoods and settlements (5%). At the same time, there is more attention and control of the environment in the city centre and adjacent areas. In working-class neighbourhoods and suburbs, the city's environmental protection and care regulations are flexible or non-existent, as they do nothing, do not warn, and do not prevent. We believe that inaction in the context of pollution leads to the reproduction of habitats that are adverse to the quality of life and inequalities in environmental health.

The analysis of different environmental plans and programmes made it possible to analyse the traceability of environmental policies between two polarised urban areas, as shown in Figure 8.

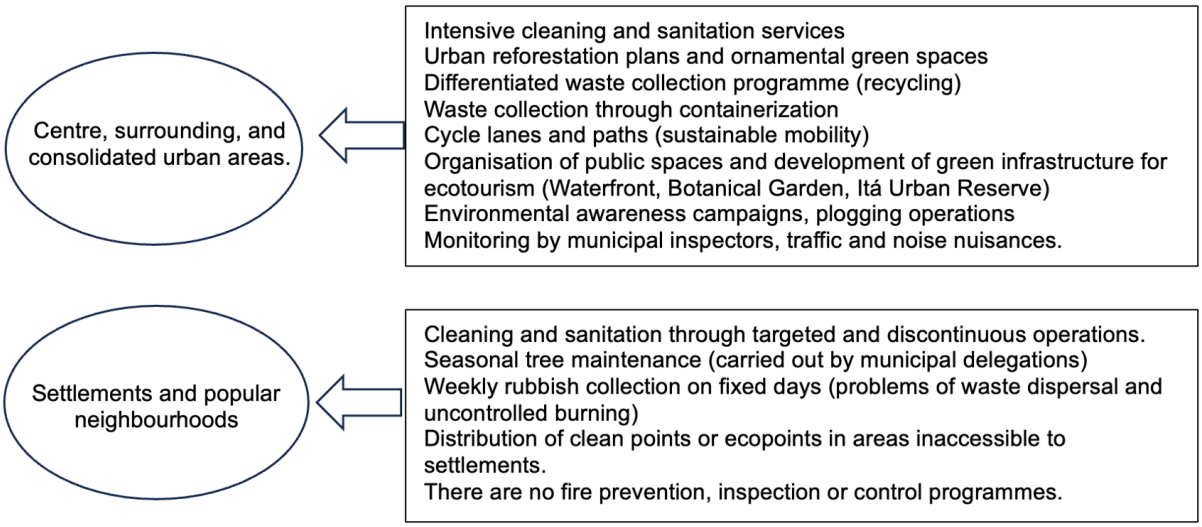

Figure 8 – Traceability of environmental policies in polarised urban areas

Source: Author, based on Environmental Policy of the Municipality of Posadas.

In Posadas, along the waterfront, there are intervention areas such as the Botanical Garden, the Arroyo Itá Urban Reserve in El Brete Bay, La Cascada Park, and other areas where there are projects to consolidate parks, squares, and gardens to improve the climatic quality of the environment. Beyond the intervened sectors, in the coastal area, the breezes from the mighty Paraná River contribute to better air quality, now combined with green recreational areas, strengthened by urban reforestation efforts. Ultimately, these actions enhance certain areas and neighbourhoods of the city.

In this sense, it can be said that the construction of green infrastructure (new squares and parks) in selected urban spaces, such as those linked to the city's waterfront, exhibits environmental policies where there are no major environmental problems. Green propaganda, with signs highlighting environmentally friendly actions, is displayed in clean urban spaces visible to tourists or passers-by, leading to a certain distortion of government actions regarding environmental care.

6 CONCLUSIONS

The city of Posadas promotes sustainability, but ecological and environmental policies do not equitably reach all sectors. The urban environmental agenda, the resources, and the quality of the policies are not only different but also unequal, installing a selective logic in the attention given to the different neighbourhoods.

Neighbourhoods in revitalised areas, such as the waterfront, downtown and surrounding areas, have better sanitation and cleaning services, new green infrastructure, landscaped areas, bike paths, and urban reforestation. Conversely, in the poorest neighbourhoods, environmental sanitation or habitat improvements are scarce, as are policies that require fewer resources, such as those for environmental awareness and care, deepening inequalities in access to environmental knowledge for quality of life.

In the poorest neighbourhoods, the cultural, social and economic appropriation of the environment is conditioned by poverty. There, survival practices and the need for sustenance seem to outweigh the effects of pollution. This is a context where misinformation and lack of awareness of the consequences of pollution converge in the definition of risks and hazards. Neglecting the environment challenges a decent living space and a healthy environment.

Finally, one of the study's contributions is that sustainability actions should be targeted at poor neighbourhoods and settlements, where pollution hotspots multiply and environmental degradation increases, and where environmental protection and maintenance actions should be prioritised.

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REFERENCES

ALCALÁ, L.; RUS, F. Áreas Urbanas Deficitarias Críticas en Territorios con Riesgo Hídrico. Análisis comparado de situaciones en las ciudades de Resistencia y Corrientes. 2017. *In:* V WORKSHOP DE LA RED IBEROAMERICANA DE OBSERVACIÓN TERRITORIAL. VI SEMINARIO INTERNACIONAL DE ORDENAMIENTO TERRITORIAL. Mendoza. **RIUNNE** Colecciones, p. 1–22. 2017.

ALVES PRATES, H. Desigualdade ambiental no município de São Paulo: análise da exposição diferenciada de grupos sociais a situações de risco ambiental através do uso de metodologias de geoprocessamento. **Revista Brasileira de Estudos de População**, n. 24, v. 2, p. 301–316, 2007. Available at: DOI: 10.1590/ S0102-30982007000200008

BARRETO, M.; ALCALÁ, L.; BENITEZ, A.; FERNÁNDEZ, M.; GIRO, M.; PELLI, B.; ROMAGNOLLI, B. Áreas urbanas deficitarias críticas como unidades de interpretación y abordaje de los nuevos territorios periurbanos. *In:* KAROL *et al.*, (comp.) **Conducir las transformaciones urbanas**: un debate sobre direcciones, orientaciones, estrategias

y políticas que modelan la ciudad futura. Universidad Nacional de La Plata, 2014. Tomo II. E-Book. La Plata, Argentina.

BERNACHE PÉREZ, G. Riesgo de contaminación por disposición final de residuos: un estudio de la región centro occidente de México. Revista internacional de contaminación ambiental, n. 28, v.1, p. 99–107. 2012.

BIFFIS GONZÁLEZ, A.; ETULAIN, J.; DOMÍNGUEZ, M. Asentamientos informales en riesgo hídrico. Estrategias arquitectónicas y urbanísticas. Caso: Subcuenca del Arroyo del Gato, La Plata, Argentina. **Cuad. Urbano**, n. 33, v. 33, p. 22–47. 2022. Available at: https://dx.doi.org/https://doi.org/10.30972/crn.33336229

BRITES, W. **Ciudades, teorías e investigación urbana**: una aproximación a los procesos urbanos de Posadas y Encarnación. Buenos Aires: CICCUS, 2019.

BRITES, W. Settlements and habitat. The conditioning role of urban space in Posadas, Argentina. **Urbano**. Concepción, v. 25, n. 45, p. 30–41, 2022a. Available at: http://dx.doi.org/10.22320/07183607.2022.25.45.03.

BRITES, W. Incidencia de la quema de basura en la contaminación de Posadas, Argentina: un desafío para las políticas de cambio climático. **Revista de Ciencias Ambientales**, n. 56, v. 2, p. 17–37. 2022b. Available at: https://doi.org/10.15359/rca.56-2.2

CAPDEVIELLE, J. Espacio urbano y desigualdades: las políticas públicas y privadas en la ciudad de Córdoba, Argentina. (1990-2011). **Cuadernos Geográficos**, n. 53, v. 2, p. 135-158. 2014. Available at: https://doi.org/10.30827/cuadgeo.v53i2.2224

CASGRAIN, A.; JANOSCHKA, M. Gentrificación y resistencia en las ciudades latinoamericanas: el ejemplo de Santiago de Chile. **Andamios**, n. 10, v. 22, p. 19–44, 2013. Available at: https://doi.org/10.29092/uacm.v10i22.265

CONNOLLY, J.; ANGUELOVSKI, I.; OSCILOWICZ, E. **Toward the Next Mode of Practice for Climate Urbanism**: understanding and preventing greening-induced displacement. Lincoln Institute of Land Policy. Working Paper WP23JC1. Available at: https://www.lincolninst.edu/publications/working-papers/toward-next-mode-practice-climate-urbanism. Accessed on: 20 nov. 2023.

CURUTCHET, G.; GRINBERG, S.; GUTIÉRREZ, R. Degradación ambiental y periferia urbana: un estudio transdiciplinario sobre la contaminación en la región metropolitana de Buenos Aires. **Ambiente & Sociedade**, n. 15, v. 2, p. 173-194. 2012. Available at: https://doi.org/10.1590/S1414-753X2012000200010

D'HERS, V. Asentamientos sobre basurales a cielo abierto. Explotación, segregación y expulsión en el manejo de los residuos. **DELOS, Revista de Desarrollo Local Sostenible**, n. 6, v. 6, p. 1–27. 2013. Available at: https://core.ac.uk/download/pdf/158837131.pdf

DAGA, D.; ZULAICA, M.; VÁZQUEZ, P. Evaluación de la vulnerabilidad socio-ambiental del periurbano de Mar del Plata. **Estudios Socioterritoriales**, v. 18, p. 45–59. 2015.

DAVIS, M. **Planeta de ciudades miseria**. Madrid: Foca. 2007.

FERNANDES, E. Regularization of Informal Settlements in Latin America. **Policy Focus Report**. Lincoln Institute. Cambridge, MA, May 2011. Available at: https://www.lincolninst.edu/publications/policy-focus-reports/regularization-informal-settlements-in-latin-america. Accessed on: 15 sep. 2022.

FERNÁNDEZ, I.; KOPLOW-VILLAVICENCIO, T.; MONTOYA-TANGARIFE, C. Urban environmental inequalities in Latin America: a scoping review. **World Development Sustainability**, n. 2, p. 1–11. 2023. Available at: https://doi.org/10.1016/j.wds.2023.100055

FERRARO, R.; ZULAICA, L.; ECHECHURI, H. Perspectivas de abordaje y caracterización del periurbano de Mar Del Plata, Argentina. **Letras Verdes. Revista Latinoamericana de Estudios Socioambientales**, n. 13, p. 19-40. 2013. Available at: https://doi.org/10.17141/letrasverdes.13.2013.926.

FLACKE, J.; SCHÜLE, S.; KÖCKLER, H.; BOLTE, G. Mapping Environmental Inequalities Relevant for Health for Informing Urban Planning Interventions. A Case Study in the City of Dortmund, Germany. **Int. J. Environ. Res. Public Health***, n. 13, v. 711, p. 2-19. 2016*. Available at: https://doi.org/10.3390/ijerph13070711

GALINDO, C.; DELGADO, J. Los espacios emergentes de la dinámica rural-urbana. Problemas del desarrollo". **Revista Latinoamericana de Economía**, v. 37, n. 147, p. 187-216. 2006. Available at: https://www.redalyc.org/articulo.oa?id=11820100008

GARZÓN-DUQUE, M.; CARDONA-ARANGO, D.; RODRÍGUEZ-OSPINA F.; SEGURA-CARDONA, M. Perspectivas teóricas y metodológicas para el estudio del ambiente como determinante de la salud. **Rev. Fac. Nac. Salud Pública**, n. 34, v. 3, p. 350-358. 2016. Available at: https://doi.org/10.17533/udea.rfnsp.v34n3a09

GÓMEZ, N.; VELÁZQUEZ, G. Asociación entre los espacios verdes públicos y la calidad de vida en el municipio de Santa Fe, Argentina. **Cuadernos de Geografía: Revista Colombiana de Geografía**, n. 27, v. 1, p. 164-179. 2018. Available at: https://doi.org/10.15446/rcdg.v27n1.58740

HARVEY, D. **Justice, Nature and the Geography of Difference**. Oxford. Blackwell. 1996.

KRIEG, J.; FABER, D. Not so Black and White: environmental justice and cumulative impact assessments. **Environmental impact assessment review**. Elsevier Inc. n. 24, p. 667–694. 2004. Available at: https://doi.org/10.1016/j.eiar.2004.06.008

LONDON, S. Sobre el análisis de la pobreza urbana y el medio ambiente: una visión socioecológica. **Letras Verdes. Revista Latinoamericana de Estudios Socioambientales**, n. 24, p. 143-160. 2018. Available at: https://doi.org/10.17141/letrasverdes.24.2018.3306

MUNICIPALIDAD DE POSADAS. **Políticas Ambientales**. Available at: https://posadas.gov.ar/sustentable/girsu/ 2022. Accessed on: 9 sep. 2023.

NCAIR. "Respira... no quemes". Educación de Calidad de Aire. **División de Calidad de Aire de Carolina del Norte**. Carolina del Norte, mar. 2012. Available at: https://www.deq.nc.gov/water-quality/surface-water-protection/edu/obot-2017-spanish-curriculum-p1-45/download. Accessed on: 5 jul. 2020.

ORGANIZACIÓN MUNDIAL DE LA SALUD. Calidad del aire ambiente (exterior) y salud. **OMS**. Geneva 19 December. 2022. Available at: https://www.who.int/es/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health. Accessed on: 14 nov. 2023.

ORTIZ ESPEJEL, B.; ESPINOZA, M.; ANDRADE, B.; JIMÉNEZ, R. Vulnerabilidad socioambiental ante el cambio climático para el año 2020 en las provincias eclesiásticas de México. **Cuaderno de Investigación**. Ibero Puebla: CEAPE. 2015.

PI PUIG, A. Aportes para el estudio de las desigualdades ambientales. Un recorrido por la agenda internacional y los enfoques teóricos. *In:* ORTALE, S.; RAUSKY, M. (coord.). **Desigualdad en plural**: miradas, lecturas y estudios en el Gran La Plata. La Plata: UNLP-FHyCE. 2021. p. 53-96. Available at: https://www.libros.fahce.unlp.edu.ar/index.php/libros/ catalog/book/182. Accessed on: 7 oct. 2023.

PIERANGELI, I.; NIEUWENHUIJSEN, M.; CIRACH, M.; ROJAS-RUEDA, D. Health equity and burden of childhood asthma related to air pollution in Barcelona. **Environmental Research**, n. 186, p. 109-212. 2020. Available at: https://doi.org/10.1016/j.envres.2019.109067

REGISTRO NACIONAL DE BARRIOS POPULARES. Ministerio de Desarrollo Territorial y Hábitat. **RENABAP**. 2018. Available at: https://www.argentina.gob.ar/ barriospopulares. Accessed on: 14 feb. 2022.

SANTASUSAGNA RIU, A.; TORT DONADA, J. Agua y espacio urbano. Algunas consideraciones teóricas a propósito de la relación entre ciudad y río. **Documents d'Anàlisi Geogràfica**, v. 65, n. 2, p. 371-397. 2019. Available at: https://bibliotecas.net.ar/geoaccesoabierto/items/show/31479

SCHARAGER, A. Degradación ambiental en los márgenes urbanos. Los efectos sociales de una orden de relocalización en un barrio popular de Buenos Aires. **Revista Direito da Cidade**, v. 9, n. 3, p. 1147-1173. 2017. Available at: https://doi.org/10.12957/rdc.2017.28818

SHCAMBER, P.; SUÁREZ, F. **Recicloscopio III**: miradas sobre recuperadores urbanos, formas organizativas y circuitos de valorización de residuos en América Latina. Buenos Aires: UNLa-UNGS, CICCUS. 2011.

TRAVASSOS, L.; CAMPELLO TORRES, H.; DI GIULIO, G.; JACOBI, P.; DIAS DE FREITAS, E.; SIQUEIRA, I.; AMBRIZZI, T. Why do extreme events still kill in the São Paulo Macro Metropolis Region? Chronicle of a death foretold in the global south. **International Journal of Urban Sustainable Development**, v. 13, n. 1, p. 1-16. 2020. Available at: https://doi.org/10.1080/19463138.2020.1762197.

WALKER, G.; BULKELEY, H. Geographies of environmental justice. **Geoforum**, n. 37. p. 655–659. 2006. Available at: https://doi.org/10.1016/j.geoforum.2005.12.002.

ZULAICA, L.; VÁZQUEZ, P. Ciudades argentinas en el contexto del cambio climático: exploraciones para el análisis del riesgo y la resiliencia urbana. **Cuadernos de Geografía: Revista Colombiana de Geografía**, v. 30, n. 2, p. 396-417. 2021. Available at: https://doi.org/10.15446/rcdg.v30n2.87584.

Medioambiente urbano y políticas ambientales desiguales: un estudio de caso en Argentina

Urban environment and unequal urban environmental policies: a case study in Argentina

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ARTICLE-VARIA

RESUMEN

Este artículo analiza, diferentes y desiguales problemas urbano ambientales en la ciudad de Posadas (Argentina), donde hay distintas prácticas sociales de cuidado y gestión del ambiente de acuerdo con los vecindarios. El objetivo fue conocer y describir las acciones u omisiones de legislación y/o políticas ambientales en relación a las distintas zonas urbanas. Con base en un relevamiento cuantitativo, se vinculó el contexto espacial de los barrios con la presencia de problemas y políticas ambientales, prácticas de cuidado del ambiente, opiniones, actitudes, y procesos de autogestión social en cada vecindario. Se describe cómo las personas que viven en los barrios más pobres están desproporcionadamente expuestas a condiciones ambientales adversas. Los barrios ubicados en entornos urbanos de alta calidad ambiental disponen de mayores servicios, recursos y atención gubernamental, mientras que, los barrios más desfavorecidos en la ciudad son a la vez, los menos favorecidos por las políticas y las estructuras urbanas deficitarias.

Palabras clave: Arboles. Residuos. Contaminación. Asentamientos. Políticas ambientales.

ABSTRACT

This study analyses different and unequal urban environmental problems in the city of Posadas (Argentina), where there are different social practices of environmental care and management according to neighbourhoods. The aim was to understand and describe the action or lack of action of environmental legislation or policy concerning different urban areas. Based on a quantitative survey, the spatial context of the neighbourhoods was linked to environmental problems and policies, environmental care practices, opinions, attitudes, and social self-management processes in each neighbourhood. It describes how people living in the poorest neighbourhoods are disproportionately exposed to adverse environmental conditions and risks. Neighbourhoods in urban spaces with high environmental quality have more services, resources and government attention, while the most disadvantaged neighbourhoods in the city are also the least favoured by policies and deficient urban structures.

Keywords: *Trees. Waste. Pollution. Settlements. Environmental policies.*

1 INTRODUCCIÓN

Hoy, las estrategias de marketing urbano actúan bajo el eslogan de la ciudad verde y sustentable. Sin embargo, las intervenciones urbano ambientales más significativas llegan en zonas urbanas y residenciales distinguidas, aumentando su valor económico Connolly *et al.* (2023). Los distintos espacios urbanos son expresión de las desigualdades socio-espaciales, de distribución de oportunidades y recursos (Capdevielle, 2014). Por ello, analizamos aquí, como la distribución desigual de los servicios ambientales o su inaccesibilidad condicionan la calidad de vida, y por lo tanto, las condiciones medioambientales a los que se exponen los residentes en las distintas áreas urbanas.

En la actual coyuntura de crisis climática, las políticas ambientales adquieren inusitada relevancia, al adoptar mecanismos para mitigar las nuevas adversidades ambientales: contaminación, emisiones, sequía, aumento de la temperatura, incendios, etc. En este contexto, en la ciudad de Posadas, la agenda gubernamental viene desarrollando programas y políticas urbano ambientales en el marco del discurso de las ciudades sostenibles y resilientes.

Desde el año 2020, el municipio está generando distintas acciones bajo el slogan: “una Posadas sustentable, más verde, moderna e innovadora”. Concretamente ha implementado la promoción de la educación ambiental, la recolección diferenciada de residuos, la provisión de contenedores, el reciclaje y la economía circular, la construcción de bicisendas, arborización urbana, programas de compostajes y abono, el uso de chips de podas en espacios públicos, entre otras acciones. Como crítica, se ha observado, por un lado, que el conjunto de estas acciones llega con mayor intensidad en algunos sectores y barrios de la ciudad, por otro, la ausencia de políticas ambientales, que controlen las emisiones vehiculares y de quemas domiciliarias, en conjunto con la exigua legislación de protección ambiental (Brites, 2022b).

Más allá, de la contaminación y la crisis ambiental en las ciudades, cobra importancia la espacialidad urbana, en la medida en que, los problemas ambientales se distribuyen de modo desigual dentro de la ciudad. Hay lugares donde los problemas son más crónicos que en otros, una situación que puede generar desigualdades en la salud urbana y vulnerabilidades sanitarias. Ello lleva a replantear las desigualdades ambientales como el resultado de una sinergia con otras formas de desigualdades, cuyos efectos profundizan las desventajas y situaciones de riesgo ambiental.

Este artículo destaca la importancia de comprender a la contaminación y los riesgos como desigualdades ambientales, una categoría que refiere a las adversidades del medioambiente contaminado, la exposición a riesgos y distintas vulnerabilidades del entorno urbano ambiental y, por lo tanto, como un engranaje más de las desigualdades urbanas. Como contribución, la discusión enfatiza las disparidades que generan las políticas urbanas, al descompensar la calidad de vida y el hábitat de los sectores populares, donde los costos asociados a la contaminación y sus efectos no son tenidos en cuenta por las acciones de sustentabilidad.

2 APROXIMACIONES TEÓRICAS

La problemática ambiental de las ciudades Latinoamericanas se ha convertido en el epicentro del debate sobre la sostenibilidad, sin embargo, las acciones no han sido equitativas (Fernández *et al.*, 2023; London, 2018). La contaminación y las vulnerabilidades socioambientales conllevan incidencias no solo en los ecosistemas urbanos, sino consecuencias directas en el deterioro de la calidad de vida urbana y la salud de la población. Sin olvidar, que el medioambiente limpio, saludable e inclusivo es reivindicado desde el enfoque más equitativo de justicia ambiental propuesto por Harvey (1996).

Los riesgos ambientales en un contexto de cambio climático son variables y su estudio está en el foco de las agendas políticas y los distintos planes de mitigación (Zulaica; Vázquez, 2021), por otro lado,

las cuestiones del cambio climático y la justicia medioambiental evidencia las correlaciones entre los patrones socioambientales y las condiciones de vulnerabilidad social (Travassos *et al.*, 2021).

En las últimas décadas, el crecimiento urbano y sus distintas funcionalidades están generando efectos medioambientales negativos, los cuales se distribuyen de modo desigual entre la población, existiendo un impacto diferencial de los problemas ambientales concomitantes entre los sectores o comunidades de más bajos ingresos (Krieg; Faber, 2004; Walker; Bulkeley, 2006). Un contexto donde las desigualdades urbanas y medioambientales configuran modos desiguales de habitar el espacio (Suárez, 2021).

Los desiguales costos y beneficios ambientales de las políticas generan efectos diferenciales y desiguales. El acceso diferenciado a bienes ambientales como el aire puro, el agua limpia o las áreas verdes (Alves Prates, 2007; Brites, 2022b; Pi Puig, 2021) son, por citar, indicadores de bienestar ambiental. Sin embargo, las distintas desigualdades (socio-espaciales, residenciales, ambientales, etc.) están generando un paisaje urbano más homologado en las ciudades.

La inversión en infraestructura y la reestructuración de espacios públicos (ramblas, jardines y parques) está siendo acompañada de nuevos y acondicionados edificios confortables para sectores de mayor poder adquisitivo (Brites, 2019). Además, se ha señalado a los frentes costeros y espacios verdes como recursos paisajísticos (Santasusagna Riu; Tort Donada, 2019) y también como recursos ambientales y turísticos de recualificación urbana e inmobiliaria. Un proceso que consolida las desigualdades de clase y aumenta la desposesión (Casgrain; Janoschka, 2013).

Las políticas urbanas sustentables, en su experiencia han sido acompañadas por la búsqueda de plusvalías, generando en entornos urbanos embellecidos y paisajísticos, incidiendo en la relegación de barrios hacia nuevas periferias con degradación ambiental. Las áreas de pobreza extrema y la contaminación ambiental se superponen generando zonas urbanas hiperdegradadas (Davis, 2007). El avance de la dinámica inmobiliaria reorganiza la ciudad y empuja a crear zonas de alta vulnerabilidad ambiental como los barrios pobres y asentamientos de las periferias, a veces “emplazados sobre basurales, bañados y con altísimos niveles de contaminación” (Curutchet; Grinberg; Gutiérrez, 2012, p.173). Los espacios periurbanos o suburbanos aparecen como “híbridos”, donde zonas rurales y urbanas son a menudo difíciles de diferenciar (Ferraro et al., 2013; Galindo; Delgado, 2006), espacios donde la legislación ambiental muchas veces no llega o no se aplica.

Desde el punto de vista ecológico, el surgimiento de barrios pobres y vulnerables remite a la carencia de espacios verdes, falta de cuidados en zoonosis, la contaminación de los suelos, agua y aire (por contaminación interna o por cercanía a zonas industriales) o de producción de alta contaminación (London, 2018). Algunas investigaciones (Fernandes, 2011; Fernández *et al.*, 2023) señalan que la frecuente expansión de asentamientos informales en las periferias urbanas ha producido una pérdida y degradación de los hábitats naturales. Además, los gobiernos han permitido la expansión de ciudades en áreas propensas a riesgos ambientales con carencias de infraestructuras y servicios. En los bordes de la ciudad, muchos terrenos vacantes son vulnerables al arrojo no controlado de basura creando zonas ambientalmente desfavorables y sitios de disposición de residuos comúnmente llamados “basurales a cielo abierto” (D’hers, 2013, p.2).

Las desigualdades ambientales también pueden ser analizadas desde la categoría operativa de Áreas Urbanas Deficitarias Críticas (AUDC) (Barreto *et al.*, 2014). La misma analiza una porción del espacio residencial periurbano, altamente fragmentado, donde conviven barrios desiguales (en términos de características físicas y sociales), que se distinguen por estar segregados, en territorios desarticulados y carentes de urbanidad. Al igual que en las periferias, las AUDC se caracterizan por déficits en infraestructuras, servicios y equipamientos, problemas de comunicación y accesibilidad, vulnerabilidad ambiental y, en algunos casos, territorios de riesgo hídrico (Alcalá; Rus, 2017).

Las inundaciones y la falta de obras de infraestructuras son resultado de los distintos entrecruzamientos entre vulnerabilidad y amenazas de riesgos: socioeconómico, material o físico y ambiental *(*Biffis *et al.*, 2022). Una idea que sugiere, que la experiencia del habitar en los márgenes urbanos degradados conlleva un sufrimiento ambiental expresado en un relacionamiento de la vulnerabilidad social con el riesgo ambiental (*Scharager, 2017).*

Estudios han encontrado diferencias significativas en la calidad ambiental y de vida de acuerdo a las condiciones socioeconómicas de los hogares de barrios pobres o desfavorecidos y los residentes barrios de clase alta (Flacke *et al.*, 2016). *Gómez y Velázquez (2018)* han observado cómo en las periferias hay áreas más desfavorables para la calidad de vida en función de una relación entre la cantidad de habitantes y la superficie de espacios verdes públicos. *Ello permite pensar cómo las características propias del contexto social se objetivan en desigualdades ambientales y sanitarias.*

La contaminación del aire, por ejemplo, se distribuye de manera desigual dentro de las ciudades, lo que puede generar disparidades en la salud urbana (Pierangeli et al., 2020). Así, junto a la desigualdad ambiental, algunos autores (Garzón-Duque et al., 2016) hacen hincapié en los determinantes sociales de la salud, que crean enormes desigualdades en la probabilidad de enfermar y el riesgo de morir prematuramente, es decir de forma no natural sino socialmente determinada, que podrían y deberían evitarse.

Más allá de los efectos de las adversidades ambientales, en el escenario de la crisis climática, se viene hablando de la vulnerabilidad socioambiental (Daga et al., 2015; Ortiz Espejel et al., 2015), un fenómeno que impacta con mayor fuerza entre los sectores de escasos recursos, donde al margen de las características del entorno, son mayores los riesgos de exposición a amenazas externas, emergentes y extraordinarias, donde los sectores populares deberán hacer frente a nuevos peligros ambientales.

3 METODOLOGÍAS

El área de estudio comprendió a la ciudad de Posadas en sus distintos sectores urbanos (el centro y alrededores, los barrios de la zona oeste, sur y suroeste). El principal abordaje metodológico correspondió a un diseño cuantitativo y exploratorio implementado en dos etapas: la primera etapa a través de un formulario web online, y la segunda por medio de encuestas en terreno. La investigación recabó información a partir de un muestreo probabilístico por conglomerado incorporando un total de 322 personas con residencia en distintos barrios o sectores (conglomerados), luego la selección de los casos que integraron la muestra, siguió un criterio aleatorio dentro de cada barrio.

Tabla 1 – Distribución de casos analizados por conglomerados

Tipo de conglomerado	*Sectores o Barrios*	*Frecuencia*	*Porcentaje*
Barrios de viviendas sociales	Villa Cabello, A-4, Yacyretá, Santa Rita, 80 viviendas. 90 viviendas. Chacra 32-33, Cocomarola Oeste. Giovinazzo (autódromo). Itaembé Miní. Itaembé Guazú, Hipotecario (ch.124). Las Orquídeas. Los Jilgueros. Prat, San Isidro, M. Lanús (A-3.2). Nemesio Parma, Sesquicentenario, Papel Misionero (Ch.122), Prosol, 10 de Junio.	72	22%
Asentamientos o barrios populares	Santa Rosa, Aeroclub. Chacra 252. El Mangal. Los Lapachitos, Ita Verá (Ch.145). Chacra 178. Los Lapachitos. Los Oleritos, La Tablada. Nestor kirchner. Sol Naciente. San Jorge. San Onofre, San Marcos. Los Paraísos. Villa Flor, Sol de Misiones. Vecinos Unidos. Ch. 127, V. Cariño.	76	24%

Tipo de conglomerado	*Sectores o Barrios*	*Frecuencia*	*Porcentaje*
Barrios con trazado urbano abierto, con veredas y desagües	San Alberto, Alta Gracias. Altos de Bella Vista. Alto de Irupé, Bancario, Congreso, Gazupí. Los Lapachos, Independencia. Las Dolores. Hermoso, El Libertador, Jardín. Latinoamérica, Mini City. Libertador San Martín. La Picada. Rocamora. San Lucas. Santa Lucía. Sur Argentino, Villa Poujade, 25 de Diciembre, 25 de mayo, A. Guacurari Ch.105., Ch.34. Cha. 183.	117	36%
El centro urbano y alrededores	Centro (cuatro Avenidas y microcentro) Tajamar, Apos. El Palomar. Los Aguacates. Villa Sarita, Villa Urquiza, 23 de Sep., Ch.7., Ch. 46., Patoti, Tiro Federal.	57	18%
Total		**322**	**100%**

Fuente: Elaboración propia con base en matriz de datos.

El levantamiento de los casos se realizó entre los meses de abril y noviembre de 2023, y se tomó como unidad de registro a personas adultas residentes en los conglomerados seleccionados. En un primer momento se compartió el formulario online a través de teléfono móvil, cuidadosa y controladamente a las personas, posteriormente el relevamiento se realizó más focalizadamente mediante visitas domiciliarias en los barrios. La encuesta (voluntaria y anónima) en sus dimensiones, exploró sobre aspectos relativos a los problemas ambientales y de contaminación en los vecindarios, las prácticas de cuidado del ambiente, la acción de las políticas gubernamentales, entre otras opiniones indagadas en el formulario. El tratamiento cuantitativo de los datos se realizó mediante un análisis estadístico descriptivo procesado en el software SPSS.

En la etapa de trabajo de campo se realizaron observaciones y registros, además de relevamiento fotográfico y audiovisual en las distintas zonas de la ciudad. Por otro lado, de modo complementario a las encuestas, se han realizado 10 entrevistas semiestructuradas para captar la percepción de vecinos y referentes barriales con conocimiento local sobre hábitat y medioambiente en su vecindario o sector de residencia. Es decir, se optó por complementar la investigación con un análisis cualitativo/compresivo a fin de entender aspectos socioculturales, vinculados a los problemas de contaminación, las prácticas y representaciones sobre los riesgos.

Para el análisis de la espacialidad, se delimitó los 67 asentamientos de Posadas con base a distintas fuentes como el Registro Nacional de Barrios Populares (Renabap, 2018), y la ONG Techo (2016). Para la localización de los conjuntos de viviendas sociales se utilizó información provista por el Instituto Provincial de Desarrollo Habitacional (Iprodha). En tanto para el análisis de planes y programas de políticas ambientales se utilizó información oficial de la Municipalidad de Posadas en su sitio web.

En el orden de las desigualdades ambientales se buscó conocer y explorar los distintos barrios o zonas (como unidades espaciales) en las que se implementaron o no, políticas urbano ambientales, o de cuidado del medioambiente. Mas allá de que proponemos un estudio exploratorio abierto a captar nuevos procesos emergentes, sostenemos dos hipótesis: a) las políticas ambientales no llegan a todos los barrios con la misma intensidad, es decir que hay acciones y omisiones en el tratamiento de la contaminación y la provisión de servicios ambientales; b) las personas que viven en vecindarios de posición socioeconómica baja (barrios populares y asentamientos) están desproporcionadamente más expuestas a condiciones ambientales adversas o negativas con potencial incidencia para la salud.

En la etapa final de la investigación, se procedió al análisis y producción de información comparativa entre los distintos barrios y sectores urbanos, así como a la elaboración de gráficos, tablas y mapas con información georreferenciada.

4 EL CONTEXTO: LA CIUDAD DE POSADAS

Posadas con 390.000 habitantes (aprox.) es el principal aglomerado urbano de Misiones y su mancha urbana se extiende hasta el municipio vecino de Garupá. En las últimas décadas, como resultado de grandes obras de tratamiento fluvial, en las costas del Río Paraná, la ciudad ha cambiado su morfología asumiendo una marcada desigualdad urbano ambiental y socio-espacial. Por un lado, un nuevo borde costero con espacios públicos de alta calidad ambiental, y por otro, la emergencia de nuevos asentamientos y barrios populares que, en muchos casos, hibridan la ocupación del suelo con conjuntos de viviendas sociales.

Los asentamientos (67 en la ciudad), más allá de la pobreza y la informalidad en la ocupación del suelo, se caracterizan por hábitats deficitarios y condiciones urbano ambientales degradadas, algunos más adversos que otros, en función de su localización en el espacio urbano (Brites, 2022a). A pesar de las adversidades inherentes a los asentamientos, las problemáticas por las que atraviesan presentan distintas magnitudes, como las distancias al centro urbano, segregación, déficits en infraestructuras y servicios, calles terradas, contaminación ambiental, etc.

La forma en cómo se desarrollan nuevas urbanizaciones de viviendas sociales es otra cuestión que orbita en las condiciones medioambientales de la ciudad. Grandes extensiones de tierra cubierta por pastizales, árboles y vegetación natural son arrasadas indiscriminadamente en la construcción masiva de viviendas, un fenómeno que dilapida recursos naturales y genera desigualdades ambientales.

En la experiencia de Posadas, la construcción de mega conjuntos de viviendas, como Itaembé Miní e Itaembé Guazú han ampliado la mancha urbana, deteriorando áreas naturales mediante prácticas de deforestación, remoción de tierras, y rellenos, afectado arroyos y humedales, sin un adecuado tratamiento ambiental. En el proceso de transformación, las políticas habitacionales han cambiado los servicios ecosistémicos por un entorno más precario y adverso.

5 RESULTADOS Y DISCUSIONES

5.1 LOS PROBLEMAS AMBIENTALES

La investigación analizó una serie de problemas ambientales reiterados en muchos sectores de la ciudad, tales como: acumulación de basura, quemas de residuos, malos olores, humo, quema de podas y pastizales, aguas residuales, contaminación fabril, etc. Se pudo conocer que las mayores prevalencias de contaminación se manifiestan con mayor intensidad en los asentamientos y con menor recurrencia en el centro de Posadas y zonas aledañas. Como puede observarse en la Figura 1, los barrios pobres (a pesar localizarse muchas veces en entornos verde) están desproporcionadamente desfavorecidos por el mal estado del medioambiente. En otras palabras, hay ciertas problemáticas de contaminación a los que están expuestos los residentes en función del contexto socioeconómico de los barrios, lo que también permite pensar, ciertas desigualdades en materia de servicios urbanos.

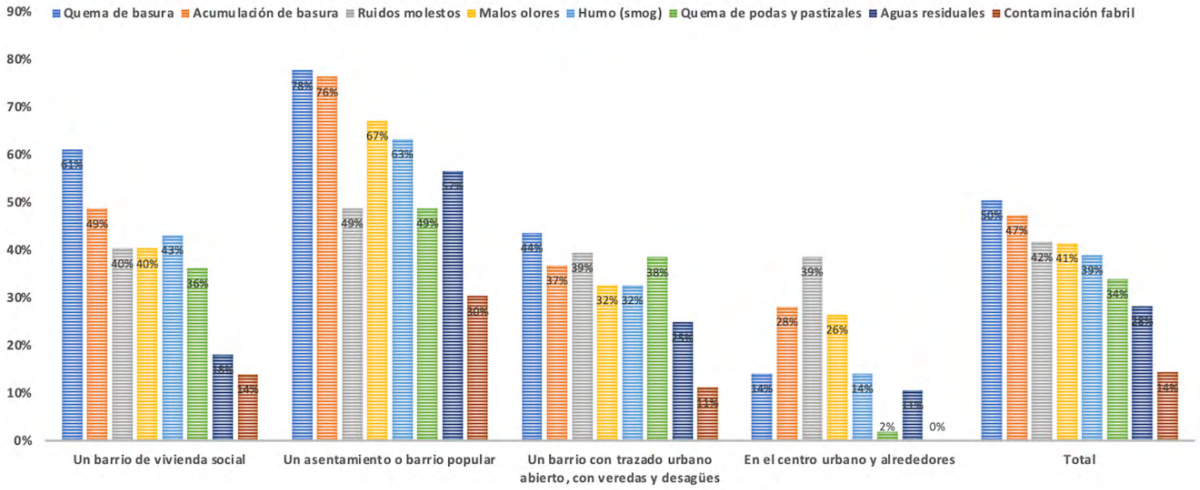

Figura 1 – Principales problemas ambientales según tipo de barrio

Fuente: Elaboración propia con base en matriz de datos.

En Posadas, el problema de las quemas tiene marcada contribución a la contaminación en la ciudad, en término de prevalencia (Brites, 2022). Un fenómeno que, sumado en sus distintas dimensiones, quema de basura y/o de podas/pastizales y presencia de humo agudizan el problema de la contaminación del aire. El análisis de los datos por tipo de sectores o barrios (Figura 1), reafirma el hecho de que, los asentamientos escenifican con mayor crudeza e intensidad los problemas de quemas: el 78% manifiesta la existencia de quema de basura, un 49% quema de podas/pastizales, y un 63% refiere a problemática de humo (smog) en el vecindario.

Más allá de las quemas, la contaminación al interior de los asentamientos es diversa y muchas veces no es debidamente concebida como problemas por sus residentes. Hay pequeños basurales a cielo abierto, arrojo de basura en arroyos, desagote de aguas servidas en calles internas y pasillos, acopio de desechos de materiales de construcción, presencia de roedores en baldíos, etc. En una entrevista un vecino comenta que, suele juntar retazos de chapas, maderas, tachos, lona, metales u otros elementos que podrían ser de utilidad para el arreglo de la vivienda.

En el caso de los asentamientos más periféricos del sur de Posadas, puede decirse, que la pobreza extrema, el hábitat precario/deficitario, y la permisividad de prácticas de manipulación residuos, facilitan que algunas familias desarrollen estrategias de autoempleo en la recuperación de materiales de la basura, para consumo propio o venta en acopiadores. De modo que, la lógica de alejamiento de los residuos hacia la periferia combina la emergencia de villas y el cirujeo (Schamber; Suárez, 2011).

Los barrios con trazados urbanos (en damero), tienen levemente menos prevalencia de problemas ambientales con respecto a los barrios de viviendas sociales, aunque en algunos aspectos hay diferencias, como por ejemplo, en los conjunto de viviendas sociales hay menos problemas de agua residuales ya que disponen de obras de infraestructuras como alcantarillados, en cambio en otros barrios, como San Jorge, se pudo conocer que hay viviendas con salida de cloacas a desagües a cielo abierto hacia el arroyo Zaimán. También hay que considerar problemáticas ambientales que pueden estar relacionadas con el contexto urbano de vegetación y mal manejo de la biomasa, ya que, en las barriadas del sur de Posadas hay más prácticas de quemas de podas, ramas y pastizales. En los asentamientos, la situación es crítica, a las aguas residuales, vapores y malos olores, se le suma la manipulación de la basura por fuego, mediante quemas al aire libre, con aparejados problemas de smog y degradación ambiental.

Por otro lado, en las afueras de la ciudad, en áreas de expansión urbana se encuentran fábricas o industrias que ha sido indicadas en las encuestas como contaminantes. Entre las referencias pueden mencionarse olerías (fábrica artesanal de ladrillos), industria de envoltorios plásticos, talleres de

automóviles, acopiadores de materiales y comercios con manejo inadecuado de residuos. En opinión de un vecino del barrio Alto de Bella Vista en la zona “hay olor a químicos de la industria copaflex” y han realizado denuncias, sin soluciones al problema. Por otra parte, una vecina de la zona de Itaembé Miní acusa a residentes de un asentamiento aledaño por la presencia de un horno ladrillero: “la olería de ahí humea por días, inunda el barrio de olor a barro quemado” (entrevista vecina).

El cruce entre los datos estadísticos y el relevamiento por observación en campo ha permitido conocer áreas más o menos delimitadas de deterioro ambiental y contaminación (dispersión de basura, quemas, aguas residuales, presencia de humo, etc.), como se ilustra en la Figura 2, estas áreas están más alejadas del centro y alrededores.

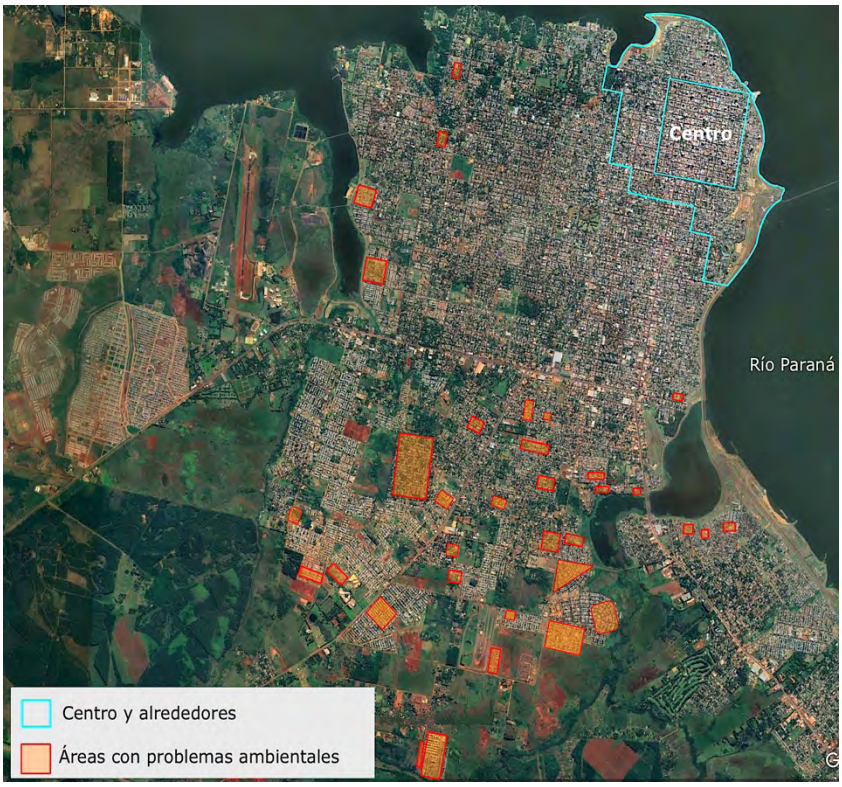

Figura 2 – Áreas delimitadas con deterioro ambiental

Fuente: Elaboración propia con base a Google Earth.

De modo general, los mayores problemas de contaminación se objetivan en áreas de expansión urbana. En Posadas, muchos conjuntos de viviendas sociales, construidos por el Estado comparten espacios urbanos con barrios populares auto-construidos y asentamientos que, a pesar de las adversidades, son producto de procesos de autogestión social.

5.2 ARBOLADO Y ESPACIOS VERDES

En la tabla 2 se analiza la tenencia de árboles y la presencia de espacios verdes en el entorno a la residencia de los encuestados. Particularmente, vemos cómo indistintamente del barrio o sector urbano en el que residen las personas, la disponibilidad de árboles en veredas es elevada, entre el 72% y el 85% de las personas encuestadas en las distintas áreas han manifestado tener árboles en veredas. Sin embargo, la pregunta: ¿la municipalidad ha plantado árboles en su barrio? marca una diferencia en las respuestas, en la medida en que se puede observar un mayor despliegue gubernamental en los distintos sectores urbanos en detrimento de los asentamientos y barrios populares, allí solamente el

13% afirma que el municipio ha plantado árboles, frente al 38% en los conjuntos habitaciones, el 34% en otros barrios, y el 26% en el centro y alrededores.

Tabla 2 – Espacios verdes y arbolados según tipo de barrio

	Tipo de barrio				
Arboricultura	*B.º de vivienda social*	*Asentamiento/ B.º popular*	*B.º con trazado urbano abierto*	*Centro urbano y alrededores*	*Total*
Tiene árboles en su vereda	83%	79%	85%	72%	81%
No tiene árboles en su vereda	17%	21%	15%	28%	19%
Planto algún árbol en los últimos 2 años	36%	50%	48%	46%	45%
No planto algún árbol en los últimos 2 años	64%	50%	52%	54%	55%
La municipalidad ha plantado árboles en el barrio	38%	13%	34%	26%	29%
La municipalidad no ha plantado árboles en el barrio	63%	87%	66%	74%	71%
Dispone de algún espacio verde o parque	72%	39%	70%	61%	62%
No dispone de algún espacio verde o parque	28%	61%	30%	39%	38%

Fuente: Elaboración propia con base en matriz de datos.

La distribución de los espacios verdes también escasea en proximidades a los barrios más pobres, el 61% de encuestados en asentamientos afirmó no disponer. Como puede verse en el mapa de la Figura 3, los mayores espacios verdes se ubican en proximidad a la zona de costanera en diversos tramos. En este sentido, es pertinente referir a la investigación de Gómez y Velázquez (2018) que plantean una asociación entre calidad de vida y los Espacios Verdes Públicos (EVP), sugiriendo que las áreas de calidad de vida tienen límites más o menos definidos en la ciudad, mientras en zonas periféricas, se observan las áreas más “desfavorables” de calidad de vida, en las zonas centrales hay áreas más favorables para la calidad de vida. Por otro lado, si bien la mayor parte de los asentamientos de Posadas se ubican en el suroeste de la ciudad, donde la urbanización hibrida con vegetación natural, no debe confundirse un entorno verde con calidad ambiental, en la periferia la exuberante vegetación hace mixtura con prácticas antropogénicas de contaminación, quemas de pastizales, residuos, relleno sanitario, emprendimientos industriales, etc.

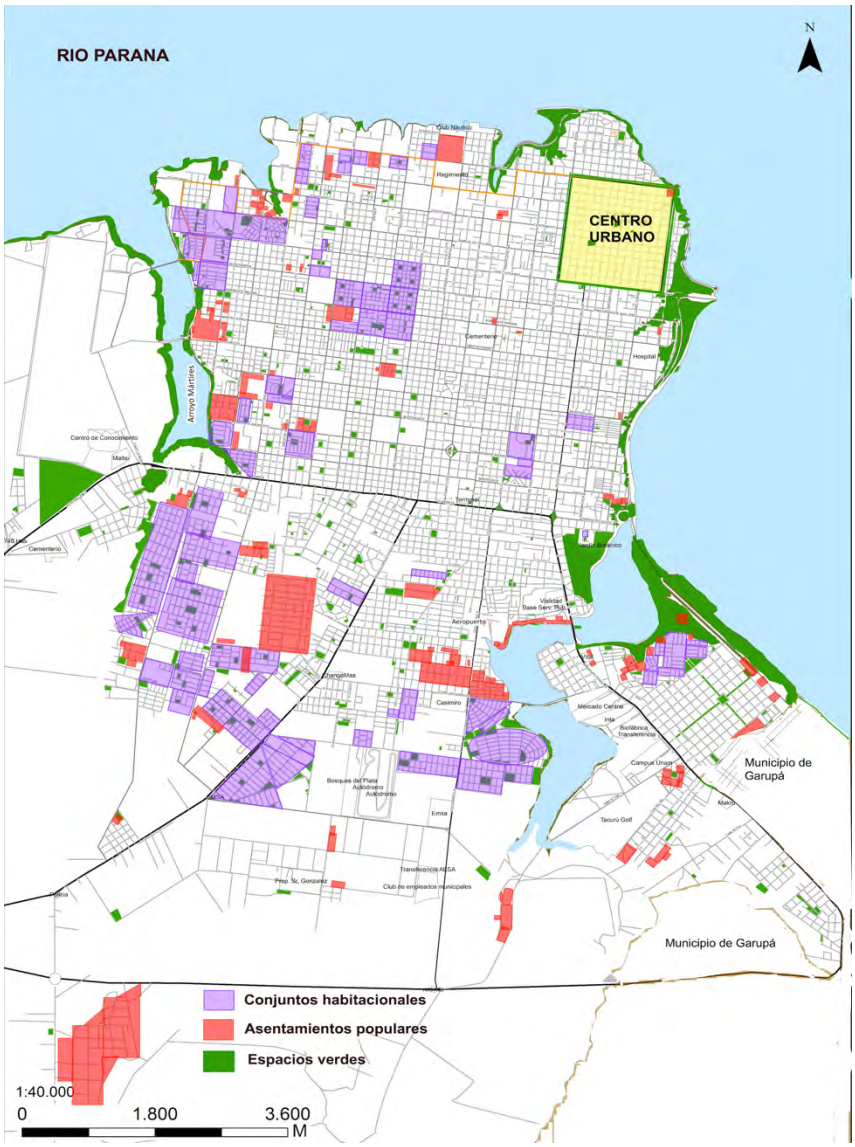

Figura 3 – Mapa ciudad de Posadas y localización espacios verdes

Fuente: Elaboración propia con base en RENABAP (2018) y Municipalidad de Posadas.

Como marco interpretativo más general, en Posadas, la proximidad a los frentes fluviales y la centralidad urbana tienen un interés crucial. No siempre las familias de mayor poder adquisitivo tienen preferencias para asentarse en zonas verdes alejadas del centro urbano. La presencia a asentamientos, la inseguridad (delictiva y vial), la proximidad a industrias (contaminación), la lejanía de la centralidad, etc., son externalidades ponderadas como negativas, y operan como elementos que refuerzan las distancias socio-espaciales.

Entre los motivos aludidos en el relato de quienes no han plantado árboles emergen algunas dimensiones cualitativas como: a- la falta de espacios en patios (asentamientos), b- las raíces como amenazas a las edificaciones, c- temor en días de lluvias y tormentas, d- vivir en edificios o alquiler en departamentos, e- las hojas ensucian patios y drenajes, f- otros motivos de limpieza y mantenimiento.

Concretamente, en la expresión de algunos vecinos: “los árboles, son grandes y necesitan espacio, las raíces crecen y van a amenazar mi casa” ... “con las lluvias pueden caer” … “no me gusta tener árboles en mi patio porque ensucian mi piscina y tapan los desagües” (entrevistas vecino). En fin, en los motivos negativos al cultivo de árboles prima una representación de algo que amenaza y ensucia, lo que además evidencia un problema de relación de la gente con los árboles.

5.3 QUEMAS Y CONTAMINACIÓN DEL AIRE

En los asentamientos más empobrecidos como Lapachitos, Oleritos, N. Kirchner, San Onofre, Los Paraísos y Aeroclub, las quemas son un problema generalizado, lo que sugiere que la calidad del aire es poco segura o inadecuada, por lo que sus residentes pueden estar expuestos a la contaminación y, por lo tanto, vulnerables a padecer enfermedades. Como se ilustra en la Figura 4, el análisis de los datos evidencia que en los asentamientos y barrios pobres el 54% de los encuestados ha manifestado realizar quemas de manera reiterada en domicilios, en tanto en el centro urbano y alrededores no hubo casos registrados al respecto. La situación también es llamativa en los conjuntos de viviendas sociales, donde un 33% ha manifestado realizar prácticas de quemas.

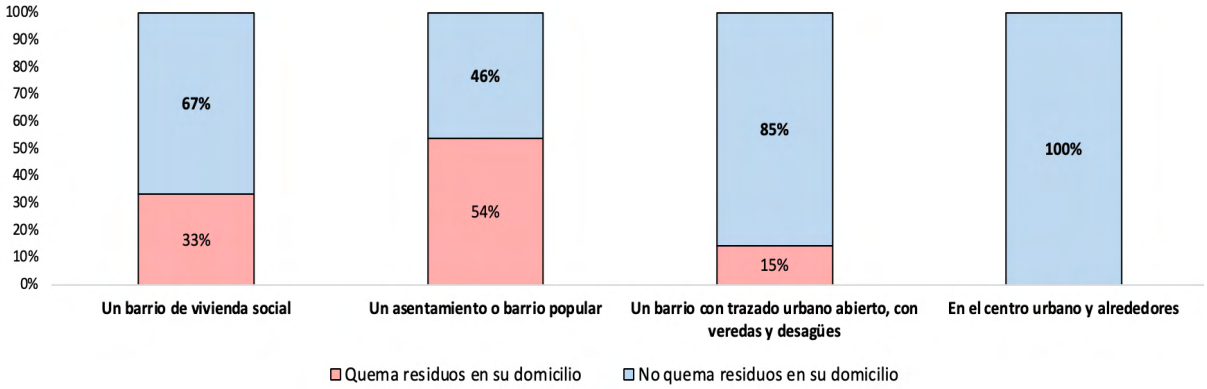

Figura 4 – Quemas de residuos en domicilio según tipo de barrio o sector

Fuente: Elaboración propia con base en matriz de datos.

Otra manera estratégica y diferencial de indagar sobre las quemas consistió en preguntar: ¿conoce algún vecino que quema residuos? Allí, el cambio de enfoque muestra casos desde otra perspectiva, incluso emergen casos en los alrededores del centro urbano, donde la legislación urbana es más constrictiva. Como puede observarse en la Figura 5, el 91% de las personas encuestadas en asentamientos conoce a vecinos que suelen realizar quemas.

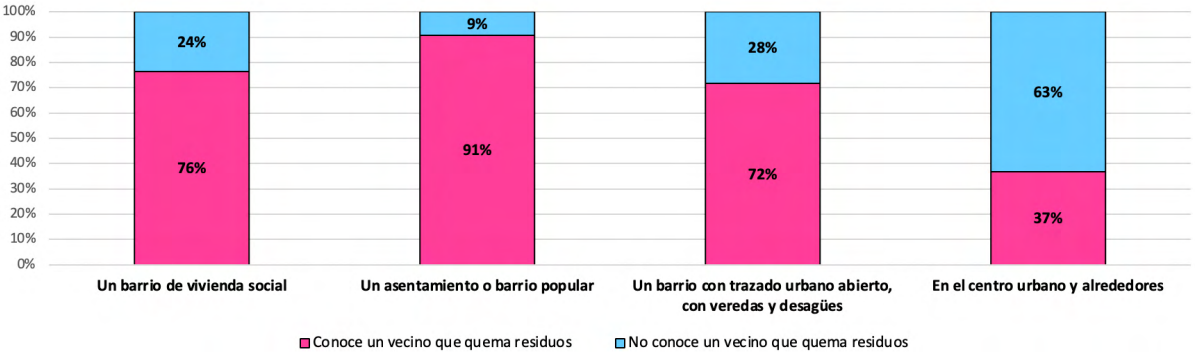

Figura 5 – Conoce vecino que quema según tipo de barrio o sector

Fuente: Elaboración propia con base en matriz de datos.

Estos datos refuerzan los hallazgos en otra investigación (Brites, 2022b) sobre la periferia sur de Posadas, donde los vecinos realizan quemas en veredas, en terrenos baldíos, en patios de las casas, en calles poco usadas, una problemática que no está informada, controlada, ni regulada. En Posadas, es conocido que las quemas constituyen una problemática en asentamientos, donde a veces los camiones recolectores de residuos no ingresan debido a la ausencia de calles, o el servicio es discontinuo. Por otro lado, tanto en barrios de viviendas sociales como en otros barrios con óptimos servicios urbanos hay entre 76% y 72% de personas encuestadas que afirman conocer a vecinos que queman (Figura

5). Un dato relevante, que permite ver prácticas ocultas de quemas en espacios privados como en traspatios de las viviendas.

Al igual que en otras ciudades de Argentina, en el centro urbano de Posadas y alrededores, el suelo se ocupa de forma más intensiva y organizada, el control de la legislación urbano ambiental es mayor, hay inspecciones, limpieza diaria y cuidado de espacios verdes. En cambio, la ubicación condicionada de barrios populares y asentamientos, empujados hacia los bordes urbanos coincide muchas veces con su proximidad a los sitios de disposición desechos, tiraderos, basurales improvisados, habilitados y no habilitados, generando contaminación de aire, suelo y agua. Como señala D'hers (2013), en las áreas sub-urbanas de las ciudades, la existencia circuitos de informalidad/ilegalidad, vinculados a los desechos permiten la contaminación.

A partir de un abordaje cualitativo, por entrevistas, se pudo evidenciar que, en algunos vecindarios existe cierta "naturalización" de las prácticas de quemas, que son vistas como formas convencionales y no riesgosas de eliminar los residuos, es decir hay pistas para interpretar el fenómeno como una práctica cultural, común, compartida y hasta cierto punto normalizada en muchos vecindarios. Así, a juicio de un vecino de San Lucas: "quemamos alguito cada tanto, el fuego no es mucho… los vecinos también suelen quemar" … "No molesta porque se quema de noche ahí en el baldío (entrevista).

Otras observaciones realizadas en campo enriquecen el modelo de interpretación sobre la contaminación en asentamientos. Allí, suele ser común (pero no generalizado) el uso de leñas como forma de energía para cocinar a bajo costo, además la alta ocupación del suelo (densificación) y construcción de mamposterías y chapas crean islas de calor con aumento de las temperaturas, que se suman a las emisiones antropogénicas. Una problemática más crítica en temporadas de verano, por la escasez de agua de red, lo que genera mayor vulnerabilidad socioambiental.

Entre otras discusiones, se reafirma que en el sur de Posadas los problemas de emisiones son más crónicos entre la población pobre, y, más allá de otras fuentes de contaminación externas a los barrios (como las exiguas industrias o el tránsito automotor), las quemas son prácticas recurrentes. La eliminación de residuos mediante fuego genera smogs nocivos, que ocasionan contaminación severa del aire, que se dispersa por acción de los vientos (Bernache Pérez, 2012; NCAIR, 2012). El nuevo paradigma en epidemiologia ambiental relaciona a este tipo de contaminación con alergias, enfermedades respiratorias, cardiovasculares e incluso oncológicas (OMS, 2018). Por ello, se enfatiza aquí, que la contaminación del aire, en algunas zonas, es parte de las desigualdades urbanas, que expresa la divergencia socioambiental, que conlleva potenciales costos para la calidad de vida y la salud.

Como se verá en el próximo apartado, la falta o deficiencia de servicios públicos, la ausencia de programas de concientización sobre riesgos y peligros de la contaminación, facilitan diversas prácticas de quemas, de basuras y residuos de biomasa (hojas y restos de podas), etc.

5.4 LAS ACCIONES AMBIENTALES DEL MUNICIPIO

De modo general, las acciones gubernamentales ambientales del municipio de Posadas distan de los problemas ambientales más reiterados y poco visibilizadas, como aquellos ligados a la contaminación del aire o el saneamiento de arroyos y afluentes urbanos. Como puede verse en la Figura 6, el control de emisiones vehiculares y por quemas de residuos es prácticamente nulo, en cambio hay preocupación por el dengue a partir de operativos de descacharrización y fumigación, (62% y 51% respectivamente) en detrimento de otros problemas ambientales igualmente severos. Una preocupación marcada por el aumento en los casos de dengue en los últimos años.

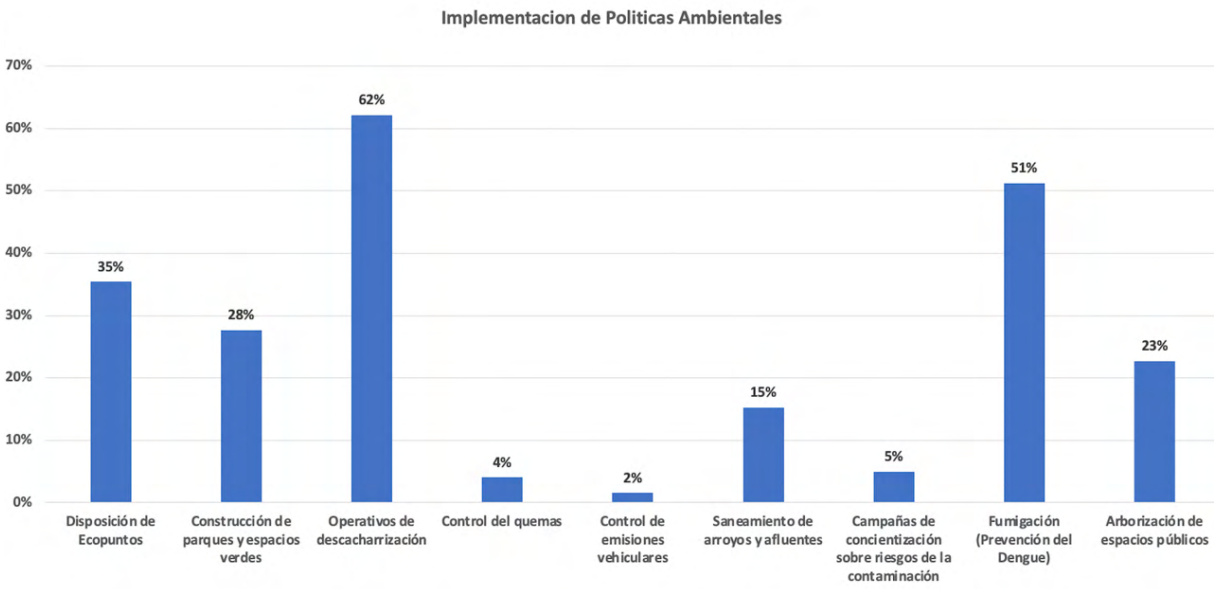

Figura 6 – Implementación de políticas ambientales del municipio de Posadas

Fuente: Elaboración propia con base en matriz de datos.

Por otro lado, respecto a la concientización, resulta llamativo que solamente el 5% de los encuestados (16 casos en barrios no pobres) han afirmado que llegan a su barrio campañas de concientización sobre riesgos de contaminación. En este aspecto, la agenda política, por ejemplo, la referida a los problemas de contaminación del aire está relegada y pendiente.

En la siguiente Figura 7, se analiza la presencia del municipio en relación a los distintos conglomerados estudiados: barrios de viviendas sociales, asentamientos, barrios con trazados en cuadrículas y la zona centro y alrededores. Allí podemos ver, por ejemplo, que el 68% de los encuestados en asentamientos y barrios populares ha manifestado que el gobierno no inspecciona los problemas de hábitat o de contaminación en los vecindarios.

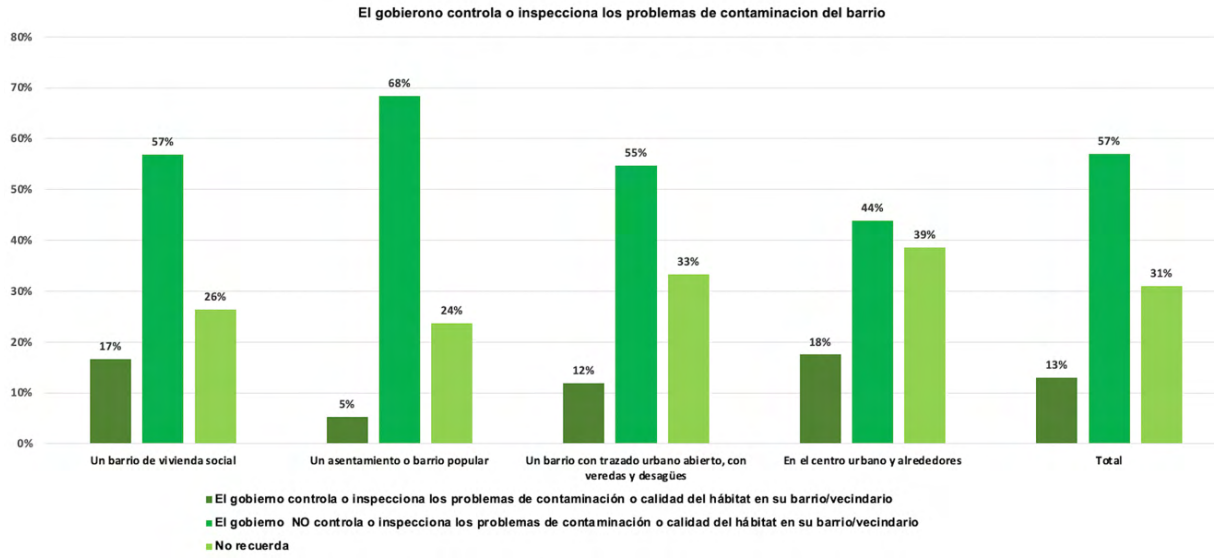

Figura 7 – El gobierno controla los problemas de contaminación según tipo de barrio

Fuente: Elaboración propia con base en matriz de datos.

La ausencia gubernamental es elevada, si se contempla que otro 24% de encuestados no recuerda, o no tiene registros de campañas (más allá del dengue). En opinión de una entrevistada en un barrio pobre: “el gobierno se acerca después de una gran tormenta por el agua que entra a las casas o para traer mercaderías al comedor, pero por otra cosa no vienen” … “igual, acá la gente no se molesta por el ambiente, tener trabajo y comida es más importante” (entrevista vecina).

La investigación descubre que, el monitoreo o inspección de la contaminación tiene poco alcance también en otros barrios de Posadas e incluso en el mismo centro urbano y alrededores, pero debería ser una prioridad en asentamientos y barrios pobres donde hay múltiples situaciones de vulnerabilidad socioambiental y contaminación. Conocer los efectos de la contaminación ambiental sobre la salud y la vida de las personas es vital, y constituye una cuestión de asuntos pendientes en las acciones ambientales del municipio. Como señala London (2018) en muchos barrios pobres, la contaminación interna no es atendida y rara vez forma parte de la agenda política, donde lo urgente predomina sobre lo importante; la mitigación se antepone a la prevención, gestión del hábitat y el medio ambiente.

La Figura 7, destaca que la contaminación tiene desigual manifestación en el espacio urbano de Posadas, y su control es exiguo en los barrios populares y asentamientos (5%), mientras que en la centralidad urbana y áreas adyacentes hay más atención y supervisión del medioambiente. En los barrios populares y en las afueras de la ciudad, las normas urbanísticas de protección y cuidado del medioambiente son flexibles o están ausentes, al dejar hacer, no advertir, o no prevenir. Consideramos que, la inacción en un contexto de contaminación deriva en la reproducción de hábitats adversos para la calidad de vida y en desigualdades en salud ambiental.

A partir del análisis de distintos planes y programas ambientales se puedo analizar la trazabilidad de las políticas ambientales entre dos áreas urbanas polarizadas, que se ilustran en la Figura 8.

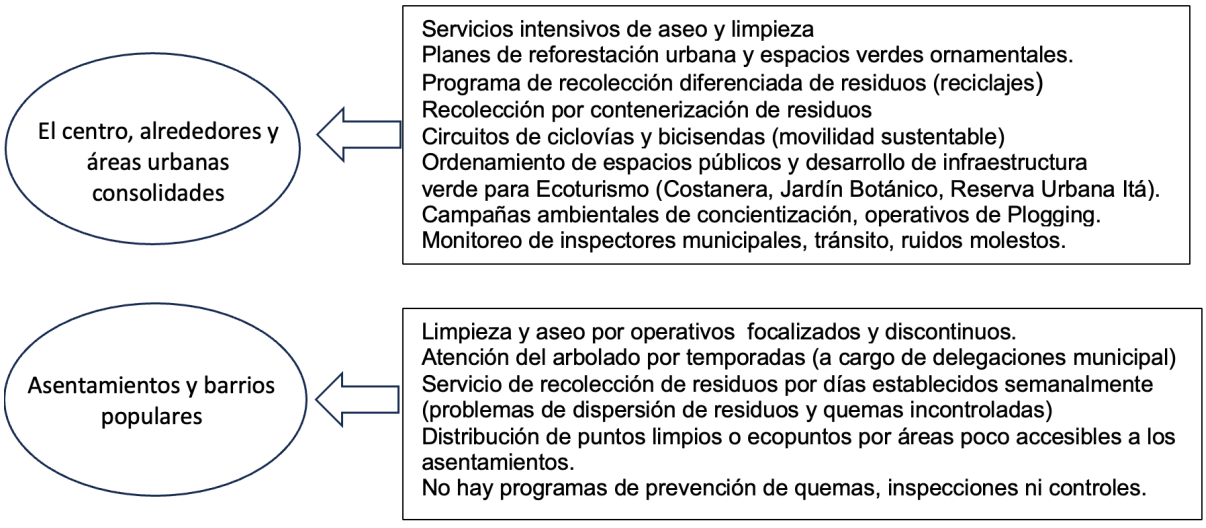

Figura 8 – Trazabilidad de las políticas ambientales en áreas urbanas polarizadas

Fuente: Elaboración propia.

En Posadas, a lo largo de la costanera hay sectores intervenidos, como el Jardín Botánico, la Reserva Urbana Arroyo Itá, en la bahía El Brete, el Parque la Cascada y otras zonas donde hay proyectos de consolidación de parques, plazas y jardines, para mejorar la calidad climática ambiental. Más allá de los sectores intervenidos, en el área costera, las brisas del caudaloso río Paraná inciden en una mejor calidad del aire, hoy combinadas con zonas verdes de esparcimiento, fortalecidas con acciones de reforestación urbana. En el fondo, el conjunto de estas acciones pone en valor determinadas áreas y vecindarios de la ciudad.

En este sentido, puede decirse, que la construcción de infraestructura verde (nuevas plazas y parques) en selectivos espacios urbanos, como los vinculados al frente costero de la ciudad escenifican políticas ambientales allí donde no hay mayores problemas ambientales. La propaganda verde con cartelerías que exaltan acciones amigables con el medioambiente es dispuesta en espacios urbanos limpios y de visibilidad al turista o paseante, lo que conlleva cierta distorsión de las acciones gubernamentales en materia de cuidado del medioambiente.

6 CONCLUSIONES

La ciudad de Posadas promociona la sustentabilidad, pero las acciones ecológicas y ambientales no llegan a todos los sectores de manera equitativa. La agenda urbano ambiental, los recursos y la calidad de las políticas, no solo son diferenciales, sino desiguales, instalando una lógica selectiva en la atención de los distintos barrios.

Los barrios en áreas revalorizadas, como los circundantes al frente fluvial, en el centro y alrededores, disponen de mejores servicios de aseo y limpieza, nuevas infraestructuras verde, parquizados, ciclovías y reforestación urbana. En cambio, en los barrios más pobres, las políticas de saneamiento ambiental o mejoras del hábitat son escasas, al igual que políticas que implican menos recursos, como las de concientización y cuidado del medioambiente, lo que profundiza las desigualdades en el acceso a conocimientos ambientales para la calidad de vida.

En los vecindarios más pobres, la apropiación cultural, social y económica del entorno, está condicionada por la pobreza. Allí, las prácticas de supervivencia y la necesidad del sustento parecieran tener más importancia que los efectos de la contaminación. Un contexto donde la desinformación y/o desconocimiento de las consecuencias de la contaminación converge en la definición de riesgos y peligros. En definitiva, el desamparo de las acciones ambientales constituye un desafío para un hábitat adecuado y un ambiente sano.

Finalmente, entre algunas contribuciones del estudio, se señala que las acciones de sustentabilidad tendrían que direccionarse hacia los barrios pobres y asentamientos, allí los focos de contaminación se multiplican y el deterioro ambiental crece, por lo que allí, debería ser una prioridad establecer acciones de protección y cuidado del medioambiente.

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REFERENCIAS

ALCALÁ, L.; RUS, F. Áreas Urbanas Deficitarias Críticas en Territorios con Riesgo Hídrico. Análisis comparado de situaciones en las ciudades de Resistencia y Corrientes. 2017. *In:* V WORKSHOP DE LA RED IBEROAMERICANA DE OBSERVACIÓN TERRITORIAL. VI SEMINARIO INTERNACIONAL DE ORDENAMIENTO TERRITORIAL. Mendoza. **RIUNNE** Colecciones, p. 1–22. 2017.

ALVES PRATES, H. Desigualdade ambiental no município de São Paulo: análise da exposição diferenciada de grupos sociais a situações de risco ambiental através do uso de metodologias de geoprocessamento. **Revista Brasileira de Estudos de População**, n. 24, v. 2, p. 301–316, 2007. Available at: DOI: 10.1590/ S0102-30982007000200008

BARRETO, M.; ALCALÁ, L.; BENITEZ, A.; FERNÁNDEZ, M.; GIRO, M.; PELLI, B.; ROMAGNOLLI, B. Áreas urbanas deficitarias críticas como unidades de interpretación y abordaje de los nuevos territorios periurbanos. *In:* KAROL *et al.*, (comp.) **Conducir las transformaciones urbanas**: un debate sobre direcciones, orientaciones, estrategias y políticas que modelan la ciudad futura. Universidad Nacional de La Plata, 2014. Tomo II. E-Book. La Plata, Argentina.

BERNACHE PÉREZ, G. Riesgo de contaminación por disposición final de residuos: un estudio de la región centro occidente de México. Revista internacional de contaminación ambiental, n. 28, v.1, p. 99–107. 2012.

BIFFIS GONZÁLEZ, A.; ETULAIN, J.; DOMÍNGUEZ, M. Asentamientos informales en riesgo hídrico. Estrategias arquitectónicas y urbanísticas. Caso: Subcuenca del Arroyo del Gato, La Plata, Argentina. **Cuad. Urbano**, n. 33, v. 33, p. 22–47. 2022. Available at: https://dx.doi.org/https://doi.org/10.30972/crn.33336229

BRITES, W. **Ciudades, teorías e investigación urbana**: una aproximación a los procesos urbanos de Posadas y Encarnación. Buenos Aires: CICCUS, 2019.

BRITES, W. Settlements and habitat. The conditioning role of urban space in Posadas, Argentina. **Urbano**. Concepción, v. 25, n. 45, p. 30–41, 2022a. Available at: http://dx.doi.org/10.22320/07183607.2022.25.45.03.

BRITES, W. Incidencia de la quema de basura en la contaminación de Posadas, Argentina: un desafío para las políticas de cambio climático. **Revista de Ciencias Ambientales**, n. 56, v. 2, p. 17–37. 2022b. Available at: https://doi.org/10.15359/rca.56-2.2

CAPDEVIELLE, J. Espacio urbano y desigualdades: las políticas públicas y privadas en la ciudad de Córdoba, Argentina. (1990-2011). **Cuadernos Geográficos**, n. 53, v. 2, p. 135-158. 2014. Available at: https://doi.org/10.30827/cuadgeo.v53i2.2224

CASGRAIN, A.; JANOSCHKA, M. Gentrificación y resistencia en las ciudades latinoamericanas: el ejemplo de Santiago de Chile. **Andamios**, n. 10, v. 22, p. 19–44, 2013. Available at: https://doi.org/10.29092/uacm.v10i22.265

CONNOLLY, J.; ANGUELOVSKI, I.; OSCILOWICZ, E. **Toward the Next Mode of Practice for Climate Urbanism**: understanding and preventing greening-induced displacement. Lincoln Institute of Land Policy. Working Paper WP23JC1. Available at: https://www.lincolninst.edu/publications/working-papers/toward-next-mode-practice-climate-urbanism. Accessed on: 20 nov. 2023.

CURUTCHET, G.; GRINBERG, S.; GUTIÉRREZ, R. Degradación ambiental y periferia urbana: un estudio transdiciplinario sobre la contaminación en la región metropolitana de Buenos Aires. **Ambiente & Sociedade**, n. 15, v. 2, p. 173-194. 2012. Available at: https://doi.org/10.1590/S1414-753X2012000200010

D'HERS, V. Asentamientos sobre basurales a cielo abierto. Explotación, segregación y expulsión en el manejo de los residuos. **DELOS, Revista de Desarrollo Local Sostenible**, n. 6, v. 6, p. 1–27. 2013. Available at: https://core.ac.uk/download/pdf/158837131.pdf

DAGA, D.; ZULAICA, M.; VÁZQUEZ, P. Evaluación de la vulnerabilidad socio-ambiental del periurbano de Mar del Plata. **Estudios Socioterritoriales**, v. 18, p. 45–59. 2015.

DAVIS, M. **Planeta de ciudades miseria**. Madrid: Foca. 2007.

FERNANDES, E. Regularization of Informal Settlements in Latin America. **Policy Focus Report**. Lincoln Institute. Cambridge, MA, May 2011. Available at: https://www.lincolninst.edu/publications/policy-focus-reports/regularization-informal-settlements-in-latin-america. Accessed on: 15 sep. 2022.

FERNÁNDEZ, I.; KOPLOW-VILLAVICENCIO, T.; MONTOYA-TANGARIFE, C. Urban environmental inequalities in Latin America: a scoping review. **World Development Sustainability**, n. 2, p. 1–11. 2023. Available at: https://doi.org/10.1016/j.wds.2023.100055

FERRARO, R.; ZULAICA, L.; ECHECHURI, H. Perspectivas de abordaje y caracterización del periurbano de Mar Del Plata, Argentina. **Letras Verdes. Revista Latinoamericana de Estudios Socioambientales**, n. 13, p. 19-40. 2013. Available at: https://doi.org/10.17141/letrasverdes.13.2013.926.

FLACKE, J.; SCHÜLE, S.; KÖCKLER, H.; BOLTE, G. Mapping Environmental Inequalities Relevant for Health for Informing Urban Planning Interventions. A Case Study in the City of Dortmund, Germany. **Int. J. Environ. Res. Public Health***, n. 13, v. 711, p. 2-19. 2016*. Available at: https://doi.org/10.3390/ijerph13070711

GALINDO, C.; DELGADO, J. Los espacios emergentes de la dinámica rural-urbana. Problemas del desarrollo". **Revista Latinoamericana de Economía**, v. 37, n. 147, p. 187-216. 2006. Available at: https://www.redalyc.org/articulo.oa?id=11820100008

GARZÓN-DUQUE, M.; CARDONA-ARANGO, D.; RODRÍGUEZ-OSPINA F.; SEGURA-CARDONA, M. Perspectivas teóricas y metodológicas para el estudio del ambiente como determinante de la salud. **Rev. Fac. Nac. Salud Pública**, n. 34, v. 3, p. 350-358. 2016. Available at: https://doi.org/10.17533/udea.rfnsp.v34n3a09

GÓMEZ, N.; VELÁZQUEZ, G. Asociación entre los espacios verdes públicos y la calidad de vida en el municipio de Santa Fe, Argentina. **Cuadernos de Geografía: Revista Colombiana de Geografía**, n. 27, v. 1, p. 164-179. 2018. Available at: https://doi.org/10.15446/rcdg.v27n1.58740

HARVEY, D. **Justice, Nature and the Geography of Difference**. Oxford. Blackwell. 1996.

KRIEG, J.; FABER, D. Not so Black and White: environmental justice and cumulative impact assessments. **Environmental impact assessment review**. Elsevier Inc. n. 24, p. 667–694. 2004. Available at: https://doi.org/10.1016/j.eiar.2004.06.008

LONDON, S. Sobre el análisis de la pobreza urbana y el medio ambiente: una visión socioecológica. **Letras Verdes. Revista Latinoamericana de Estudios Socioambientales**, n. 24, p. 143-160. 2018. Available at: https://doi.org/10.17141/letrasverdes.24.2018.3306

MUNICIPALIDAD DE POSADAS. **Políticas Ambientales**. Available at: https://posadas.gov.ar/sustentable/girsu/ 2022. Accessed on: 9 sep. 2023.

NCAIR. "Respira... no quemes". Educación de Calidad de Aire. **División de Calidad de Aire de Carolina del Norte**. Carolina del Norte, mar. 2012. Available at: https://www.deq.nc.gov/water-quality/surface-water-protection/edu/obot-2017-spanish-curriculum-p1-45/download. Accessed on: 5 jul. 2020.

ORGANIZACIÓN MUNDIAL DE LA SALUD. Calidad del aire ambiente (exterior) y salud. **OMS**. Geneva 19 December. 2022. Available at: https://www.who.int/es/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health. Accessed on: 14 nov. 2023.

ORTIZ ESPEJEL, B.; ESPINOZA, M.; ANDRADE, B.; JIMÉNEZ, R. Vulnerabilidad socioambiental ante el cambio climático para el año 2020 en las provincias eclesiásticas de México. **Cuaderno de Investigación**. Ibero Puebla: CEAPE. 2015.

PI PUIG, A. Aportes para el estudio de las desigualdades ambientales. Un recorrido por la agenda internacional y los enfoques teóricos. *In:* ORTALE, S.; RAUSKY, M. (coord.). **Desigualdad en plural**: miradas, lecturas y estudios en el Gran La Plata. La Plata: UNLP-FHyCE. 2021. p. 53-96. Available at: https://www.libros.fahce.unlp.edu.ar/index.php/libros/ catalog/book/182. Accessed on: 7 oct. 2023.

PIERANGELI, I.; NIEUWENHUIJSEN, M.; CIRACH, M.; ROJAS-RUEDA, D. Health equity and burden of childhood asthma related to air pollution in Barcelona. **Environmental Research**, n. 186, p. 109-212. 2020. Available at: https://doi.org/10.1016/j.envres.2019.109067

REGISTRO NACIONAL DE BARRIOS POPULARES. Ministerio de Desarrollo Territorial y Hábitat. **RENABAP**. 2018. Available at: https://www.argentina.gob.ar/ barriospopulares. Accessed on: 14 feb. 2022.

SANTASUSAGNA RIU, A.; TORT DONADA, J. Agua y espacio urbano. Algunas consideraciones teóricas a propósito de la relación entre ciudad y río. **Documents d'Anàlisi Geogràfica**, v. 65, n. 2, p. 371-397. 2019. Available at: https://bibliotecas.net.ar/geoaccesoabierto/items/show/31479

SCHARAGER, A. Degradación ambiental en los márgenes urbanos. Los efectos sociales de una orden de relocalización en un barrio popular de Buenos Aires. **Revista Direito da Cidade**, v. 9, n. 3, p. 1147-1173. 2017. Available at: https://doi.org/10.12957/rdc.2017.28818

SHCAMBER, P.; SUÁREZ, F. **Recicloscopio III**: miradas sobre recuperadores urbanos, formas organizativas y circuitos de valorización de residuos en América Latina. Buenos Aires: UNLa-UNGS, CICCUS. 2011.

TRAVASSOS, L.; CAMPELLO TORRES, H.; DI GIULIO, G.; JACOBI, P.; DIAS DE FREITAS, E.; SIQUEIRA, I.; AMBRIZZI, T. Why do extreme events still kill in the São Paulo Macro Metropolis Region? Chronicle of a death foretold in the global south. **International Journal of Urban Sustainable Development**, v. 13, n. 1, p. 1-16. 2020. Available at: https://doi.org/10.1080/19463138.2020.1762197.

WALKER, G.; BULKELEY, H. Geographies of environmental justice. **Geoforum**, n. 37. p. 655–659. 2006. Available at: https://doi.org/10.1016/j.geoforum.2005.12.002.

ZULAICA, L.; VÁZQUEZ, P. Ciudades argentinas en el contexto del cambio climático: exploraciones para el análisis del riesgo y la resiliencia urbana. **Cuadernos de Geografía: Revista Colombiana de Geografía**, v. 30, n. 2, p. 396-417. 2021. Available at: https://doi.org/10.15446/rcdg.v30n2.87584.

Dynamics of the natural regeneration of forest remnants in the state of São Paulo, Brazil

Dinâmica da regeneração natural de remanescentes florestais no estado de São Paulo, Brasil

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ARTICLE-VARIA

ABSTRACT

The main factors that favour the regeneration of native vegetation in two regions in southeast Brazil were evaluated over an approximate period of 30 years. Region 1 covers 5.2 million hectares and is situated in the northern and northeastern portions of São Paulo. Region 2, located in eastern São Paulo, is formed by the Paraíba do Sul River basin and spans over 1.4 million hectares. In 2016, the area of native forests in Region 1 accounted for 19.3% of the territory against 16.9% in 1988. In Region 2, forests expanded by 83%, from 250,000 to 455,000 hectares. However, while in Region 1, characterised by competition between agricultural crops, the forest gain was modest, in Region 2, marked by steep terrain and a decline in livestock activities, significant natural forest regeneration was favoured. Restoration of native forest vegetation in the state of São Paulo may vary significantly over regions.

Keywords: Forest restoration. Geotechnology. Change in land use and cover.

RESUMO

Os principais fatores que favorecem a regeneração da vegetação nativa foram avaliados em duas regiões paulistas para um período aproximado de 30 anos. A Região 1, com 5,2 milhões de hectares, está localizada no norte e nordeste paulista. A Região 2, com 1,4 milhão de hectares, está localizada no leste paulista e é formada pela Bacia do Rio Paraíba do Sul. A área das florestas nativas da Região 1 em 2016 representou 19,3% do território ante 16,9% em 1988. Na Região 2, houve aumento de 83% das florestas, de 250 mil para 455 mil hectares. Enquanto na Região 1, caracterizada pela competição entre culturas agrícolas, o ganho florestal foi pequeno, na Região 2, caracterizada pela presença acentuada de áreas declivosas e retração das atividades pecuárias, houve expressiva regeneração natural das florestas. O restabelecimento da vegetação florestal nativa no estado de São Paulo pode variar significativamente nas diferentes regiões.

Palavras-chave: *Recomposição florestal. Geotecnologia. Mudança de uso e ocupação da terra.*

1 INTRODUCTION

Native forest vegetation has been cleared to make way for agricultural activities since the beginning of the 20th century (Solórzano *et al.*, 2021). However, from the mid-1970s onward, a large part of the inland of the state of São Paulo began to experience land use and land cover changes exclusively between agricultural and livestock uses, i.e., no longer involving the clearing of forests for the opening of new fields (Rudorff *et al.*, 2010; Sparovek *et al.*, 2007).

Since 1990/92, a series of mappings initiated by the São Paulo Forest Institute (Instituto Florestal, in Portuguese) through the Forest Inventory project has shown the evolution of native vegetation cover in the state. In 2020, the vegetation cover in the state of São Paulo reached 5,670,532 ha of native vegetation in various stages of restoration and featuring significant fragmentation, altogether an area equivalent to 22.9% of the state's territory (Nalon et al., 2022). Despite the increased number of vegetation fragments in the Mata Atlântica biome (Atlantic Forest) throughout Brazil, more than 97% of these fragments are smaller than 50 ha and mean fragments decreased to 16 ha (Vancine *et al.*, 2023).

This new phenomenon, portrayed by a decrease in deforestation rates for the Atlantic Forest biome in São Paulo from the 1990s onwards, began to occur because, in addition to the relatively small amount of forest remnants, there was an effort by the State to curb deforestation by means of greater control and inspection, rural environmental policies of São Paulo municipalities, fines against illegal deforestation, and respect for environmental laws and instruments, including the Brazilian Federal Constitution of 1988, the Brazilian Forest Code (no. 12.651/2012), and the Atlantic Forest Law (*Lei da Mata Atlântica*, no. 11.428/2006), the only one to protect a biome (Brancalion *et al.*, 2012; Giglio *et al.*, 2013; Vancine *et al.*, 2023). Other factors contributing to preservation were tourism, cultural industry, and the development of initiatives to include populations that make sustainable use of resources (Silva *et al.*, 2020).

Not only has the deforestation rate decreased, there have also been some forest gains due to the spontaneous recolonisation of secondary native vegetation, not to active reforestation (Bicudo da Silva *et al.*, 2023; Silva *et al.*, 2020). Natural regeneration (spontaneous or assisted recovery of native tree species that colonise and establish themselves in abandoned or unmanaged agricultural or pasture areas) has shown ecological and economic results that are similar to or more satisfactory than those obtained by active restoration in tropical forests (Crouzeilles *et al.*, 2017; Inhamuns *et al*., 2021; Zanini *et al*., 2021).

Data from the latest mapping of native vegetation cover in the state of São Paulo (Nalon *et al*., 2022) show a net increase of 4.9%, or approximately 214,000 hectares, in 10 years. With the net gains in native forest cover over a broader base of São Paulo cities, some studies suggest the occurrence of a

so-called 'Forest Transition' in the state of São Paulo (Calaboni *et al.*, 2018; Molin *et al.*, 2017; Silva *et al.*, 2018).

However, the use and occupation of lands in different regions of the state of São Paulo is very diverse and may show different forest dynamics. In its inland, where the Cerrado and Atlantic Forest biomes are present, occupation occurs mainly by agricultural crops linked to agribusiness. These crops compete with each other for space, influenced by the expansion of sugarcane areas in flatter terrains and more fertile soils (Ferreira *et al.*, 2015; Rudorff *et al.*, 2010; Sparovek *et al.*, 2007).

The regions closest to the coast or the Serra da Mantiqueira and Serra do Mar mountain ranges, within the Atlantic Forest biome, feature rugged terrain, which makes it difficult to manage agricultural crops and are therefore occupied mainly by anthropic cultivated pastures in small and medium-sized rural properties where native forests develop in a considerable portion of the area (Calaboni *et al.*, 2018; Molin *et al.*, 2017; Silva *et al.*, 2020).

Forest recovery or loss processes are distinct in different regions of the state of São Paulo, and understanding them better is necessary. This study aims to identify the biophysical factors related to deforestation, the expansion of agriculture and livestock, and the recovery of native forests in the state of São Paulo in these two regions. The study covers the evolution of these regions over time (about 30 years): one is a place characterised by competition for land between agribusiness sectors, and the other is a region with predominantly irregular terrains and which has livestock as its main agricultural activity. Understanding the factors associated with these processes enables exploring future scenarios of land use changes and their consequences for native forest cover and supporting the establishment of public policies focused on nature conservation and agricultural production.

2 MATERIAL AND METHODS

2.1 STUDY AREAS

The Region 1 delimited in this study is composed of the whole or part of the river basins: Baixo Pardo Grande, Mogi-Guaçu, Pardo, Piracicaba/Capivari/Jundiaí, Sapucaí Grande, Tietê/Batalha, Tietê/Jacaré and Turvo-Grande. This area accounts for 5.2 million hectares or 20.5% of São Paulo's territory and comprises 125 cities (Figure 1). The original vegetation cover of this whole area is predominantly Cerrado and Atlantic Forest biomes, and its terrain varies mostly between flat, gently undulating, and undulating, with slopes varying between 0% and 20%. The region is currently occupied by agroforests linked to agribusiness, such as pastures, eucalyptus, citrus, and large grain crops, which are especially influenced by the expansion of sugarcane areas that have been gaining ever more space (Ronquim; Fonseca, 2018).

Region 2 is located in the São Paulo portion of the Paraíba do Sul River basin and encompasses 34 cities. It has an area of 1.4 million hectares and is situated between two mountain ranges, known as Serra da Mantiqueira and Serra do Mar. The basin is located in the Atlantic Forest biome, in a landscape characterised by 'seas of hills' (Figure 1). Its flat areas or gently undulating reliefs are concentrated in the lower part of the valley and have as their main axis the Paraíba do Sul River, which the Presidente Dutra Federal Highway parallels along much of its length. The Presidente Dutra Highway is the region's main transportation axis and connects Brazil's most important metropolitan areas, the São Paulo-Rio de Janeiro axis (Calaboni *et al.*, 2018; Ronquim *et al.*, 2016).

2.2 MAPPING LAND USE AND LAND COVER AND TERRAIN SLOPE

For Region 1, the analysis period covered the years 1988 and 2016, while for Region 2, it spanned from 1985 to 2015 due to their association with scientific studies and projects produced in different periods.

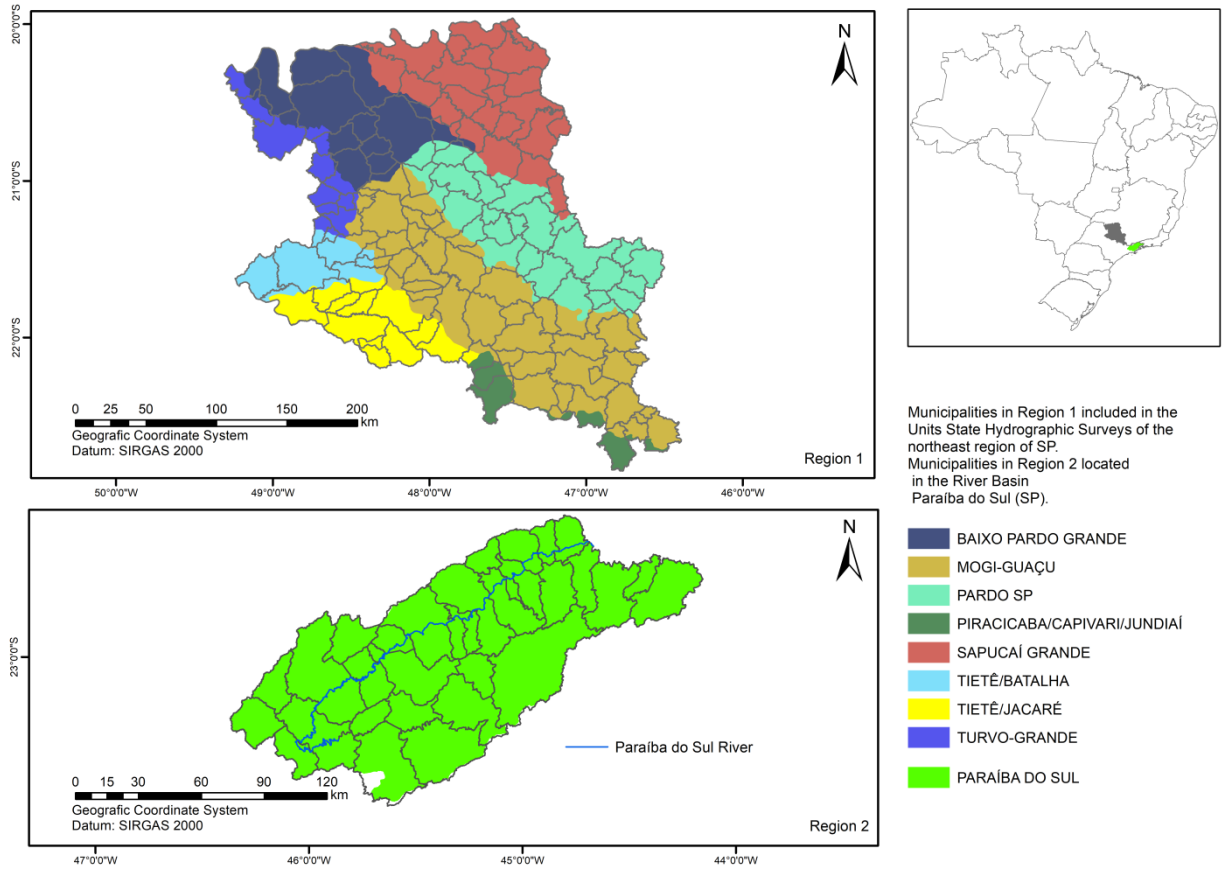

Figure 1 – Maps showing the geographic location of: Region 1 (5.2 million hectares), composed of the whole or part of the river basins Baixo Pardo Grande, Mogi-Guaçu, Pardo, Piracicaba/Capivari/Jundiaí, Sapucaí Grande, Tietê/Batalha, Tietê/Jacaré, and Turvo-Grande; and Region 2 (1.4 million hectares), composed of the Paraíba do Sul River basin

Source: Authors' elaboration.

In the case of Region 1, for the year 1988, the mapping was made using orbital images from the Landsat 5 Thematic Mapper (TM) satellite, RGB321 bands in the visible spectrum, with a spatial resolution of 30 m, and the following orbit-point combinations: 219/75, 219/76, 220/74, 220/75, 220/76, 221/74, and 221/75. After importing and preparing the images in the ArcGIS 10.5 analysis software, land-use classes were mapped by visual interpretation (Ronquim; Fonseca, 2018). For the year 2016, sugarcane crop areas were classified by updating the base maps generated by the Canasat Project (Rudorff *et al.*, 2010). This involved on-screen, visual interpretation of high-resolution images from the Google Earth Pro software and the inclusion of these new areas occupied by the crop into the computational environment. This was achieved by using mapping software, comparing and adding them to the database by means of digitisation, and filling out the attribute table.

For Region 2, for the land use and land cover mapping of 2015, we used a pair of Landsat-8 (Operational Land Imager - OLI) images, orbit-point scenes 218/76 and 219/76, which were pre-selected for their lack of significant cloud cover. These two Landsat-8 images covered the entire study area of the Paraíba do Sul River (Figure 1). For the land use and land cover mapping of 1985, we used a set of Landsat 5 Thematic Mapper (TM) images, which were part of the historical archive. The images available

on the GloVis Geological Survey platform were generated using Level 1T processing (USGS). Image preprocessing involved atmospheric correction using the Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes (Flaash) algorithm. Following atmospheric correction, the images were segmented using the parameters: Segmentation Algorithm, Edge; Scale Level, 30; Merging Algorithm, Full Lambda Schedule; and Merge Level (implemented in ENVI 5.1), Feature-Based Extraction. A Texture Kernel Size filter was maintained at 3x3 pixels.

The training dataset was collected using visual interpretation of high spatial resolution images available on the Google Earth platform. For each scene, a different number of random samples was selected for each land use and land cover class, as each Landsat-8 image used for mapping in the year 2015 covered different percentages of the study area: scene 219/76 covered approximately 35% of the Paraíba do Sul River basin in the state of São Paulo, while scene 218/76 covered the remaining 65%. Approximately 1,000 samples were collected for each class in the land use and land cover classification to assess the overall accuracy of scene 218/76, and 200 samples from each class were collected for scene 219/76. Based on the total training dataset for each Landsat-8 image, we randomly allocated 90% for training and classification procedures and reserved the remaining 10% for accuracy assessment. The maximum likelihood supervised classification algorithm was used for the classification procedure.

In addition to the land use and land cover map for Region 1, a majority filter procedure was applied with a window size of 3x3 pixels to reassign a land use and land cover class to the centre of the 3x3 window. After the mosaic, the mapping results of both scenes' mapping were evaluated using an independent set of 100 samples for each land use and land cover class. These samples were selected by visual interpretation of high spatial resolution images from Google Earth to assess the accuracy of the mapping.

The DEM (Digital Elevation Model) based on data from the Shuttle Radar Topography Mission (SRTM, NASA) was used to generate the slope percentage map for both study regions, with a spatial resolution of 30.0 m. The Slope tool from the Spatial Analyst extension in the ArcGIS 10.5 software was also employed. Subsequently, the Reclassify geoprocessing tool was used to create a reclassified raster file based on slope classes: 0% to 12% (flat to gently undulating), 12% to 20% (gentle undulating to undulating), 20% to 75% (undulating to hilly), and greater than 75% (steep). Once the slope map was obtained, a spatial overlay was performed with the land use and land cover map to determine the location of these categories within their respective slope classes for all the cities studied. Then, the Tabulate Area tool in the ArcGIS software was used to extract, by city, the respective areas in hectares for this set of information layers. This study focuses on analysing the classes of native tree vegetation areas and their spatiotemporal regeneration in both study regions.

3 RESULTS AND DISCUSSION

The clearing of lands for new agricultural crops and livestock has contributed to the destruction of the native flora in the state of São Paulo since the 19th century. The use of numerous controlled burns to clear forests and make way for pastures hindered forest regeneration and helped establish an anthropic landscape that currently predominates over a significant portion of the lands in the two evaluated regions (Rudorff *et al.*, 2010). Both these areas went through these phases of forest exploitation.

Since the 1980s, the landscapes of Regions 1 and 2 had already been predominantly characterised by anthropic agricultural use. Region 1 was already occupied by large-scale monocultures competing for space, with a notable expansion of sugarcane areas and a significant decrease in pasture areas (Figure 2 and Table 1). Region 2 was characterised by extensive pasture cultivation (Figure 2 and Table 1), even on steep terrain (Table 2 and Figure 3).

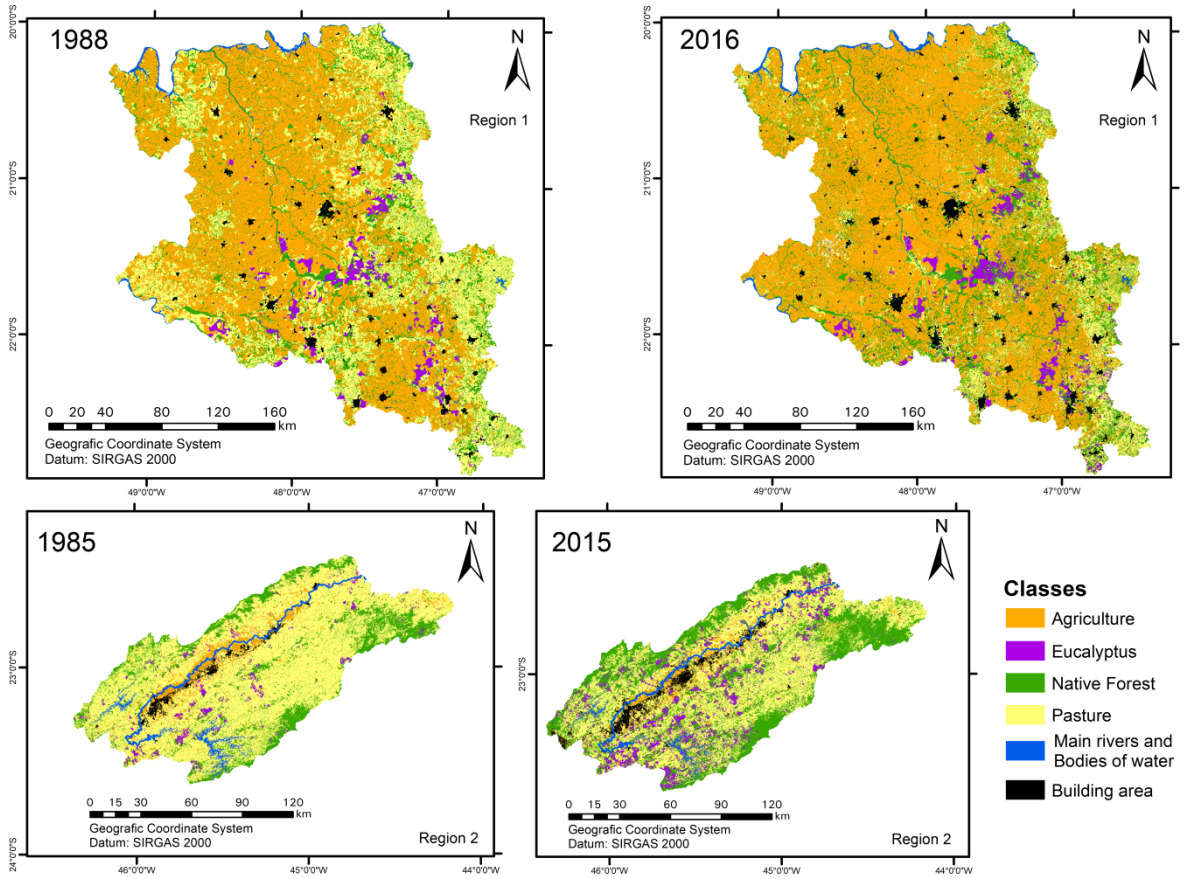

Figure 2 – Maps depicting the dynamics of land use and land cover change in areas of native forest, pasture, agriculture, eucalyptus, built-up areas, and water bodies in Region 1 (5.2 million hectares) for the years 1988 and 2016, and in Region 2 (1.4 million hectares) for the years 1985 and 2015

Source: Authors' elaboration.

In Region 1, agricultural areas showed the most significant expansion. The expansion of sugarcane fields was the primary driver of land use and land cover change, mainly encroaching upon pastures and areas previously occupied by annual crops, similar to many other regions in São Paulo's inland (Ferreira *et al.*, 2015; Ronquim; Fonseca, 2018; Rudorff *et al.*, 2010; Sparovek et al., 2007). During this same period, there was an increase in the area occupied by eucalyptus and built-up areas (Table 1). Native forests in 2016 accounted for 19.3% of the area, compared to 16.9% in 1988, and grew from 872,000 ha to 998,000 ha (Table 1), a 14.5% increase in native forest cover.

In Region 2, beef and dairy production pastures accounted for the largest land cover in 2015: 651,000 ha. However, over 30 years, this area decreased by 31% (Table 1). During these 30 years, pastures gave way to eucalyptus reforestation, which now occupies 8.1% of the basin area (Table 1). Eucalyptus crops for cellulose production were established in the region in the 1960s, and a significant portion of the pulp produced is sold to markets in China and Europe (Ronquim *et al.*, 2016). The growing global demand for sustainable products has compelled companies to adhere to specific environmental management standards and practices to achieve environmental certification, which has had a positive impact on the recovery of native forests in the surrounding areas (Bicudo da Silva *et al.*, 2023; Silva *et al.*, 2020; Vancine *et al.*, 2023). Areas occupied by native forests increased substantially, from 249,542 ha to 455,232 ha, i.e., an 82% gain over 30 years, totalling 205,690 ha of additional native forest area (Table 1).

Table 1 – Amount of areas, in hectares (ha) and percentage (%), covered with native forest, agriculture, pasture, eucalyptus, built-up areas and water bodies in 1988 and 2016 in Region 1 and 1985 and 2015 in Region 2

Change in Land Use and Cover	Region 1				Region 2			
	1988		2016		1985		2015	
	thousand ha	(%)	thousand ha	(%)	thousand ha	(%)	thousand ha	(%)
Native Forest	872.1	16.9	998.8	19.3	249.5	17.9	455.2	32.6
Agriculture	2,580.2	49.9	3,079.5	59.6	102.0	7.4	83.7	6.0
Pasture	1,410.6	27.3	692.6	13.4	946.4	67.7	651.2	46.7
Eucalyptus	139.6	2.7	159.3	3.1	35.2	2.5	113.6	8.1
Built-up Areas	90.6	1.8	166.4	3.2	38.5	2.8	63.6	4.6
Water Bodies	77.5	1.5	74.1	1.4	24.4	1.7	28.7	2.1
Total	**5,170.6**	**100**	**5,170.6**	**100**	**1,395.9**	**100**	**1,395.9**	**100**

Source: Authors' elaboration.

Although in Region 1 agriculture no longer competes with native vegetation, the percentage increase in native forest cover, 14.5% over 30 years, was small compared to what was achieved in Region 2. Region 1, known as the country's main sugarcane centre, has witnessed significant changes in land use and land cover dynamics in recent decades, primarily driven by the expansion of sugarcane areas (Molin *et al.*, 2017; Rudorff *et al.*, 2010).

In two other studies on the dynamics of natural forest regeneration in an area of approximately 25,000 square kilometres in the northwest (FERREIRA *et al.*, 2015) and central-south (Silva *et al.*, 2018) portions of the state of São Paulo, characterised by sugarcane cultivation, the percentage of forest gain was also small, even smaller than what was observed in Region 1. Silva *et al.* (2018) considered the occurrence of a significant forest transition in the region; however, the increase in forest cover in this part of São Paulo's inland may be primarily explained by the expansion of commercial eucalyptus plantations, which were not considered as an expansion of native forest cover in this study, as they are non-native commercial plantations.

The areas in Region 1 are mostly flat: 83% have slopes of up to 12% (Table 2). However, the increase in native forests in this region was more significant on slopes greater than 12%, as only 17% of the basin area with such slopes concentrated approximately 46% of the native vegetation. Slope plays a more significant role in natural regeneration in areas occupied by mechanised agriculture (Molin *et al.*, 2018), which is consistent with the machinery operations for sugarcane production, the dominant crop in the region, which requires slopes below 12% for mechanised management (Rudorff *et al.*, 2010).

The native forest vegetation in Region 1 is primarily concentrated near the border with the state of Minas Gerais or following the direction of the Paulista basaltic cuestas (Figure 3). Both the region near southern Minas Gerais and the cuestas (plateaus) areas are characterised by steep terrain that has either ceased to be used for agriculture and livestock or is minimally managed. This situation favours the retention or recolonisation of native forest vegetation on the escarpments.

Table 2 – Slope classes with the total area of all land use within each slope category and increase in native forest cover over a period of approximately 30 years in Region 1 and Region 2

River Basins	Slope classes	Total Area		Increase in Native Forest	
	(%)	thousand ha	(%)	thousand ha	(%)
Region 1	0 - 12	4,309.0	84.4	65.3	53.6
	12 - 20	549.5	10.3	25.2	20.5
	20 - 75	306.2	5.2	31.2	25,7
	> 75	0.01	0.1	0.8	0.07
	Total	**5,170.6**	**100**	**122.5**	**100**
Region 2	0 - 12	336.4	24.2	31.2	14.8
	12 - 20	234.4	16.8	30.1	14.1
	20 - 75	814.6	58.2	141.9	70.0
	> 75	11.5	0.8	2.5	1.1
	Total	**1,395.9**	**100**	**205.7**	**100**

Source: Authors' elaboration.

The 54% increase in native forest cover, even on small slopes of up to 12% (Table 2), likely represents the regularisation of permanent preservation areas (APP), especially along riverbanks and legal reserve (RL) areas, carried out by the sugarcane sector, the main landholders of sugarcane areas.

Large sugarcane areas owned by agro-industries are subject to greater environmental scrutiny by public authorities, requiring them to regularise their areas through reforestation and to reduce cultivated land boundaries to establish APPs along riverbanks. Environmental regularisation has led to the restoration of riparian forests along lakes, rivers and springs and has significantly increased forest cover within many rural properties in São Paulo over the last two decades, particularly those cultivated with sugarcane (Rother *et al.*, 2018).

The significant increase in forested areas in the cities of Region 2 did not result from planting new trees but rather from the natural regeneration of vegetation in areas where agriculture and livestock are not competitive, primarily on steep terrain. In Region 2, approximately 59% of the total area is dominated by slopes with gradients exceeding 20% (Table 2), which are rugged terrains challenging for agricultural crops and mechanisation. These areas account for 71% of the forest increase observed over the approximately 30-year period assessed.

Region 2 is primarily suited for extensive pasture cultivation and is responsible for meat and milk production. However, even livestock farming faces challenges regarding production profitability on such uneven terrain and has been struggling to remain competitive with other regions in Brazil that are more suitable (Novo *et al.*, 2012; Silva *et al.*, 2018).

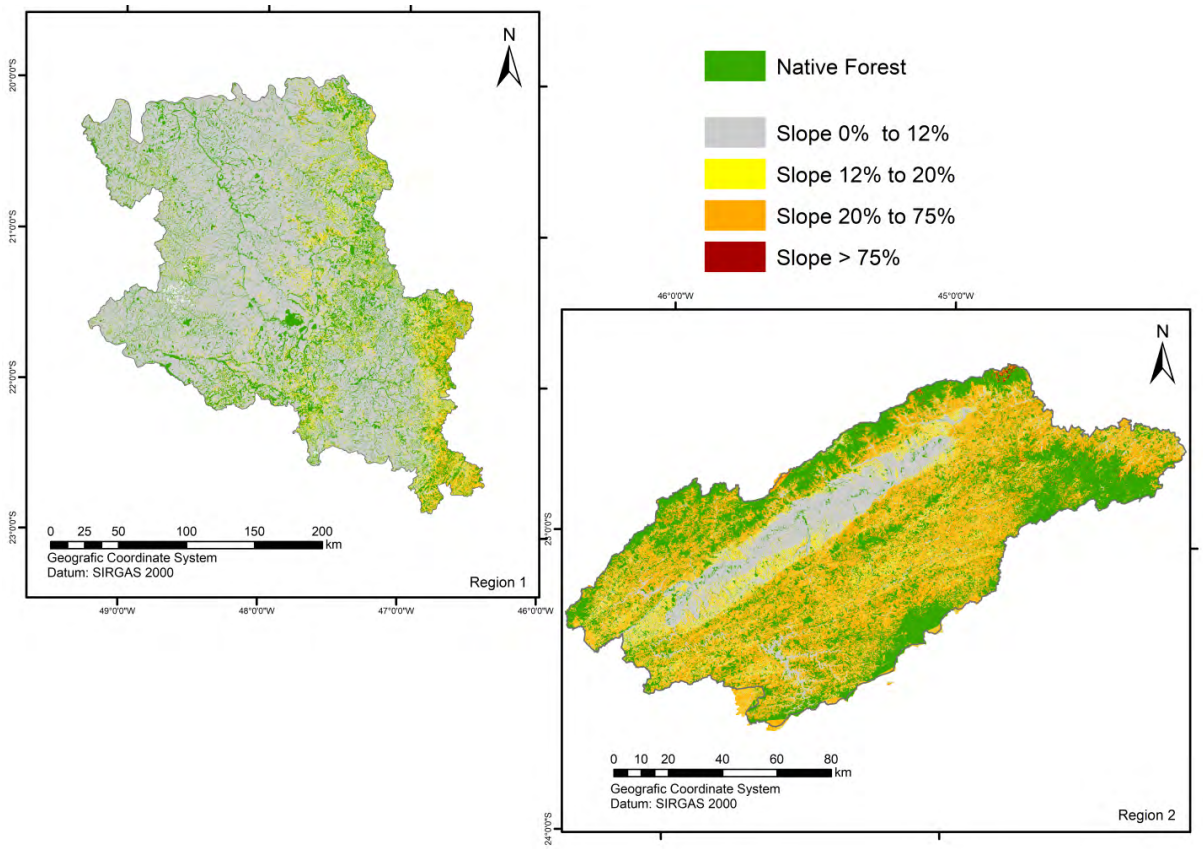

Figure 3 – Slope classes with the distribution of native forest area in Regions 1 and 2.

Source: Authors' elaboration.

Low profitability of the dairy sector, increased quality standards required by dairy industries, and difficulties in hiring and finding qualified labour, among other factors, make it challenging for rural landowners to sustain this activity (Novo *et al.*, 2012). Reduced investments by cattle ranchers contribute to less management in areas less suitable for grazing, such as hilltops and steeper slopes, which favours the regeneration of native vegetation (Ronquim *et al.*, 2016). Current environmental laws also impose restrictions that hinder the cutting or burning of 'capoeira' (secondary growth) that forms in these unmanaged areas (Brancalion *et al.*, 2012; Molin *et al.*, 2018; Rother *et al.*, 2018; Vancine *et al.*, 2023). Consequently, the abandonment of pasture areas favours the return of native tree vegetation.

According to Ronquim *et al.* (2016), the regeneration of native vegetation in the landscape of the Paraíba River Valley in São Paulo (Region 2) is primarily related to the abandonment of areas with topography unsuitable for mechanised agriculture, rural population migration to large urban centres, and environmental preservation projects involving eucalyptus cultivation.

Eucalyptus cultivation is one of the few forms of commercial exploitation that has managed to establish itself in the Paraíba do Sul River Basin despite the steep terrain. Areas of rural properties with eucalyptus crops in the Paraíba do Sul River Basin have shown an increase in native forest areas (Ronquim *et al.*, 2016). Unlike sugarcane crops, eucalyptus reforestation is naturally more environmentally friendly and conducive to native forest regeneration (Leite *et al.*, 2020; Molin *et al.*, 2017). Silvicultural companies that use eucalyptus as raw material follow a rigorous protocol of commercial certifications based on sustainable development, contributing to the export of timber and paper products and ensuring compliance with environmental legislation (Leite *et al.*, 2020).

Molin *et al.* (2017), while studying sub-basins of the Piracicaba River (1.3 million hectares) in São Paulo's inland, also found distinct patterns of native vegetation regeneration. In areas predominantly

covered by sugarcane, there was a loss of native forest cover. However, native forests increased in the sub-basins of the Atibaia River, where more rugged terrain prevailed, cultivated with pastures and, in some cases, eucalyptus.

Forest cover increased in both regions studied. However, even though Regions 1 and 2 are located within the state of São Paulo and are subject to the same restrictive environmental laws due to market influences, rural exodus, labour shortages, and other factors which are characterised as important for the forest transition hypothesis (Bicudo da Silva *et al.*, 2023; Calaboni *et al.*, 2018; Molin *et al.*, 2017; Silva *et al.*, 2018), the more significant percentage of return of native vegetation occurred only in the Paraíba do Sul River basin.

This vegetation that has emerged from natural regeneration in abandoned tropical agricultural landscapes due to a lack of management has shown ecological, economic, and carbon sequestration results that are similar to or even more satisfactory than active restoration processes (Crouzeilles *et al.*, 2017; Inhamuns *et al.*, 2021; Zanini *et al.*, 2021).

If the relief of the Paraíba do Sul river basin were favourable to agricultural crops, it would likely be occupied by agricultural cultures that require more and more area, such as sugarcane, which has expanded extensively in São Paulo's inland, and secondary native vegetation would not have spontaneously recolonised the landscape.

4 CONCLUSIONS

The re-establishment of native forest vegetation in the state of São Paulo varies significantly in different regions and depends mainly on the interactions between biophysical terrain characteristics and economic activities. This can potentially hinder the cultivation and occupation by agricultural crops. In Region 1, the native forests grew from 872,000 ha to 998,000 ha, a 14.5% increase in native forest cover. In Region 2, areas occupied by native forests increased substantially, from 249,542 ha to 455,232 ha, i.e., an 82% gain over 30 years. The predominant presence of steep and unsuitable terrain for commercial agriculture in the Paraíba do Sul river basin was the primary factor influencing its non-occupation by large agribusiness-related crops. Instead, the region has been primarily used for cattle farming, which in recent years has shown signs of economic decline, resulting in the loss of large areas to secondary native forests, particularly in higher and steeper areas.

For the entire state of São Paulo, increases in secondary native forest cover are expected in the coming years. This multifaceted phenomenon will depend on both conservation policies and the relationship between society and the environment, and these factors represent possibilities for additional studies. This process is likely to occur as lands unsuitable for agriculture on steep terrain become increasingly recolonised by native vegetation, as more non-agricultural rural activities emerge alongside multifunctional landscape activities, and as permanent preservation (APP) and legal reserve (RL) areas on rural properties, as defined by the Brazilian Rural Environmental Registry (CAR), are truly and effectively reforested or recolonised by native vegetation (a requirement of the New Forest Code, Law No. 12,651 of May 25, 2012), which has not yet occurred to a large extent.

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REFERENCES

BICUDO DA SILVA, R. F.; MORA, N. E.; VIÑA, A.; MILLINGTON, J. D. A.; DOU, Y.; VIEIRA, S. A.; LOPEZ, M. C.; LIU, J. Toward a forest transition across the Brazilian Atlantic Forest biome. **Frontiers in Forests and Global Change**, v. 6, 2023. DOI: 10.3389/ffgc.2023.1071495.

BRANCALION, P. H. S.; GARCIA, L. C.; LOYOLA, R.; RODRIGUES, R. R.; PILLAR, V. D.; LEWINSOHN, T. M. A critical analysis of the Native Vegetation Protection Law of Brazil (2012): updates and ongoing initiatives. **Natureza e Conservação**, v. 14, n. S1, p. 141-15, 2016. DOI: 10.1016/j.ncon.2016.03.003.

CALABONI, A.; TAMBOSI, L. R.; IGARI, A. T.; FARINACI, J. S.; METZGER, J. P.; URIARTE, M. The forest transition in São Paulo, Brazil: historical patterns and potential drivers. **Ecology and Society**, v. 23, n. 4, 2018. DOI: https://doi.org/10.5751/ES-10270-230407.

CROUZEILLES, R.; FERREIRA, M. S.; CHAZDON, R. L.; LINDENMAYER, D. B.; SANSEVERO, J. B.; MONTEIRO, L.; IRIBARREM, A.; LATAWIEC, A. E.; STRASSBURG, B. B. Ecological restoration success is higher for natural regeneration than for active restoration in tropical forests. **Science Advances**, v. 3, n. 1, e1701345, 2017. DOI: 10.1126/sciadv.1701345.

FERREIRA, M. P.; ALVES, D. S.; SHIMABUKURO, Y. E. Forest dynamics and land-use transitions in the Brazilian Atlantic Forest: the case of sugarcane expansion. **Regional Environmental Change**, v.15, p. 365–377, 2015. DOI: 10.1007/s10113-014-0652-6.

GIGLIO, E.; LUIZ, A.; NAJBERG, E. As relações sociais como fatores determinantes na rede de implementação de políticas ambientais rurais: investigação a partir de alguns municípios do estado de São Paulo. **Revista Desenvolvimento em Questão**, v.11, n. 24, p.169-203, 2013. Available in: http://www.redalyc.org/articulo.oa?id=75229296007.

INHAMUNS, M. C.; DE SOUZA REZENDE, R.; COELHO, G. C. Restoring riparian forest in the Atlantic Forest: does planting seedlings make a difference? **Restoration Ecology**, v. 29, n. 4, e13356, 2021. DOI: https://doi.org/10.1111/rec.13356.

LEITE, M. S.; SILVA JUNIOR, J. A.; CALABONI, A.; IGARI, A. T. Fatores socioeconômicos e a vegetação nativa em imóveis rurais no estado de São Paulo. **Ambiente & Sociedade**, v. 23, 2020. DOI: https://doi.org/10.1590/1809-4422asoc20170309r3vu2020L1AO.

MOLIN, P. G.; GERGEL, E.; SOARES-FILHO, B. S.; FERRAZ, S. F. B. Spatial determinants of Atlantic Forest loss and recovery in Brazil. **Landscape Ecology**, v. 32, p. 857–870, 2017. DOI: https://doi.org/10.1007/s10980-017-0490-2.

MOLIN, P. G.; CHAZDON, R.; FERRAZ, S. F. B.; BRANCALION, P. H. S. Data from: a landscape approach for optimising the cost-effectiveness of large scale for restrestoration. **Zenodo Digital Repository**, 2018. DOI: https://doi.org/10.5281/zenodo.1256029.

NALON, M. A.; MATTOS, I. F. A.; FRANCO, G. A. D. C. **Inventário da cobertura vegetal nativa do estado de São Paulo**. São Paulo, SP: SIMA/IPA. 2022. 238 p. Available in: https://adobeindd.com/view/publications/a5aba10f-0090-4109-ac1c-944c8260b1ff/57wk/publication-web-resources/pdf/INVENTARIOflorestal_livroFINAL.pdf.

NOVO, A.; JANSEN, K.; SLINGERLAND, M. The sugarcane e biofuel expansion and dairy farmers' responses in Brazil. **Journal of Rural Studies**, v. 28, n. 4, p. 640-649. 2012. DOI: https://doi.org/10.1016/j.jrurstud.2012.07.004.

RONQUIM, C. C.; SILVA, R. F. B.; FIGUEIREDO, E. B.; BORDONAL, R. O.; TEIXEIRA, A. H. C.; COCHASRK, T. C. D.; LEIVAS, J. F. Carbon sequestrations sociated to the land-use and land-cover changes in the forestry sector in Southern Brazil. **Proceedings of Spie**, v. 9998, p. 1-14, 2016.

RONQUIM, C. C.; FONSECA, M. F. **Avanço das áreas de cana-de-açúcar e alterações em áreas de agropecuária no interior paulista**. Campinas, SP: Embrapa Territorial, 2018. p. 48. (Embrapa Territorial. Documentos, 123).

ROTHER, D. C.; VIDAL, C. Y.; FAGUNDES, I. C.; SILVA, M. M. da.; GANDOLFI, S.; RODRIGUES, R. R.; NAVE, A. G.; VIANI, R. A. G.; BRANCALION, P. H. S. How legal-oriented restoration programs enhance landscape connectivity? Insights from the Brazilian Atlantic Forest. **Tropical Conservation Science**, v. 11, p. 1-9, jul. 2018. DOI: 10.1177/1940082918785076.

RUDEL, T. K.; COOMES, O. T.; MORAN, E.; ACHARD, F.; ANGELSEN, A.; XU, J.; LAMBIN, E. Forest transitions: towards a global understanding of the land use change. **Global Environmental Change**, v. 15, n. 1, p. 23-31, 2005. DOI: https://doi.org/10.1016/j.gloenvcha.2004.11.001.

RUDORFF, B. F. T.; AGUIAR, D. A.; SILVA, W. F.; SUGAWARA, L. M.; ADAMI, M.; MOREIRA, M. A. Studies on the rapid expansion of sugarcane for ethanol production in São Paulo State (Brazil) using Landsat Data. **Remote Sensing**, v. 2, n. 4, p. 1057-1076, 2010. DOI: https://doi.org/10.3390/rs2041057.

SILVA, A. L.; DIOGENES, S. A.; FERREIRA, M. P. Landsat-Based Land Use change assessment in the Brazilian Atlantic Forest: forest transition and sugarcane expansion. **Remote Sensing**, v. 10, n. 7, 2018. DOI:10.3390/rs10070996.

SILVA, R. F. B.; MILLINGTON, J. D. A.; MORAN, E. F.; BATISTELLA, M.; LIU, J. Three decades of land-use and land-cover change in mountain regions of the Brazilian Atlantic Forest. **Landscape and Urban Planning**, v. 204, 2020. DOI: https://doi.org/10.1016/j.landurbplan.2020.103948.

SOLÓRZANO, A.; BRASIL, L. S. C. DE A.; DE OLIVEIRA, R. R. The Atlantic Forest Ecologica History: from pre-colonial times to the anthropocene. *In:* MARQUES, M. C. M.; GRELLE, C. E. V. (ed.). **The Atlantic Forest**: history, biodiversity, threats and opportunities of the mega-diverse forest. Springer International Publishing, p. 25–44, 2021. DOI: 10.1007/978-3-030-55322-7_2.

SPAROVEK, G.; BARRETTO, A.; BERNDES, G.; MARTINS, S.; MAULE, R. Environmental, land use and economic implications of Brazilian sugarcane expansion 1996–2006. **Mitigation Adaptation Strategies Global Change**, v. 14, n. 3, p. 285–298. 2009. DOI: 10.1007/s11027-008-9164-3.

VANCINE, M. H.; MUYLAERT, R. L.; NIEBUHR, B. B.; OSHIMA, J. E. F.; TONETTI, V.; BERNARDO, R.; DE ANGELO, C.; ROSA, M. R.; GROHMANN, C. H.; RIBEIRO, M. C. The Atlantic Forest of South America: spatiotemporal dynamics of remaining vegetation and implications for conservation. **bioRxiv**, 2023. DOI: https://doi.org/10.1101/2023.09.16.558076.

ZANINI, A. M.; MAYRINCK R. C.; VIEIRA, S. A.; CAMARGO, P. B.; RODRIGUES, R. R. The effect of ecological restoration methods on carbon stocks in the Brazilian Atlantic Forest. **Forest Ecology and Management**, v. 481, 2021. DOI: https://doi.org/10.1016/j.foreco.2020.118734.

Unlocking the sustainable livelihoods strategy for forest communities in the southern slope of Mount Slamet, Indonesia

Explorando as estratégias de subsistência sustentável em comunidades florestais na encosta sul do Monte Slamet, Indonésia

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ABSTRACT

Mount Slamet in Central Java Province, Indonesia, boasts significant biodiversity potential, yet communities on its southern slope grapple with poverty. This study delves into sustainable livelihood strategies for these communities. Employing participatory rural appraisal methods engages residents in identifying issues and devising solutions. Findings advocate for agrosilvopasture as a viable livelihood, blending crop farming, silviculture, and animal husbandry to balance environmental preservation with economic advancement. Additionally, the study underscores the importance of capacity-building within local communities, emphasizing skill and knowledge enhancement. By advocating community engagement and offering multifaceted sustainable livelihood strategies, this research enriches the discourse on sustainable development for forest communities residing on the southern slope of Mount Slamet.

Keywords: Sustainable livelihoods. Economic resilience. Participatory rural appraisal. Agrosilvopasture. Sustainable forest management.

RESUMO

O Monte Slamet, na Província de Java Central, Indonésia, possui um significativo potencial de biodiversidade, no entanto, as comunidades que residem em sua encosta sul enfrentam a pobreza. Este estudo investiga estratégias de subsistência sustentável para essas comunidades. Utilizando métodos participativos de avaliação rural, envolve os moradores na identificação de questões e na formulação de soluções. Os resultados defendem a agrossilvopastagem como uma subsistência viável, mesclando agricultura de cultivo, silvicultura e criação de animais para equilibrar a preservação ambiental com o avanço econômico. Além disso, o estudo enfatiza a importância do fortalecimento da capacidade nas comunidades locais, ressaltando o aprimoramento de habilidades e conhecimentos. Ao defender o engajamento comunitário e oferecer estratégias de subsistência sustentável multifacetadas, esta pesquisa enriquece o discurso sobre o desenvolvimento sustentável para as comunidades florestais que residem na encosta sul do Monte Slamet.

Palavras-chave: *Meios de subsistência sustentáveis. Resiliência econômica. Avaliação rural participativa. Agrossilvopastoril. Gestão florestal sustentável.*

1 INTRODUCTION

Mount Slamet, located in the Districts of Banyumas, Purbalingga, Pemalang, Tegal, and Brebes, stands as the highest mountain in Central Java Province, Indonesia. This region encompasses rich biodiversity,

including diverse ecosystems (Aqim; Permatasari, 2023; Widhiono, 2015), flora and fauna (Pribadi et al., 2011; Setiawan *et al.*, 2011; Wibisono *et al.*, 2018; Widhiono, 2015; Widhiono *et al.*, 2017). The diversity and sustainability of this biodiversity hold significant value from ecological, social, and economic perspectives. The ecological importance of the forest ecosystem manifests in its pivotal role in supporting life, serving as a water source (Livesley *et al.*, 2016; Neary *et al.*, 2009), preventing landslides (Moos *et al.*, 2018; Preti, 2013; Scheidl *et al.*, 2020), and contributing to climate change mitigation (Alemu, 2014; Hisano *et al.*, 2018; Munang *et al.*, 2013).From a sociocultural perspective, the forest area significantly shapes the community's way of life and culture (Ihemezie *et al.*, 2021; Torri; Herrmann, 2011). Mount Slamet, situated in the central part of Java Island (Sutawidjaja, 2009), is revered as a sacred site by certain communities (Sulistyo, 2020). This belief system influences the social dynamics within the community, leading to the preservation of Mount Slamet's sustainability through traditional rituals that endure to the present day (Asofi *et al.*, 2023; Rostiyana, 2020). Economically, Mount Slamet and its ecosystem play a pivotal role in sustaining the livelihoods of the surrounding communities (Dewanti; Ayuwat, 2015). The communities residing on the slopes of Mount Slamet, spanning across 14 districts in 5 different districts, often depend on the sustainable management of Mount Slamet's ecosystem for their economic well-being.

Despite its crucial significance for life, the forest ecosystem of Mount Slamet continues to face ecological pressures (Devenish *et al.*, 2022; Saringatin; Hidayati, 2021; Soemarno; Girmansyah, 2012). These pressures are triggered by anthropogenic factors, such as land-use conversion from forest to non-forest, wildlife hunting (Setiawan *et al.*, 2011; Van Balen *et al.*, 2010), and forest fires. These conditions can potentially result in ecosystem degradation, fragmentation, or even the loss of wildlife habitats (Maharadatunkamsi, 2011)Central Jawa was conducted. Three types of habitats as representation of\nprimary forest, secondary forest and plantation were examined at Kalipagu, Kaliwadas and\nBambangan in order to record its small mammals biodiversity. Combination of trapping and\ndirect observation recorded 31 species of small mammals from the areas observed. ShannonWiener index was the highest in secondary forest (3.8.

Upon further examination, the pressures causing ecological damage in the Mount Slamet area are driven by economic factors and the limited knowledge of the community regarding the sustainable utilization of forest resources (Dharmawan *et al.*, 2023). According to the Central Bureau of Statistics of Central Java Province (2023), four districts on the slopes of Mount Slamet are identified as poverty-stricken areas in Central Java Province. The significant number of impoverished communities in these regions is presumed to result from their primary dependence on natural resources, including agriculture and the forest ecosystem in Mount Slamet.

In the context of conventional management, the preservation of forest resources and community welfare is often perceived as conflicting (Miteva *et al.*, 2015; Nugroho *et al.*, 2023). Therefore, addressing issues of poverty and the limited knowledge of communities regarding sustainable forest resource utilisation requires a comprehensive approach (Haji *et al.*, 2021; Kumar *et al.*, 2021). Communities around the forest need to be equipped with knowledge about models of forest resource utilisation that integrate various efforts (Torres-Rojo *et al.*, 2019). This model enables the alignment of efforts for protecting and conserving forest resources with the enhancement of the welfare of surrounding communities, eliminating the dichotomy between these two aspects. Using a case study approach, this research aims to develop sustainable livelihood strategies for communities living on the southern slopes of Mount Slamet. Therefore, by developing an innovative framework, we aim to establish agrosilvopasture as a sustainable method of livelihood inside the framework of this research. The procedure was perceived as a significant advancement with the goal of enhancing the welfare of the forest community. Our main objective is to prioritise sustainability in all aspects of life, including the economic and social aspects.

2 METHODS

2.1 THE STUDY AREA

This research took place in Kemutug Lor Village, situated on the southern slope of Mount Slamet in Banyumas District, Central Java Province, Indonesia. The research location is shown in Figure 1. At least two factors drive the selection of this location. First, community groups affiliated with the village forest community institution are actively engaged in efforts to protect the forest ecosystem. Second, this village is one of the areas with the largest population in the southern region of Mount Slamet, characterised by socioeconomic features where the community still relies on the forest ecosystem, both directly and through its environmental services.

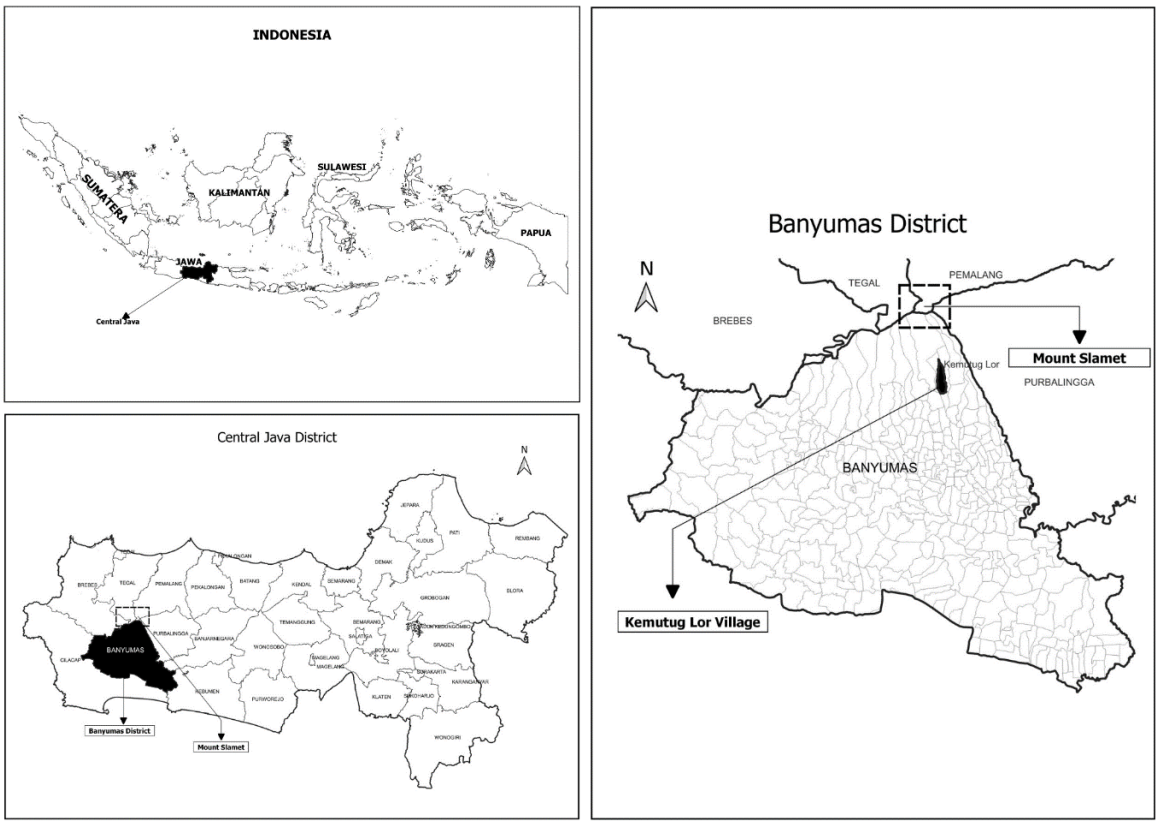

Figure 1 – Study Area. Kemutug Lor Village, Banyumas District, Indonesia

Source: Elaborated by the authors.

2.2 RESEARCH DESIGN

This research employed a qualitative descriptive approach. Creswell and Creswell (2013) suggest that a qualitative approach has advantages in revealing the phenomena of community participation habits, which are common in development planning. Additionally, this approach provides a more comprehensive explanation through interpretations based on logical and intuitive certainty.

The research was conducted from April to December 2023. The respondents of this study amounted to 36 individuals who are members of forest management community groups affiliated with the *Wana Karya Lestari* Forest Village Community Organization (*LMDH Wana Karya Lestari*). The number of respondents accounts for 62 per cent of the total members of *LMDH Wana Karya Lestari*. The data

type used was primary data obtained from interviews and direct field observations and secondary data obtained from various relevant publications or literature. Subsequently, triangulation methods were employed to test the validity and reliability of the collected data.

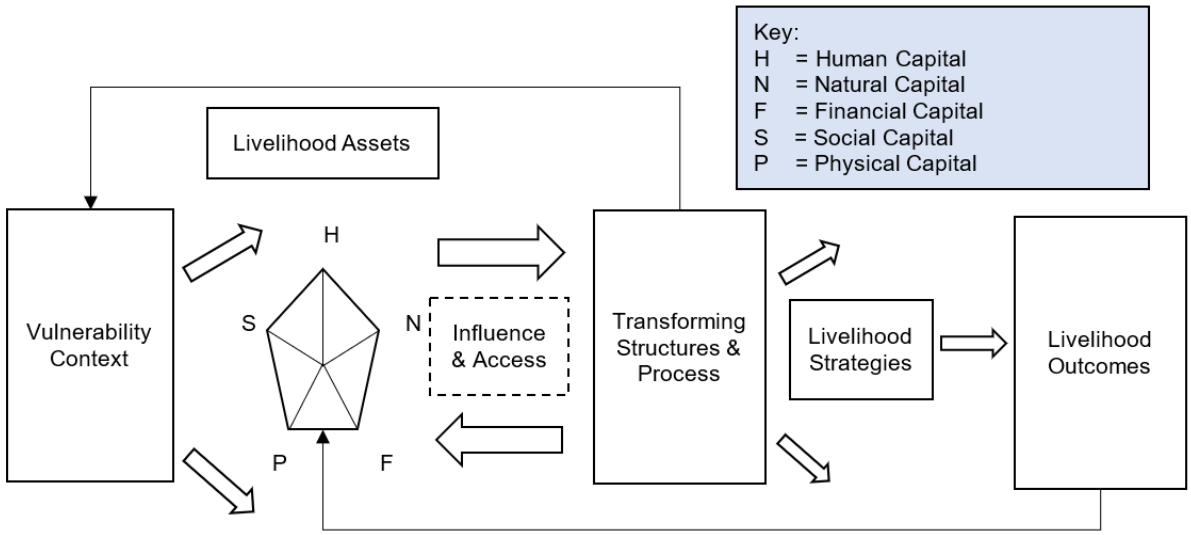

Figure 2 – Sustainable Livelihood Framework

Source: DFID, 1999

The formulation of sustainable livelihood strategies for the forest communities in Kemutug Lor Village is conducted within the framework developed by the Department for International Development/DFID (1999), as illustrated in Figure 2. The approach employed is participatory rural appraisal (PRA) to derive these strategies. PRA is a community-based research and assessment approach emphasising active collaboration between researchers and local communities to comprehensively understand rural issues, resources, and needs (Aziz *et al.*, 2011). PRA underscores the exchange of knowledge, experiences, and ideas among community members, empowering them to participate in problem-solving, decision-making, and the development of sustainable solutions (Bonye *et al.*, 2012).

In this study, the research team simultaneously acted as facilitators in identifying issues and formulating sustainable livelihood strategies. This process was carried out through a participatory approach, specifically using the PRA method. The process unfolded in three main stages: (1) preparation, (2) formulation of the analytical framework, and (3) local-level analysis (Chiwaka; Yates, 2005). The preparation stage involved raising awareness at the site level, setting objectives, stakeholder analysis, team preparation, and formation. The second stage involved a situational analysis, which entailed identifying issues that cause vulnerability, analysing community actions and capacities, and formulating a strategy. The third stage involved local-level analysis, where the team presented the obtained results to the community for validation and feedback.

This study only presents various strategies that support sustainable livelihoods for forest communities in Kemutug Lor Village, based on forest resource management and environmental services. These strategies were formulated participatively to explore the community's capacity to identify potentials and problems and devise activities to address them. Subsequently, the community will implement the formulated strategies within the land they manage. Therefore, various benefits from the strategies and actions implemented have not been directly experienced. The presentation of the benefits of implementing strategies in this study is based on previous research findings or best practices from similar activities.

3 RESULTS AND DISCUSSION

3.1 THE LIVELIHOOD ASSETS OF FOREST COMMUNITIES IN SOUTHERN SLOPE OF MOUNT SLAMET

In order to build a sustainable livelihood strategy, this research has identified the assets possessed by the community that contribute to their livelihoods. DFID (1999) and Veisi *et al.* (2014) identify five asset types: human capital, natural capital, physical capital, social capital, and financial capital. Table 1 presents the socioeconomic characteristics of the participants. Those living in Kemutug Lor Village's livelihoods are predominantly intertwined with natural resources and agriculture. The Village economy is primarily sustained by the agricultural sector, with a substantial portion of the people engaged in farming or small-scale traders. The research findings indicated that 91.67% of the respondents were male, while 41.67% came in the productive age range of 30 to 40 years. This condition differs from that reported by Budiyoko *et al.* (2023), who found that farmers in rural areas of Central Java Province are predominantly elderly (above 60 years old).

Regarding education, 36.11% of participants have completed junior high school. An individual's socioeconomic characteristics significantly impact their motivation to enhance productivity and foster personal development to enhance their overall welfare (Putri, 2023; Sumo *et al.*, 2022). In particular, an individual's educational background will impact their capacity to embrace novel technologies or acquire new knowledge (Sennuga *et al.*, 2020; Suvedi *et al.*, 2017)focus group discussion and in-depth interview while the secondary data\nwhich relate to the objectives of the study were collected from the office of the Kaduna State\nAgricultural Development Project (ADP. Meanwhile, Zulkifli *et al.* (2023) discovered that the failure to embrace sustainable agriculture puts farming businesses vulnerable, causing limited gains from the crop.

Kemutug Lor Village in Baturraden District has rich natural tourism potential, as demonstrated by the characteristics of its natural resources. Located at the base of Mount Slamet, this community provides magnificent natural landscapes with a blend of rugged mountains, cascading waterfalls, cultural richness, and a refreshing climate. This community is situated near several renowned tourist destinations, including the Baturraden Botanical Gardens, Baturraden *Lokawisata*, and numerous more captivating attractions. Consequently, this region has emerged as a popular tourist spot, attracting both domestic and international visitors who seek to relish the ambience of relatively intact tropical rainforests. Moreover, this factor contributes to the economic reliance of many people on tourism-related pursuits, including employment in tourist destinations and commerce involving food and beverages in nearby places.

Table 1 – Socioeconomic Characteristics of Respondents

Socioeconomic Characteristic	*Percentage (%)*
Age (Year)	
<30	16,67
30-40	41,67
41-50	22,22
>50	19,44
Gender	
Male	91,67
Female	8,33

Socioeconomic Characteristic	Percentage (%)
Educational Background	
Elementary School	25
Junior High School	36,11
Senior High School	30,56
Higher Education	8,33
Occupation	
Farmer	33,33
Tradesman	36,11
Labourer	5,56
Employee	22,22
Housewife	2,78

Source: Elaborated by the authors.

Furthermore, apart from its notable prowess in nature tourism, the village of Kemutug Lor exhibits substantial agricultural potential. The location is renowned for its production of premium-grade bovine milk. Kemutug Lor has a total area of 1,251 hectares, with 79.92% covered by forests (Central Bureau of Statistics of Banyumas, 2023). This evidence emphasizes the importance of maximizing land utilization in rural areas to effectively enhance the welfare of individuals, particularly in terms of sustainable economic prospects. Kemutug Lor, located in the Baturraden area, is a popular tourist attraction and presents a chance for economic development, particularly through agriculture, which serves as the basis of the local economy.

The physical capital examined in this research encompasses land ownership, power lines, machinery, and equipment. Based on the identification, it is evident that most farmers in the village of Kemutug Lor cultivate small plots of land, specifically less than 0.5 hectares in size. The money generated by such agricultural activities is generally inadequate to cover the overall living expenses of the community, hence leading to economic fragility among households in the society. Nevertheless, the people of Kemutug Lor Village delight in excellent access to power. Every household can utilize electrical energy, including Kemutug lor village, which ranks fifth in terms of electricity usage within the Baturraden (Central Bureau of Statistics of Banyumas, 2023). Nearly all communities possess basic manual farming equipment for the ownership of agricultural machinery. Agricultural machinery, including tractors and lawnmowers, is a valuable resource owned by farmers that the community may share and utilise. Facilitating the sharing of agricultural equipment and machinery can enable small-scale farmers to acquire contemporary equipment and enhance efficiency in a cost-efficient manner (Artz; Naeve, 2016; Singh *et al.*, 2016).

The social capital identified in this study comprises informal norms utilised and applied by the community, particularly *LMDH Wana Karya Lestari* members. Two major societal norms in interpersonal interactions are mutual cooperation (*gotong royong*) and tolerance (*tepo seliro*). These rules serve as both social dynamics and a solid basis for regulating social life. The establishment of community cohesiveness and harmony within organisational processes, along with the allocation of responsibility in the management of forest resources, enhances the overall efficacy of management and contributes to the well-being of the surrounding communities. *LMDH Wana Karya Lestari* is an organization that assists in forest management and serves as a model for other communities. It promotes the preservation of social norms, which in turn becomes a valuable asset for the community. This organization aims to achieve sustainable forest management and improve the community's welfare. Chhetri *et al.* (2023) and

Poudyal *et al.* (2023) assert that incorporating forest area communities is essential for implementing adaptive forest management in response to socioeconomic changes.

Financial capital encompasses monetary resources and credit instruments utilised to sustain individuals' livelihoods. Within the scope of the research, there is a substantial availability of credit facilities, encompassing both official offerings from the government and commercial sector, as well as informal credit options. Formal credit facilities are provided through banks and financial institutions, including cooperatives. Non-formal credit refers to loans obtained via intermediaries or individuals inside one's community, such as middlemen or relatives/fellow community members (Yoko; Prayoga, 2019).

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The forest-adjacent community in the research site tends to avoid debt. A total of 91.67 per cent of respondents stated their preference not to incur debt. This finding is consistent with (Trinh *et al.*, 2022), who noted that individuals residing in rural areas tend to refrain from borrowing. However, when compelled to borrow or necessitate external funding, 75 per cent of respondents prefer accessing non-formal financing from their relatives, particularly for consumption needs, children's education expenses, or agricultural capital. Rural communities with strong familial ties tend to favour non-formal financing over formal financing (Dwiputri, 2020; Sulistianingsih; Santi, 2023). Meanwhile, 25% of respondents access financing from financial institutions such as cooperatives and government-facilitated microfinance institutions. This group of respondents has their primary occupation as traders.

3.2 SUSTAINABLE LIVELIHOOD STRATEGIES FOR FOREST COMMUNITY ON THE SOUTHERN SLOPE OF MOUNT SLAMET

The development of sustainable livelihood strategies for the forest communities in Kemutug Lor Village, Baturraden Sub-district, is a collaborative effort involving facilitators and the community. This process consists of a sequence of participatory steps to augment awareness (Cilliers; Timmermans, 2014) and foster a sense of ownership of the formulated program (Ramos *et al.*, 2017). Referring to the sustainable livelihood framework presented in Figure 2, the initial stage involves facilitators striving to impart an understanding of sustainable forest management and applying the PRA approach in crafting sustainable livelihood strategies. The objective is to enhance awareness and community participation in all planned activities. Subsequently, facilitators and the community identify the stakeholders involved and delineate the outcomes of these activities. The established outcome is 'Sustainable Forest, Prosperous Community.' The philosophy underpinning this objective is the commitment to sustainable forest utilisation to improve the community's well-being continually.

In the second stage, facilitators and the community strive to identify and analyze vulnerability-related issues. This process unfolds through guided discussions to elucidate the community's perspectives on the interconnectedness of primary issues and their resultant impacts. Ecosystem degradation and low community well-being are deemed the most critical issues associated with economic, social, and ecological changes affecting their lives. Cahyaningsih *et al.* (2022) assert that forest degradation is primarily triggered by anthropogenic factors leading to the conversion of forest land to non-forest. Pressures partly originate from the extensive development of tourist attractions and related activities in the southern region of Mount Slamet. In order to address the issue of forest degradation caused by tourism development, it is crucial to adopt sustainable management approaches. This encompasses meticulous strategizing, constructing ecologically sustainable infrastructure, implementing effective

waste management systems, educating tourists, and enforcing stringent rules to save natural habitats. Engaging local people in the decision-making process can additionally guarantee environmental sustainability in the area of Mount Slamet. Climate crises and natural factors also contribute to the decline in the quality of the forest ecosystem (Boisvenue; Running, 2006; Seidl *et al.*, 2017). According to De Chazal and Rounsevell (2009), these various factors then lead to land fragmentation, posing a potential threat to biodiversity loss.

The decline in the ecosystem quality of Mount Slamet's forest poses a significant threat to the livelihoods of communities heavily dependent on it (Mainka *et al.*, 2008). Therefore, efforts are needed to manage and utilise forest resources that can serve as a middle ground for the conservation of forest resources and support the economic and social well-being of the community. In connection with the capacity and conditions at the local level, the strategy that is driven to address this issue is the development of an agrosilvopasture model. This model is considered appropriate as it combines forest conservation efforts with integrated farming practices involving seasonal crops and livestock cultivation (Febriantoko *et al.*, 2023; Haddad; Ariza; Malmer, 2021; Hanisch *et al.*, 2022).

The second identified issue is associated with the low well-being of the communities residing around the forest. This observation is linked to the limited diversification of livelihood sources in the research area. The majority of the population in this region depends on income derived from forest resources and agriculture (Central Bureau of Statistics of Banyumas, 2023), as well as tourism services (working in tourist locations or trading around them). Unfortunately, the community lacks full rights to forest management, as the forest in the Baturraden Area is presently under the jurisdiction of a state-owned enterprise (SOE) in the forestry sector.

The well-being issue is intricately linked to the educational and skill factors within the community. Demographically, most participating community members hold only primary school degrees (see Table 1). Therefore, addressing this issue requires strategic efforts to enhance the forest surrounding communities' capacity, knowledge, and skills, especially those related to the development of local economic activities that can diversify their livelihoods (Kusel, 2001; Tole, 2010). This is as stated by the chairman of *LMDH Wana Karya Lestari*:

> The forest on the southern slope of Mount Slamet is rich in biodiversity and the potential for environmental services, such as water provision and tourism. However, the community has not managed it well. Empowerment efforts are needed to enhance the capacity of the community to manage the forest and its environmental services, thereby opening up various new economic opportunities for the surrounding forest community (Lestari, [s.d]).

To ensure the achievement of these objectives, the involvement and collaboration of various stakeholders are required, including the government, universities, the private sector, and social organizations. The forest surrounding the community plays a strategic role, acting as both an actor and a beneficiary of these activities. The matrix depicting the identification results between facilitators and the community can be found in Table 2.

Table 2 – Identification of Vulnerability Issues, Sources, Impacts, and Formulated Strategies

Vulnerability Issues	*Source*	*Impact and consequences*	*Strategy*
Degradation of forest ecosystems	• Land-use conversion from forest to non-forest triggered by the development of tourist attractions • Climate change	• Land fragmentation • Biodiversity decline	Agrosilvopasture

Vulnerability Issues	Source	Impact and consequences	Strategy
The low well-being level of the community	• Undiversified livelihood sources • Dependency of livelihood on natural resources (forests and agriculture)	• Increase in the number of impoverished population • High urbanization • Decrease in agricultural land productivity • Abandon farms and shift to off-farm jobs	Enhancement of community capacity, knowledge, and skills

Source: Elaborated by the authors.

3.3 IMPLEMENTATION OF THE AGROSILVOPASTURE MODEL FOR SUSTAINABILITY SOLUTIONS

The implementation of the agrosilvopasture model carried out together with local communities, is a dynamic approach to sustainable land management and economic empowerment. This initiative includes the creation of pilot plots that apply agrosilvopasture principles and integration of agriculture, forestry and livestock. Through a series of educational training and community engagement, participants gain the skills and knowledge needed to implement and manage the system effectively.

The main objective of this initiative is to empower the community with a range of skills and sustainable livelihood sources, allowing them to exploit different income streams through crop cultivation, livestock farming, and environmental services. The community's ability to navigate changes in economic, environmental, and social conditions is fortified by developing these competencies. Consequently, this initiative provides a route to achieving long-term economic stability and promotes sustainable land-use practices.

The existing vegetation in the Kemutug Lor forest area consists of *damar* (*Agathi dammara*) and *rasamala* (*Altingia excelsa*), which a state-owned forest company manages. The agrosilvopasture plots will be developed among these *damar* and *rasamala* trees. The development of the agrosilvopasture model involves a participatory approach, engaging in discussions with the community, particularly in the selection of commodities for cultivation. This process considers the suitability of plant types based on the land characteristics and existing vegetation at the agrosilvopasture development site. Furthermore, the selection of commodities is based on considerations such as economic value, harvest time, and their contributions to the conservation of water resources and biodiversity. These considerations aim to align with the primary objective, which is to bolster the economic resilience of forest communities intricately connected to forest protection and conservation efforts on the southern slope of Mount Slamet.

Based on discussions with the community, the agrosilvopasture model to be developed involves the integration of forest plants with biopharmaceutical plants/medical herbs, multipurpose tree species (fruit trees), elephant grass (*Pennisetum purpureum cv.Mott*), goat farming, and beekeeping. Biopharmaceutical plants/medical herbs are designated as low shrubs that can yield short-term harvests. Some of the biopharmaceutical plants grown are cardamom (*Amomum compactum*), turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), and galangal (*Kaempferia galanga*). Furthermore, the cultivated fruit trees include durian (*Durio zibethinus*), stink beans/petai (*Parkia speciosa*), avocado (*Persea americana*), matai (*Pometia pinnata*), and guava (*Psidium guajava*). The development of biopharmaceutical plants/medicinal herbs and fruit plants is expected to provide an alternative livelihood source for the Kemutug Lor Village community.

Furthermore, the cultivation of elephant grass is an integral component of the goat farming practices already adopted by the community. The developed elephant grass serves as a source of livestock feed, and the resulting animal waste can be utilized as organic material to enhance soil fertility. Additionally,

within the same land area, the community integrates beekeeping into their practices. The abundant availability of natural nectar and pollen, coupled with the economic value derived from honey production, is a primary consideration in opting for beekeeping. The selection of these commodities and implementing of the agrosilvopasture model are expected to generate a sustainable circular effect, positively impacting economic and environmental productivity. A comprehensive illustration of the agrosilvopasture model implemented in Kemutug Lor Village is discovered in Figure 3. Meanwhile, documentation of the participatory process in developing activities and implementing agrosilvopasture model activities is presented in Figure 4.

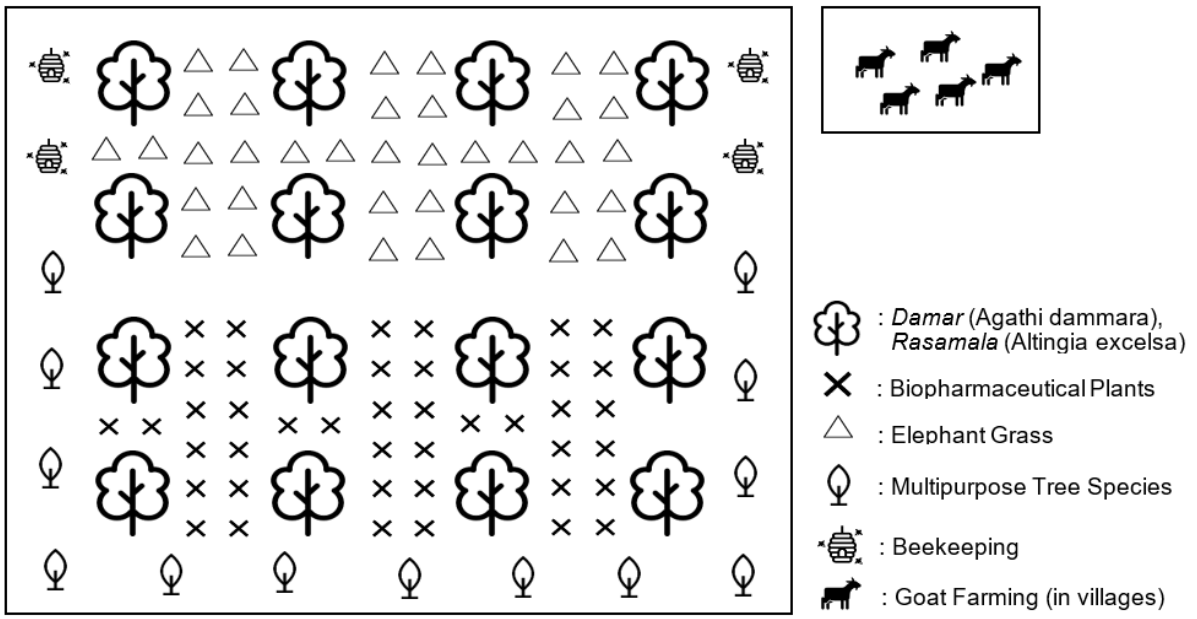

Figure 3 – Agrosilvopasture model in Kemutug Lor, Banyumas District

Source: Elaborated by the authors.

The integration of trees, forage, and livestock in agrosilvopasture has influenced farmers' well-being favourably. Studies have shown that agrosilvopasture systems can result in higher production, greater ability to withstand challenges, and improved household income, food security, and nutrition in rural areas (Makate *et al.*, 2016). Moreover, the implementation of these agricultural innovations has been proven to enhance agricultural productivity, relieve poverty, and enhance smallholder farmers' ownership of assets, hence encouraging their economic and social progress (Awotide *et al.*, 2015). Furthermore, studies have demonstrated that agricultural extension programs, which disseminate knowledge and familiarize farmers with advanced techniques like agrosilvopasture, effectively enhance agricultural output and welfare (Ngeno, 2018). These findings emphasize the potential of agrosilvopasture to enhance the economic conditions of farmers by improving their general well-being and resilience to environmental and economic challenges.

Figure 4 – Forest-adjacent community activities in the development of the agrosilvopasture in Kemutug Lor, Banyumas District

Source: Elaborated by the authors

In the medium term, the development of the existing agrosilvopasture model has the potential to evolve into an agro-educational facility managed by the local community. This future vision acknowledges that the agrosilvopasture model currently under development serves as more than just a means to yield harvests (both food and biopharmaceuticals) directly. They also serve as a tool for disseminating knowledge and skills within the community. Through well-structured agro-educational programs, community members can acquire comprehensive insights into agrosilvopasture practices, encompassing diverse crop cultivation, sustainable forestry, and effective animal husbandry. This knowledge transfer process enhances their capacity to manage agrosilvopasture systems and teaches them how to enhance the economic benefits of forests without resorting to damaging practices. Thus, this enhances the ecosystem's sustainability and supports sustainable economic growth for the local community and its surrounding environment.

The main objective of this agroeducation dedication is to shift the approach towards economic growth of forest-dependent communities towards utilising non-timber forest products and environmental services. By implementing agrosilvopasture and sustainable land management, community members can gain economic benefits that are intrinsically linked to the protection of forest ecosystems while also revolutionising the approach to natural resource management. An important aspect of this approach is the recognition that exploitation or deforestation is not sustainable. Instead, agrosilvopasture allows for coexistence between economic development and ecosystem preservation. This encourages communities to work harmoniously with the forest, and fosters shared responsibility for their well-being (Dar *et al.*, 2023; Köthke; Ahimbisibwe; Lippe, 2022).

4 CONCLUSION

Strengthening the capacity of forest communities around the southern slope of Mount Slamet to develop productive activities is critical for enhancing their economic resilience. Promoting productive economic activities should align with conservation principles and the sustainable utilisation of forest resources. Through participatory identification and analysis, it has been determined that an appropriate and suitable sustainable livelihood strategy for the conditions and characteristics of Kemutug Lor Village, Banyumas District, is the development of agrosilvopasture. This model incorporates a blend of damar and rasamala trees, biopharmaceutical plants, multipurpose tree species (such as fruit trees), elephant grass, and the husbandry of goats and beekeeping. The implementation of the agrosilvopasture model adopts a participatory approach, involving the community in the planning, execution, and maintenance phases. Active community engagement has proven to enhance participation and ownership of the implemented program. The integration of seasonal crops and livestock on forest land is anticipated to offer sustainable alternative livelihoods for communities, thus mitigating conflicts between community economic development and forest conservation initiatives. Furthermore, it is envisaged that this agrosilvopasture development area will evolve into an agroeducational zone managed by the community, disseminating information and knowledge through best practices in integrated farming techniques and forest ecosystem conservation.

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REFERENCES

ALEMU, B. The Role of Forest and Soil Carbon Sequestrations on Climate Change Mitigation. **Research Journal of Agriculture and Environmental Management**, v. 3, n. 10, p. 492–505, 2014.

AQIM, S.; PERMATASARI, I. T. Species Diversity of Gunung Slamet Protection Forest. **JPPP**, v. 1, n. 1, p. 21–30, 2023.

ARTZ, G.; NAEVE, L. The Benefits and Challenges of Machinery Sharing Among Small-scale Fruit and Vegetable Growers. **Journal of Agriculture, Food Systems, and Community Development**, p. 1–17, 2016.

ASOFI, T. S.; BANOWATI, E.; HAYATI, R. Tuk Sikopyah Water Taking Ritual to Revitalize Local Wisdom in Anticipating Drought in Serang Village. **Journal of Educational Social Studies**, v. 12, n. 2, p. 101–109, 2023.

AWOTIDE, B. A. *et al.* Impact of agricultural technology adoption on asset ownership: the case of improved cassava varieties in Nigeria. **Food Security**, v. 7, n. 6, p. 1239–1258, dez. 2015.

AZIZ, A.; SHAMS, M.; KHAN, K. S. Participatory action research as the approach for women's empowerment. **Action Research**, v. 9, n. 3, p. 303–323, set. 2011.

BOISVENUE, C.; RUNNING, S. W. Impacts of climate change on natural forest productivity – evidence since the middle of the 20th century. **Global Change Biology**, v. 12, n. 5, p. 862–882, maio 2006.

BONYE, S. Z. *et al.* Promoting Community-Based Extension Agents as an Alternative Approach to Formal Agricultural Extension Service Delivery in Northern Ghana. **Asian Journal of Agriculture and Rural Development**, v. 2, n. 1, p. 76–95, 2012.

BUDIYOKO, B. *et al.* Don't stop me now: ageing farmers and its impact on rice farming productivity. **International Conference on Economy, Management, and Business (IC-EMBus)**, v. 1, p. 496–502, 2023.

CAHYANINGSIH, A. P. *et al.* Review: causes and impacts of anthropogenic activities on mangrove deforestation and degradation in Indonesia. **International Journal of Bonorowo Wetlands**, v. 12, n. 1, 12 fev. 2022.

CENTRAL BUREAU OF STATISTICS OF BANYUMAS. **Baturraden in Numbers 2023**. CENTRAL BUREAU OF STATISTICS OF BANYUMAS, 2023.

CENTRAL BUREAU OF STATISTICS OF CENTRAL JAVA PROVINCE. **Poverty 2021-2023**. 2023. Available in: https://jateng.bps.go.id/indicator/23/34/1/kemiskinan.html.

CHHETRI, R. *et al.* Forest, agriculture, and migration: contemplating the future of forestry and agriculture in the middle-hills of Nepal. **The Journal of Peasant Studies**, v. 50, n. 1, p. 411–433, 2 jan. 2023.

CHIWAKA, E.; YATES, R. **Participatory vulnerability analysis**: a step-by-step guide for field staff. ActionAid International, 2005.

CILLIERS, E. J.; TIMMERMANS, W. The Importance of Creative Participatory Planning in the Public Place-Making Process. **Environment and Planning B**: planning and design, v. 41, n. 3, p. 413–429, jun. 2014.

CRESWELL, J. W.; CRESWELL, J. D. **Research Design**: qualitative, quantitative, and mixed methods approaches. 2013.

DAR, A. M. *et al.* Socioeconomic and ecological sustainability of agroforestry in mountain regions. *In:* **Understanding Soils of Mountainous Landscapes**. [s.l.] Elsevier, 2023. p. 375–394.

DE CHAZAL, J.; ROUNSEVELL, M. D. A. Land-use and climate change within assessments of biodiversity change: a review. **Global Environmental Change**, v. 19, n. 2, p. 306–315, maio 2009.

DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID). **Sustainable Livelihoods Guidance Sheets**. DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID), 1999.

DEVENISH, C. *et al.* Biological richness of Gunung Slamet, Central Java, and the need for its protection. **Oryx**, v. 56, n. 3, p. 429–438, maio 2022.

DEWANTI, D. S.; AYUWAT, D. The Livelihoods of Sawangan Village, a Disaster Prone Area of Mt. Slamet. **I J A B E R**, v. 13, n. 7, p. 6147–6164, 2015.

DHARMAWAN, B. *et al.* Introduksi Model Agrosilvopastura Kepada Masyarakat Sekitar Hutan Di Desa Kemutug Lor, Kabupaten Banyumas. **Jurnal Pengabdian dan Pemberdayaan Masyarakat Inovatif**, v. 2, n. 2, p. 47–53, 2023.

DWIPUTRI, I. N. Relationship Between Non-Formal Credit and the Welfare of Indonesian Households. **KnE Social Sciences**, 14 jul. 2020.

FEBRIANTOKO, J. *et al.* Implementation of Agrosilvopasture and MSME Incubation to Support Sustainability Development Goals: a multidisciplinary perspective on economic enhancement. Proceedings of the 6th International Conference of Economics, Business, and Entrepreneurship, ICEBE 2023, 13-14 September 2023, Bandar Lampung, Indonesia. **Anais [...]** *In:* Proceedings of the 6th International Conference of Economics, Business, and Entrepreneurship, ICEBE 2023, 13-14 September 2023, Bandar Lampung, Indonesia. Bandar

Lampung, Indonesia: EAI, 2023. Available in: http://eudl.eu/doi/10.4108/eai.13-9-2023.2341396. Access in: 10 fev. 2024

HADDAD, F. F.; ARIZA, C.; MALMER, A. **Building Climate Resilience Dryland Forest and Agrosilvopasture Production System**. Rome, Italy: FAO, 2021.

HAJI, L.; VALIZADEH, N.; HAYATI, D. The Role of Local Communities in Sustainable Land and Forest Management. *In:* SHIT, P. K. *et al.* (ed.). **Spatial Modeling in Forest Resources Management**. Environmental Science and Engineering. Cham: Springer International Publishing, 2021. p. 473–503.

HANISCH, A. L. *et al.* Combining silvopastoral systems with forest conservation: the caíva system in the Araucaria Forest, Southern Brazil. **Agroforestry Systems**, v. 96, n. 4, p. 759–771, abr. 2022.

HISANO, M.; SEARLE, E. B.; CHEN, H. Y. H. Biodiversity as a solution to mitigate climate change impacts on the functioning of forest ecosystems. **Biological Reviews**, v. 93, n. 1, p. 439–456, fev. 2018.

IHEMEZIE, E. J. *et al.* The influence of human values on attitudes and behaviours towards forest conservation. **Journal of Environmental Management**, v. 292, p. 112857, ago. 2021.

KÖTHKE, M.; AHIMBISIBWE, V.; LIPPE, M. The evidence base on the environmental, economic and social outcomes of agroforestry is patchy—An evidence review map. **Frontiers in Environmental Science**, v. 10, p. 925477, 11 ago. 2022.

KUMAR, M.; NISHA PHUKON, S.; SINGH, H. The role of communities in sustainable land and forest management. *In:* **Forest Resources Resilience and Conflicts**. [s.l.] Elsevier, 2021. p. 305–318.

KUSEL, J. Assessing Well-Being in Forest Dependent Communities. **Journal of Sustainable Forestry**, v. 13, n. 1–2, p. 359–384, 7 mar. 2001.

LIVESLEY, S. J.; MCPHERSON, E. G.; CALFAPIETRA, C. The Urban Forest and Ecosystem Services: impacts on urban water, heat, and pollution cycles at the tree, street, and city scale. **Journal of Environmental Quality**, v. 45, n. 1, p. 119–124, jan. 2016.

MAHARADATUNKAMSI. Profil Mamalia Kecil Gunung Slamet Jawa Tengah. **Jurnal Biologi Indonesia**, v. 7, n. 1, p. 171–185, 2011.

MAINKA, S. A.; MCNEELY, J. A.; JACKSON, W. J. Depending on Nature: ecosystem services for human livelihoods. **Environment**: science and policy for sustainable development, v. 50, n. 2, p. 42–55, mar. 2008.

MAKATE, C. *et al.* Crop diversification and livelihoods of smallholder farmers in Zimbabwe: adaptive management for environmental change. **SpringerPlus**, v. 5, n. 1, p. 1135, dez. 2016.

MITEVA, D. A.; LOUCKS, C. J.; PATTANAYAK, S. K. Social and Environmental Impacts of Forest Management Certification in Indonesia. **PLOS ONE**, v. 10, n. 7, p. e0129675, 1 jul. 2015.

MOOS, C. *et al.* Ecosystem-based disaster risk reduction in mountains. **Earth-Science Reviews**, v. 177, p. 497–513, fev. 2018.

MUNANG, R. *et al.* The role of ecosystem services in climate change adaptation and disaster risk reduction. **Current Opinion in Environmental Sustainability**, v. 5, n. 1, p. 47–52, mar. 2013.

NEARY, D. G.; ICE, G. G.; JACKSON, C. R. Linkages between forest soils and water quality and quantity. **Forest Ecology and Management**, v. 258, n. 10, p. 2269–2281, out. 2009.

NGENO, V. Impact of dairy hubs on smallholder welfare: empirical evidence from Kenya. **Agricultural and Food Economics**, v. 6, n. 1, p. 9, dez. 2018.

NUGROHO, H. Y. S. H. *et al.* A Chronicle of Indonesia's Forest Management: a long step towards environmental sustainability and community welfare. **Land**, v. 12, n. 6, p. 1238, 16 jun. 2023.

POUDYAL, B. H. *et al.* Examining forest transition and collective action in Nepal's community forestry. **Land Use Policy**, v. 134, p. 106872, nov. 2023.

PRETI, F. Forest protection and protection forest: tree root degradation over hydrological shallow landslides triggering. **Ecological Engineering**, v. 61, p. 633–645, dez. 2013.

PRIBADI, T.; RAFFIUDIN, R.; HARAHAP, I. S. Termites community as environmental bioindicators in highlands: a case study in eastern slopes of Mount Slamet, Central Java. **Biodiversitas Journal of Biological Diversity**, v. 12, n. 4, 1 jul. 2011.

PUTRI, D. D. Analisis Karakteristik Dan Motivasi Sosial Ekonomi Petani Kapulaga Di Lahan Perhutani Kabupaten Banyumas. **SEPA: Jurnal Sosial Ekonomi Pertanian dan Agribisnis**, v. 20, n. 1, p. 107, 28 fev. 2023.

RAMOS, A. K. *et al.* Sense of community, participation, and life satisfaction among Hispanic immigrants in rural Nebraska. **Kontakt**, v. 19, n. 4, p. e284–e295, 21 nov. 2017.

ROSTIYANA, N. Fungsi Ritual Agung Banyu Panguripan Dalam Menjaga Ketersediaan Air Bagi Masyarakat Di Kecamatan Pulosari Kabupaten Pemalang. **Universitas Diponegoro**, 2020.

SARINGATIN, S.; NUR HIDAYATI, I. Identification of spatial ecological sensitivity in Banyumas region. P. WICAKSONO, S. B. WIBOWO (ed.) Seventh Geoinformation Science Symposium 2021. **Anais [...]** *In:* Seventh Geoinformation Science Symposium. Yogyakarta, Indonesia: SPIE, 22 dez. 2021. Available in: https://www.spiedigitallibrary.org/conference-proceedings-of-spie/12082/2615748/Identification-of-spatial-ecological-sensitivity-in-Banyumas-region/10.1117/12.2615748.full. Access in: 11 fev. 2024

SCHEIDL, C. *et al.* The influence of climate change and canopy disturbances on landslide susceptibility in headwater catchments. **Science of the Total Environment**, v. 742, p. 140588, nov. 2020.

SEIDL, R. *et al.* Forest disturbances under climate change. **Nature Climate Change**, v. 7, n. 6, p. 395–402, jun. 2017.

SENNUGA, S. O.; FADIJI, T. O.; THADDEUS, H. Factors Influencing Adoption of Improved Agricultural Technologies (IATs) among Smallholder Farmers in Kaduna State, Nigeria. **International Journal of Agricultural Education and Extension**, v. 6, n. 2, p. 358–368, 2020.

SETIAWAN, A. *et al.* Population density and distribution of Javan gibbon (Hylobates moloch) in Central Java, Indonesia. **Biodiversitas Journal of Biological Diversity**, v. 13, n. 1, 27 set. 2011.

SINGH, T. S.; RUPINDER, C.; KUMAR, N. M. Joint Farm Machinery Ownership in Indian Agriculture-Need of the Time. **SKUAST Journal of Research**, v. 18, n. 1, p. 1–11, 2016.

SOEMARNO, S.; GIRMANSYAH, D. Kondisi Kawasan Hutan Alam Gunung Slamet, Jawa Tengah. **LIPI**, p. 41–61, 2012.

SULISTIANINGSIH, H.; SANTI, F. Does SME's financing decisions follow pecking order pattern? The role of financial literacy, risk preference, and home bias in SME financing decisions. **Cogent Business & Management**, v. 10, n. 1, p. 2174477, 31 dez. 2023.

SULISTYO, A. Persebaran Situs-Situs Megalitik Di Lereng Tenggara Gunung Slamet: bukti determinisme manusia Indonesia pada lingkungan. Prosiding Balai Arkeologi Jawa Barat. **Anais [...]** *In:* SEMINAR NASIONAL ARKEOLOGI 2019. Balai Arkeologi Jawa Barat, 29 dez. 2020. Available in: http://prosidingbalarjabar.kemdikbud.go.id/index.php/seminar/article/view/9. Access in: 10 fev. 2024

SUMO, T. V.; RITHO, C.; IRUNGU, P. Effect of farmer socioeconomic characteristics on extension services demand and its intensity of use in post-conflict Liberia. **Heliyon**, v. 8, n. 12, p. e12268, dez. 2022.

SUTAWIDJAJA, I. Cinder cones of Mount Slamet, Central Java, Indonesia. **Indonesian Journal on Geoscience**, 2009.

SUVEDI, M.; GHIMIRE, R.; KAPLOWITZ, M. Farmers' participation in extension programs and technology adoption in rural Nepal: a logistic regression analysis. **The Journal of Agricultural Education and Extension**, v. 23, n. 4, p. 351–371, 8 ago. 2017.

TOLE, L. Reforms from the Ground Up: a review of community-based forest management in tropical developing countries. **Environmental Management**, v. 45, n. 6, p. 1312–1331, jun. 2010.

TORRES-ROJO, J. M.; MORENO-SÁNCHEZ, R.; AMADOR-CALLEJAS, J. Effect of capacity building in alleviating poverty and improving forest conservation in the communal forests of Mexico. **World Development**, v. 121, p. 108–122, set. 2019.

TORRI, M. C.; HERRMANN, T. M. Spiritual Beliefs and Ecological Traditions in Indigenous Communities in India: enhancing community-based biodiversity conservation. **Nature and Culture**, v. 6, n. 2, p. 168–191, 1 jun. 2011.

TRINH, K. A. *et al.* Why Did They Not Borrow? Debt-Averse Farmers In Rural Vietnam. **The Developing Economies**, v. 60, n. 4, p. 228–260, dez. 2022.

VAN BALEN, S. (BAS); NIJMAN, V.; SÖZER, R. Distribution and conservation of the Javan Hawk-eagle *Spizaetus bartelsi*. **Bird Conservation International**, v. 9, n. 4, p. 333–349, 2010.

VEISI, H.; LIAGHATI, H.; VANINEE, H. S. Participatory assessment of the sustainability of livelihoods in the agroecosystem of Abesard, Iran. **Sustainability Science**, v. 9, n. 3, p. 347–359, jul. 2014.

WIBISONO, H. T. *et al.* Identifying priority conservation landscapes and actions for the Critically Endangered Javan leopard in Indonesia: conserving the last large carnivore in Java Island. **PLOS ONE**, v. 13, n. 6, p. e0198369, 27 jun. 2018.

WIDHIONO, I. Diversity of butterflies in four different forest types in Mount Slamet, Central Java, Indonesia. **Biodiversitas Journal of Biological Diversity**, v. 16, n. 2, 1 jan. 2015.

WIDHIONO, I.; DARSONO, D.; FASIHAH, N. Short Communication: endemics species of dung beetles (Coleoptera: Scarabaeidae) on the southern slope of Mount Slamet, Central Java, Indonesia. **Biodiversitas Journal of Biological Diversity**, v. 18, n. 1, 13 fev. 2017.

YOKO, B.; PRAYOGA, A. Understanding Farmers' Access and Perception to Islamic Microfinance on Agricultural Financing: study in Central Lampung Regency. **Journal of Halal Product and Research**, v. 2, n. 1, p. 6, 2 jun. 2019.

ZULKIFLI, L. *et al.* The hidden vulnerabilities behind financial sustainability: a case study of a sugarcane farm business in Pemalang City, Central Java, Indonesia. **Sustainability in Debate**, v. 14, n. 3, p. 207–218, 10 dez. 2023.

Evolution of traditional taboos in Suriname

Evolução dos tabus tradicionais no Suriname

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ABSTRACT

Traditional taboos have persisted in Suriname, thanks to the sustainability of African culture in Maroon communities in the interior of the country. A conceptual dichotomy emerged in the 19th and early 20th centuries coinciding with two geographical regions: in the coastal region, *'trefu'*, a food taboo, practised mainly by Creoles, violation of which was thought to result in contracting leprosy, and in the interior *'tyina'*, a 'broader' taboo concept (food, places, actions) practised by Maroons. Recent research indicates the dichotomy is weakening, reflected in a declining belief in the *trefu*-leprosy relation and a merging of *'trefu'* and *'tyina'*, exchange of taboo practices between ethnic groups and declining adherence of youngsters to taboos. The migration of Maroons to the coastal region and creolisation appear to be driving forces behind these processes, whilst the decline in leprosy incidence may also have contributed. Additional research is needed to understand the evolution of traditional taboos in Suriname and the Greater Caribbean.

Keywords: Traditional taboos. *Tyina*. *Trefu*. Leprosy. Suriname. Greater Caribbean.

RESUMO

Os tabus tradicionais persistiram no Suriname graças à sustentabilidade da cultura africana nas comunidades quilombolas no interior do país. No século XIX e início do século XX, surgiu uma dicotomia conceptual que coincidiu com duas regiões geográficas: na região costeira, o "trefu", um tabu alimentar, praticado principalmente pelos crioulos, cuja violação pode resultar em lepra; e no interior "tyina", um conceito de tabu "mais amplo" (comida, lugares, ações) praticado pelos quilombolas. Pesquisas recentes indicam um desvanecimento da dicotomia, refletido no declínio da crença na relação trefu-lepra, além da fusão de trefu e tyina, troca de práticas tabus entre grupos étnicos e declínio da adesão dos jovens aos tabus. A migração dos quilombolas para a região costeira e a crioulização parecem ser as forças motrizes por trás desses processos. O declínio na incidência da lepra pode ter contribuído. São necessárias pesquisas adicionais para compreender a evolução dos tabus tradicionais no Suriname e no Grande Caribe.

Palavras-chave: *Tabus tradicionais. Tyina. Trefu. Lepra. Suriname. Grande Caribe.*

1 INTRODUCTION

Suriname is part of the Greater Caribbean, comprising all the islands in the Caribbean Sea whilst also including mainland nations and regions in nations in the Americas, where a plantation system based on slave labour preceded the present societal structures (Girvan, 2017, p. 3-23; Menke, 2011). The ethnically diverse population of Suriname consists of descendants of European (particularly Dutch) colonisers, Sephardic and Ashkenazi Jews from Brazil and Europe, enslaved people from Africa and indentured workers from Asia (East-Indians from India, Javanese from Indonesia, Chinese from China) and also indentured peoples from Madeira and the English speaking Caribbean. Furthermore, Suriname is populated by indigenous and Maroon peoples. The Maroons are descendants of enslaved Africans who fled the plantations during slavery and settled in tribal societies in the interior. They live there to this day (Figure 1), making Suriname the country with the most enduring groups of Maroons in the world (Ngwenyama, 2007, p. 55). East Indians, Maroons, Creoles, Mixed and Javanese are the most important groups numerically in Suriname at the present time, according to census data (Menke; Sno, 2016; Menke, 2011, p. 115). The different ethnic groups have conserved their own culture to a considerable degree. However, since colonial times, we have witnessed continuous cultural exchange and adaptation between these ethnic groups, a process called creolisation (Trouillot, 2006, p. 9-21). In connection with the subject of this paper (*trefu* and *tyina*), we highlight that Jewish immigrants have played an important role in the evolution of Surinamese society, including the creolisation process (Vink, 2010). They have had a significant cultural, economic and political influence on the formation of colonial and postcolonial Suriname (Menke; Menke, 2015, p. 266).

Traditional taboos (traditional bans) originating from Africa have been described in Suriname amongst enslaved people working mainly on the plantations since the second half of the 18th century (Fermin, 1770). They are important in the spiritual and daily life of Surinamese people with African roots (Herskovits; Herskovits, 1936), but the question under discussion here is how sustainable these taboos are. The traditional taboos trefu and tyina are part of the (intangible) cultural heritage of the Maroons and Creoles in Suriname. Cultural sustainability is the fourth pillar of sustainability, next to social, economic and ecological sustainability (Soini; Birkeland, 2014). Our research, addressing the evolutionary changes of the traditional taboos, can be considered an attempt to understand the sustainability of the taboos from a historical linear time perspective.

This article examines the sustainability of traditional taboos in Suriname in the context of the recent encounter of diverse groups in the capital, Paramaribo and its surroundings. After presenting a short outline of the taboos *trefu* and *tyina* in Suriname, we address their evolution in the coastal region by discussing documentary sources and the results of our research in the neighbourhood *'Sophia's Lust'* in this region. We will show that the taboos are undergoing substantive changes, especially in the coastal region, including Paramaribo. These changes, which are based on the intercultural exchange between Maroons and other ethnic groups and associated adaptation of the taboo concepts, coincide with the migration of Maroons from the tribal communities in the interior to the coastal region (see also section 4. OBJECTIVES AND METHODOLOGY). We will show that a medical-epidemiological development, namely the sharp decline in leprosy incidence, also plays a role.

In this paper, the coastal region refers to Paramaribo and its surroundings and the part of the coastal plain where plantations were located in colonial times, namely South and East of Paramaribo along the Suriname River and the Commewijne River and their branches and West of Paramaribo (Figure 1).

Figure 1 – Map of Suriname showing capital Paramaribo and plantations (coastal area where *trefu* is practised) and the residential areas of the 6 Maroon groups in the interior (where *tyina* is practised).

Source: Authors work, partly based on Hendrik Rypkema, Naturalis Biodiversity Center (Van Andel et al, 2014).

2 *TREFU* AND *TYINA*, TABOOS PRACTISED IN SURINAME

Trefu and *tyina* continue to play an important role in the lives of Creoles and Maroons, and to a lesser extent, of people of other ethnic groups (Menke *et al.*, 2020). The crucial question relates to the meaning of these two taboo concepts and their relationship over time.

Trefu is a taboo related to food and is strongly connected with leprosy or Hansen's disease. The name *trefu* is a Surinamese corruption of the Yiddish word *treife*, pointing to the food products forbidden to Jewish people according to the Mosaic laws. *Trefu* can be regarded as a remnant of totemism, much like the African mother concept *tyina,* which it probably derives from (Benjamins, 1930). *Trefu* is hereditary through the father's line (father *trefu*). However, one can also obtain it in several other ways. For example, the forbidden food can be revealed in a dream (dream *trefu*) or can be determined through personal experience (experience *trefu*). Some people rely on the authority of a local '*trefu* connoisseur', who determines their *trefu* (Lampe, 1929, p. 546-550). The idea that leprosy can be induced by eating food that is forbidden to eat in the context of a taboo is the quintessence of *trefu*. Historically*, Trefu is* practised in Paramaribo and the country's coastal region (Lampe, 1929, p. 566). Benjamins (1930) argues that the word *trefu* was originally unknown among Maroons living in the interior.

Tyina is a complex concept, encompassing a variety of taboos, which were historically mainly practised by Maroons in the interior of Suriname. According to Lampe (1929, p. 562), in the early 20th century, *tyina* was practically unknown in the capital Paramaribo. It originates from West Africa, where similar practices were reported in Loango (present Southern Gabon, Congo and Northern Angola), where it is known as *tschina* (Pechuell Loesche, 1907, p. 455-472), and also in regions North of Loango, e.g. the Coast of Guinea (Bosman, 1907). In addition to a ban on certain foods, *tyina* includes a ban on certain places and certain actions. It is basically acquired by inheritance through the paternal line. *Tyina* is closely linked with the natural environment and the *Winti* religion in Suriname. Violation of the *tyina* can end up in disease, death and/or another disaster.

Based on the above (and on information presented in the next sections) we assume that a geographical and conceptual dichotomy has developed in colonial times along two lines. On the one hand, *trefu*, a food taboo, a violation of which may result in leprosy, is practised mainly by creoles in the coastal region. On the other hand, *tyina*, a conceptually broader taboo (for food, places and actions), practised by Maroons in the interior.

It is important to note that the term *trefu* may lead to some confusion because Maroons use it in the meaning of *tyina*, the complex concept with a broad meaning (own experience of the authors during their 2018 expedition to the *Saamaka* Maroons). In this article, the word trefu (unless stated otherwise) exclusively refers to a food taboo linked to the disease leprosy, practised in Paramaribo and the country's coastal region.

3 HISTORICAL NOTES ON LEPROSY, *TREFU* AND *TYINA*

3.1 LEPROSY

In the 19th century, close to 1% of the population of Suriname was isolated in a leprosy colony (Snelders, 2017, p. 43-78). In the early 20th century, 2.5 -3% of the capital's population suffered from leprosy (FLU, 1928). At the same time, the people were under the spell of *trefu*. They believed that eating the forbidden food (their *trefu*) could lead to leprosy. Conversely, not eating their *trefu* was considered the appropriate remedy to prevent and even treat the disease. A leprosy patient (H.E. born in 1929) explains: "*I was not allowed to eat beef, monkey, pumpkin, rice and chicken. I also knew people who only consumed bread and water for their breakfast, in order to combat their leprosy*" (Reyme; Menke, 2019, p. 99-105). Because physicians and colonial rulers considered leprosy a highly contagious disease (Drognat Landré, 1869; Schilling, 1769), patients were isolated in remote leprosy colonies (Menke *et al.*, 2020; Snelders, 2013). However, the Afro-Surinamese patients believed in *trefu* rather than in the contagiousness they despised, which only led to their isolation. To avoid this, many went into hiding.

3.2 *TREFU*

Stedman (1796, p.264) described a practice in the 1770s: *"a direct prohibition in every family, handed down from father to son, against the eating of some kind of animal food, which they call 'treff'"*. Teenstra (1835, p.199-200) explains that Africans in Suriname have some animals or plants they will not eat. In one case, it is turtle, in another, it is crab, in another, it is a certain species of fish and so on. He furthermore reports that it has been experimentally proven that Africans who were secretly fed their *trefu* developed a convulsive illness and *'treef vlekken'* (*trefu* spots) on the skin. According to Herskovits and Herskovits (1936, p.37), violating one's *trefu* could develop eczema, which could develop into leprosy by continued consumption of the forbidden food. So eating the forbidden food can lead to various diseases, but there also seems to be a gradual conceptual narrowing of the consequences of violating one's *trefu* towards leprosy. Thus, Benjamins (1930, p.187) defines *trefu* as: "*any food, the continued use of which - according to the widespread popular belief in Suriname - would give rise to the development of leprosy"*. Our interviews with leprosy patients in the 20th century indicate that the alleged relationship between *trefu* (i.e. eating of the forbidden food) and the development of leprosy had the character of a collective obsession of the people in Paramaribo and the coastal region. This idea was so firmly entrenched in their minds that leprosy was named *'treefziekte'* (Lampe, 1929, p. 545), meaning 'disease caused by *trefu*'. The physicians in charge of leprosy control accused the population of hindering the fight against this disease because of their 'ridiculous' belief in *trefu* (Landré, 1889, p. 13). However, some doctors actually supported this belief held by their patients .

Lampe (1929, p. 566) suggests that *trefu* originated in Paramaribo in the process of cultural exchange between Jews and Africans. However, according to Trouillot (2006), plantations were an important context or a fertile breeding ground for creolisation in the Caribbean during slavery (although he explains that creolisation also occurred in other contexts). Davis (2015) endorses this view for the origins of *trefu*, explaining that on the plantations in Suriname, the cooks and housemaids learned Jewish food prohibitions and compared them to those they had brought with them from Africa. Talking of this taboo in Dju-tongo, they used the Yiddish word *treff* (*treife*), which linguistically changed to *treef* (Dutch) or *trefu* (*Sranan* language). As Lampe (1929) already noted, not only on the plantations but also in the capital Paramaribo, interactions between Jews and people of African descent were part of everyday life, resulting in the continuous exchange of cultural ideas and practices. Food was a common part of cultural interaction, which, for example, can be traced in Creole (Afro-Jewish) dishes like *pom*, a Surinamese festive dish (Vink, 2010, p. 74). There is no scope in this paper to elaborate on the precise contribution of Jewish dietary rules to trefu and the similarities and differences between Jewish *treife* and Surinamese *trefu*, but the influences are apparent.

Trefu is a concept of the people. However, professionals, specifically physicians like Lampe (1929), have contributed to its construction through research papers, public presentations, and newspaper reports on the relationship between *trefu* and leprosy. These professionals influenced the *trefu* practices, the majority through their objections to it, but some through their approval. Anthropologists who followed a different research route have not explicitly delved into the relationship between leprosy and *trefu*. They studied the traditional taboos mainly in the interior of the country in the context of the culture of the Maroons; they generally considered *trefu* and *tyina* as identical taboo concepts and the two words as synonymous (Herskovits; Herskovits, 1936, p.36). While this view might have been true for the interior of Suriname, in Paramaribo and the coastal region, *trefu* has developed, as already explained, more as a taboo specifically linked to leprosy.

3.3 *TYINA*

During colonialism, Maroons settled in six tribal groups (or tribal peoples) in the interior (Figure 1). Benjamins (1930, p. 194) points out that the 'Saltwater negroes', in particular those brought in from Africa, in contrast to the 'Creole negroes' who were born in Suriname, m,.fled from the plantations

to the interior with their traditional ideas and customs. Traditional taboos (called *tyinas* or *kinas*) are practised by all Maroon tribal peoples; they are part of their *Winti* religion, and the *Winti* gods might punish people who violate the *tyina* (De Beet en Sterman, 1981, p.239). The *tyina* taboo system in the interior includes a wide range of practices. American and Dutch anthropologists have described these in the context of their research into Maroon culture. We rehearse some examples of *tyina* to illustrate its complexity. Herskovits (1928) mentions food taboos inherited from the father's line among *Saamaka*. Eliza (2017, p. 38-39) points to taboos associated with menstruation amongst the *Matawai* and *Ndyuka*. Junker (1923) describes the water splash taboo amongst the *Ndyuka*, linked to the *Winti* river god. The violation of this *tyina* was thought to be punished with heavy rains that spoiled the field crops.

Moreover, the splashed person fell ill. Green (1974, p. 185.) describes among the *Matawai* a ban linked to animal totemism: a man lost in the jungle was guided back home by a '*pomba*' (dove) with the voice of a human; his descendants do not eat '*pomba*'. This kaleidoscopic array of practices among Maroons illustrates the diversity and broad meaning of tyina, indicating its relation with the surrounding nature and the *Winti* religion.

4 OBJECTIVES AND METHODOLOGY

The foregoing shows that *trefu* is historically practised in the urban and coastal region, whilst *tyina* is practised in the interior. Since the last quarter of the 20th century, we have witnessed large waves of Maroons into the urban context, particularly the *Saamaka* and *Ndyuka*, profoundly changing the demographic situation in the coastal region. To illustrate, the number of Maroons in the urban districts of Paramaribo and Wanica grew from 33181 to 58436 (an increase of 43%) between the census years 2004 and 2012 due to urbanisation and natural increase. In the last decades of the 20th century, we also witnessed a sharp drop in leprosy incidence and subsequently, all leprosy colonies closed their doors, all as a result of the introduction of anti-leprosy drugs (Menke *et al.*, 2011; WHO, 2022). The above developments might have influenced the traditional taboos in Paramaribo and its surroundings, so it was decided to study the ideas and practices regarding these taboos amongst the people in a coastal urban neighbourhood. This case study focuses on the occurrence, meaning and role of traditional taboos and intercultural exchange in the daily lives of people in *Sophia's Lust*, a neighbourhood in the Wanica district adjacent to urban Paramaribo that can be considered a suburb of the Capital (Figure 2).

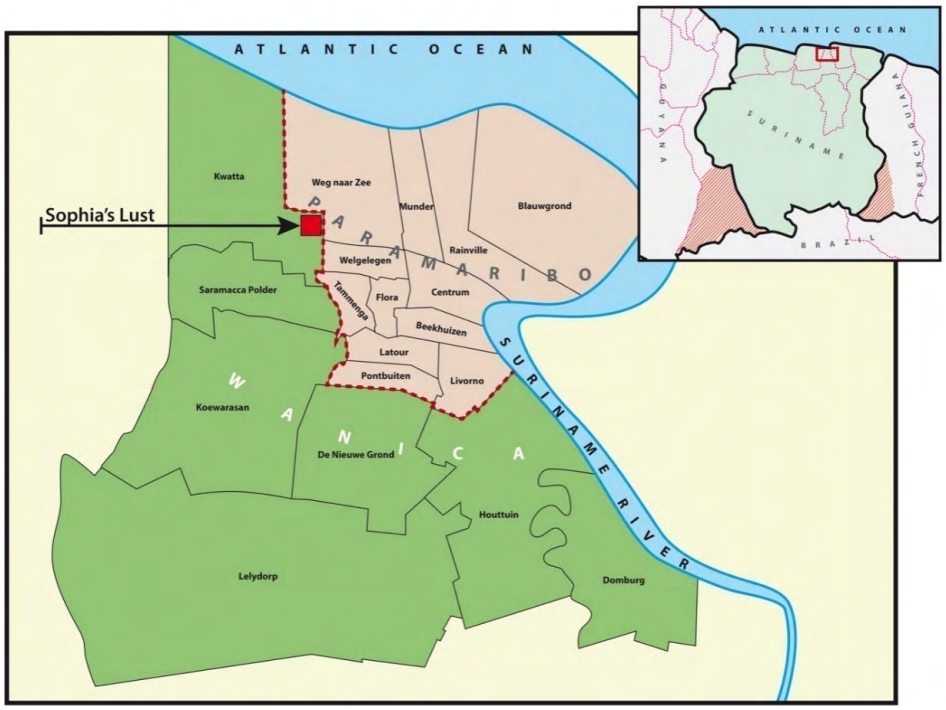

Figure 2 – Map of Paramaribo and Wanica district with the neighbourhood Sophia's Lust (in red)

Source: Authors work.

Sophia's Lust is mainly populated by Creoles and Maroons, groups who are historically familiar with taboos, but people from other ethnic groups also live there (table 1). A mixed method study was conducted, consisting of a survey amongst 60 residents (or respondents) of *Sophia's Lust* and an in-depth interview with ten of them. Of the 60 residents, 28% have always lived in this neighbourhood, 40% migrated from the Wanica district, 25% from Paramaribo and other districts in the coastal region, and 7% previously lived in the interior of the country. Most of the Maroons in this study claim not to have moved directly from the interior to *Sophia's Lust*. They first lived elsewhere in the coastal region before moving to *Sophia's Lust*.

Regarding ethical aspects of the field research in *Sophia's Lust*, the research design was approved by the Chair of *'Social Sciences in a multi-ethnic society with emphasis on research methodology'* of the Anton de Kom University of Suriname. In addition, everyone who was surveyed and interviewed received, in advance, an explanation about the nature and purpose of the study and gave permission to publish the edited results.

Table 1 – Ethnicity of respondents in *Sophia's Lust*, 2022

Ethnicity	*Number*	*Per cent.*
Creole	24	40%
Mixed	9	15%
Ndyuka (Maroon)	8	13%
Saamaka (Maroon)	7	12%
Matawai (Maroon)	1	2%
Javanese	5	8%
Indigenous	4	7%
East Indian (Hindostani)	2	3%
Total	**60**	**100%**

Source: Authors' work, based on a thesis by Robert (2022).

5 RESULTS AND DISCUSSION

Results from the recent sample survey in Sophia's Lust point to changes in taboo practices compared to the (early) 20th century. The findings fall into four categories:

1. a declining belief in a relationship between *trefu* and leprosy,
2. a merging of *tyina* and *trefu*,
3. a cross-cultural exchange of taboos between ethnic groups
4. a decreasing interest of young people in taboos.

Do the results obtained from the *Sophia's Lust* participants also apply to Paramaribo and the Wanica district, or more generally to the coastal region? We believe that the data cannot simply be generalised because the composition of the population and the distribution of key variables, such as ethnicity, is different in other neighbourhoods and regions. On the other hand, we assume that the social processes that have brought about the observed changes in *Sophia's Lust* also operate in other areas where the Maroons have settled and encountered people of other ethnic groups, possibly resulting in acculturation. We refer to densely populated neighbourhoods, such as *'Pontbuiten'* and *'Latour'* in the capital city Paramaribo, and *'De Nieuwe Grond'* and *'Saramacca Polder'*, neighbourhoods of the Wanica district (figure 2). Many Maroons, as well as people of other ethnicities, live in these neighbourhoods. This information is based on Jack Menke's personal observations and census data (Menke; Sno, 2016). Moreover, the interviews provide credible information about changes in the meaning and importance of the *tyina* and *trefu* concepts in Paramaribo and its surroundings. We assume that our findings in *Sophia's Lust* set out in four themes (in the next sections) also apply to parts of the coastal region, (including Paramaribo), with by and large the same composition of ethnic groups. But it will be clear that the validity of these findings for other regions needs to be investigated through additional research.

5.1 DECLINING BELIEF IN A RELATIONSHIP BETWEEN *TREFU* AND LEPROSY

Of the 60 residents of *Sophia's Lust* (none had leprosy) who have been surveyed, a third (33.3% of Maroons, 25% of Creoles and 29.4% of others) believe that a person can develop the disease leprosy by violating their *trefu* (Robert, 2022, p. 46). According to Lampe (1929, p. 551), almost a century ago, more than 90% of the pupils (healthy children) in a public school in the capital adhered to their *trefu* to prevent leprosy. Furthermore, there appears to be a decline in this belief among leprosy patients, although less pronounced than among healthy people. In the 1920s, 75 to 85% of leprosy patients were convinced that repeated violation of their *trefu* caused their disease (Lampe, 1929, p. 546). In the early 21st century, the belief in *trefu* as an alleged causal factor for leprosy still seemed to be alive among older leprosy patients (Van Haaren *et al*., 2016). However, interviews conducted between 2013 and 2015 among 30 leprosy patients (of whom 14 had been isolated in a leprosarium between 1938 and 1972) showed that 20 of them (67%) directly or indirectly attributed their leprosy to violating their *trefu* (Ramdas et al., p. 156). Moreover, one of these 20 patients used the word '*tyina*' rather than '*trefu*' to indicate the taboo she was supposed to adhere to. This was the first time we heard the word *tyina* in the coastal region instead of the familiar *trefu*. The narrative of this patient (named L.) indicates that things are changing and that the coastal taboo concept of *trefu* is in decline. L. is a *Saamaka* Maroon woman who had migrated from the interior to urban Paramaribo. In addition to the food products *podosiri* and *pokai*, soil (sand) is her *tyina*. She explained that sand had caused the leprosy lesions on her body (Reyme; Menke, 2019, p. 123). Her story suggests a merging between the coastal *trefu* concept and the *tyina* concept of the interior (see 5.2). We conclude that both data from the *Sophia's Lust* study and the patient's narratives indicate that today, fewer healthy people, as well as fewer leprosy patients (than in the past), believe that the disease leprosy is a result of violating their *trefu*. How can we explain this

change? We observe a general decline in young people's belief and practice of the traditional bans in the coastal region (see 5.4). This general decline also includes the belief in the relationship between *trefu* and leprosy. Indeed, 25% of people under 25 surveyed in *Sophia's Lust* are unfamiliar with the term trefu, compared to 11% of people over 25 (Robert, 2022, p.37). The decline in leprosy incidence in Suriname might also have contributed to the reduced belief in the relationship between *trefu* and leprosy. Finally, health education might be another contributing factor.

5.2 MERGING OF *TYINA* AND *TREFU*

About a century ago, *tyina* was practically unknown in Paramaribo. However, nowadays, more than 50% of the people in *Sophia's Lust* are familiar with this taboo. This can be attributed to the Maroons who have migrated to this neighbourhood. From the second half of the 20th century onwards, Maroons or their ancestors apparently brought *tyina*, an important part of their cultural heritage, from the interior to Paramaribo and the surrounding coastal region. Table 2 shows that all Maroon people (*Saamaka* and *Ndyuka*) are familiar with the concept of *tyina*. Of the Creoles (also people with African roots), 62% are familiar with it, and of the remaining groups, the vast majority (90%) are not familiar with *tyina* (Table 2).

Table 2 – Number and percentage of people in *Sophia's Lust* familiar with *tyina* (2022)

Familiar with Tyina	Ethnicity								Total	
	Saamaka		Ndyuka		Creole		Other			
	Number	Percent.	Number	Percent.	Number	Percent.	Number	Percent.	Number	Percent.
Yes	7	100%	8	100%	15	62%	2	10%	32	53%
No	0	0%	0	0%	9	38%	19	90%	28	47%
Total	**7**	**100%**	**8**	**100%**	**24**	**100%**	**21**	**100%**	**60**	**100%**

Source: Authors' work, based on a thesis by Robert (2022).

Regarding *trefu*, most Creoles (96%) and Maroons (*Saamaka* 86% and *Ndyuka* 88%) in *Sophia's Lust* appear familiar with this taboo. Of the other ethnic groups, two-thirds are aware of *trefu* (Table 3).

Table 3 – Number and percentage of people in *Sophia's Lust* familiar with *Trefu* (2022)

Familiar with Trefu	Ethnicity								Total	
	Saamaka		Ndyuka		Creole		Other			
	Number	Percent.	Number	Percent.	Number	Percent.	Number	Percent.	Number	Percent.
Yes	6	86%	7	88%	23	96%	14	67%	50	83%
No	1	14%	1	12%	1	4%	7	33%	10	17%
Total	**7**	**100%**	**8**	**100%**	**24**	**100**	**21**	**100%**	**60**	**100%**

Source: Authors' work, based on a thesis by Robert (2022).

So *trefu* is a well-known concept in *Sophia's Lust*, but compared with a century ago (Lampe, 1929, p.551), there seems to be some decline in familiarity with this food taboo. On the other hand, the familiarity with *tyina* shows an opposite movement because about 100 years ago, this term was practically unknown in urban Paramaribo. We conclude that today, *tyina* has taken root in the urban coastal region while *trefu* is diminishing as a concept. These changes coincide with the urbanisation of Maroons to Paramaribo and its surroundings.

Interviews conducted with ten respondents provide in-depth insights into ideas and practices of taboos in daily life (Robert, 2022, p. 81-87). They also illustrate the merging of *trefu* and *tyina*. Three of the interviewees, a Creole woman, an East Indian man and a Javanese man, confirmed their familiarity with *trefu*, but they had never heard of *tyina*. Of the remaining seven (all Maroon or Creole), four believe that *tyina* and *trefu* are the same and consider the words synonyms. Only one person doubts whether

the two words are the same, and two believe they are different. What is the difference between *tyina* and *trefu* according to these last two people? One of them (S.A., a Creole male) perceives *tyina* as to be a prohibition to work on certain days, so-called *tyina* dei (or *kina dei*), while in his opinion, *trefu* is a taboo on eating certain foods, including food prepared by a menstruating woman. Surprisingly, he also believes that *trefu* is taboo when entering certain roads. The other person (X.S., a Christian woman of *Saamaka* Maroon ancestry) explains that *tyina* is a prohibition obtained at birth. Her *tyinas* are *sara-sara* (shrimp) and *barbamang* (a type of catfish). If she eats them, she gets white spots, so-called 'lota spots', and a swollen throat. *Trefu*, she says, is something you should not do. For example, you cannot cook for men if you have already received '*pangi*'.

Furthermore, she explains that her mother also has *trefus*. For example, her mother is not allowed to eat certain food or do certain things because she is possessed by a snake named '*Tenzawa*'. This came about when working on an agricultural plot where she unintentionally killed a snake while lighting a fire. A kunu was born. Her mother must now worship this snake and is therefore not allowed to eat '*wānā*' and '*baaka wii*'. When her mother dies, her *trefus* can pass to someone else. This case again illustrates the entanglement of the taboos with the natural surroundings and the *Winti* religion. The narratives of S.A. and X.S. show a reversal of the meaning of *tyina* and *trefu*. For example, according to S.A., entering certain roads is a *trefu*. However, as said before, traditionally, in Paramaribo and the coastal region, *trefu* is a ban on eating certain foods, while a prohibition to enter certain places is part of the *tyina* concept from the interior.

We conclude that the interviews point to a merging of *tyina* and *trefu* in a neighbourhood where both Maroons and Creoles live and have intensive social contact in daily life.

5.3 CROSS-CULTURAL EXCHANGE BETWEEN PEOPLE OF DIFFERENT ETHNIC ORIGIN

Traditional taboos in Suriname are originally Afro-Surinamese practices. However, we are aware of cross-cultural diffusion with people of other ethnic groups. These are illustrative interviews of leprosy patients conducted between 2013-2015, indicating that various Javanese and East Indian patients ceased to eat certain foods on the advice of Creoles, hoping to turn the leprosy tide. For example, S.N., a Javanese leprosy patient, was advised by her Creole neighbours not to eat certain foods because her disease was said to be food-induced. On their advice, she stopped eating onions, garlic, scaleless fish, sardines, and red meat (Reyme; Menke, 2019, p. 130). Unsurprisingly, the recent in-depth interviews in *Sophia's Lust* indicate that the cross-cultural exchange of taboos also occurs among healthy people. A Javanese man (S.T.) explains that he knows trefu but himself has no *trefu*. He knows that many Creoles stick to their *trefu*, and he can imagine that some get leprosy if they do not adhere to their *trefu*. (Robert, 2022, p. 87). An East Indian man (R.B.) explains with great assurance that he certainly has *trefus* himself, quote: "*I don't like people lying to me, it's a trefu for me. That the people who I am with or whom I call friends or family look down on others, that is also my trefu. A trefu can be many things*" (Robert, 2022, p.85-86). R.B. uses the word *trefu* to express a state of mind and, in fact, to indicate something he does not like about people's attitudes or behaviour. R.B. has interpreted the trefu concept differently and taken on new aspects. His *trefus* does not resemble the traditional meaning assigned to the concept of *trefu* by the Afro-Surinamese community, indicating a substantive change of the coastal taboo concept (at least in the mind of R.B.) induced by acculturation.

Interestingly, the narratives of the interviewed people indicate the emergence of certain nuances and novel perspectives, by which we mean the different 'directions' the observed evolutionary changes can take. The testimony of the East Indian respondent (R.B.) is an example, representing a different nuance, indicating both a broadening and blurring of the traditional taboos. One might perhaps even speculate whether this case (R.B.) indicates that tyina and trefu in the coastal region could metamorphose into a 'container concept'. It is clear that further research is needed regarding the nuances of evolutionary developments in general.

5.4 DECREASING IMPORTANCE OF TABOOS AMONGST YOUNG PEOPLE

The *Sophia's Lust* survey indicates that young people attach decreasing importance to knowledge about and compliance with taboos. Transfer of knowledge about traditional taboos is considered less important by the younger generation than the older ones. Of the older Maroon generation in *Sophia's Lust*, 63% consider knowledge transfer about traditional taboos important, versus 55% of the young people. Amongst Creoles, these percentages are 54% versus 42%, respectively and among other ethnic groups 20% versus 15%, respectively. Furthermore, the results show that 55% of respondents violate their *trefu* or *tyina* (Robert, 2022, p. 83-84). As mentioned earlier, about a century ago, more than 90 % of the public school students in Paramaribo (for fear of leprosy) faithfully adhered to their *trefu*. The interviews in *Sophia's Lust* confirm the decline in knowledge regarding traditional taboos and actually complying with them, especially among the youth. The statement by M.M. (a Creole woman) at the end of her interview is significant: "*Young people adhere less to trefu and/or tyina than older people and people from the interior. The young people have buried their old [previous] life.*" (Robert, 2022, p. 83-84)

6 CONCLUSION AND FINAL CONSIDERATIONS

Traditional taboos originating from West Africa have been practised in Suriname until today. Our 2022 research shows that the geographical and conceptual dichotomy, with the dominance of the leprosy-related *trefu* food taboo in Paramaribo and the coastal region and the broad *tyina* taboo (food, places, action) in the interior, is diminishing. Taboo ideas and practices are still currently flourishing in the urban neighbourhood of *Sophia's Lust* in the coastal region. At the same time, however, our research indicates that things have changed compared to the (early) 20th century. In Paramaribo and the coastal region, we are witnessing a declining belief in the relationship between *trefu* (food taboo) and leprosy and a merging of *trefu* and *tyina* due to cross-cultural exchange and an adaptation of taboos (ideas and practices) between ethnic groups, and furthermore a decreasing belief in taboos by younger people.

While *trefu* is declining in Paramaribo and the coastal region, *tyina* is emerging in these regions. We assume that *trefu* originated from African totemism-linked taboo concepts, as Benjamins (1930) postulates. So *trefu* can be considered a concept that has separated itself from the African 'mother taboo concept', basically *tschina* from Loango, whether or not combined with taboos from other African regions. The present merging of*trefu* and *tyina* as concepts can thus be regarded as a kind of 'homecoming' of *trefu*.

The case study of traditional taboos in *Sophia's Lust* in 2022 indicates that cultural traditions in Paramaribo and the coastal region are changing. The migration of Maroons from the interior to the coastal region and the related creolisation process are the driving forces behind the observed changes concerning taboos. However, the strong decline in the prevalence of leprosy in the past decades might also have contributed, more in particular, to the declining belief that leprosy is caused by violating one's *trefu* (in fact, by eating the forbidden food). Finally, we suggest that what we are now mapping in the coastal region (the changes regarding traditional taboos) is part of a broader process of cultural changes in Suriname driven by recent internal demographic transitions.

Returning to the situation in the greater Caribbean, Lampe (1929, p. 562-563) noted that *kina* (another term for *tyina*) was found in the early 20th century in the Caribbean countries St Lucia, Martinique, Guadeloupe, British Guiana (now Guyana), French Guiana, British Honduras (now Belize), but not in Barbados, Trinidad, Antigua and Saint Kitts. Seventy-five years later, Maureen Warner-Lewis (2003, p. 104-106) reports that these taboos are found in Jamaica, Guyana, French Guiana and Surinamein the Americas. Recently received personal information indicates that traditional food bans are present today in a mitigated form in Haiti and Curacao[5]. The above indicates that traditional taboos in the past landed in the Greater Caribbean. These taboos may have disappeared in many countries or regions, but it could also be that they live on in a limited form, perhaps hidden in plain sight.

Suriname has the most enduring Maroon tribal communities in the Americas (Ngwenyama, 2007), which probably explains the persistence of *trefu* and *tyina*, the traditional taboos originating from West Africa. As explained before, these taboos are widely practised in the interior and the coastal region. Nevertheless, how sustainable are they in Suriname? Our study is too limited to draw far-reaching conclusions, but regarding sustainability, we have come across interesting evolutionary developments in the coastal region, e.g., young people practice traditional taboos less often than their parents (see section 5.4). This development is evident from the survey but is also made clear by the heartfelt cry of several interviewees who say with a mixture of pain and disappointment that the traditional taboos in the coastal region are in danger of fading away because young people do not adhere to the cultural traditions of their ancestors.

Additional research is needed in both Suriname and the Greater Caribbean to increase our knowledge about traditional taboos and their evolution.

NOTES

1 | In Suriname they are generally called Hindostani.

2 | The meaning of Creole and Mixed changed over the years in the censuses, in which ethnicity is determined by self-identification (Menke; Sno, 2016, p.105-126). In the *Sophia's Lust* study, ethnicity is also determined by self-identification. Creole refers to dark skinned people of predominantly African descent. Mixed refers to people who arise from a mixture of people of different ethnic groups.

3 | Other terms are also used to denote cultural fusion, depending on the context, like hybridization and acculturation.

4 | Various spellings and pronunciations are used, e.g.: *trefu*, *treff*, *treef*.

5 | Various spellings and pronunciations are used, e.g.: *tyina*, *tschina*, *xina*, *kina*, *kinah*.

6 | The Sephardic Jews from Pernambuco (Brazil) settled with their African slaves in the mid-17th century in Suriname and established sugar plantations in the Suriname River area. These Jews together with Northern European Ashkenazi jews were demographically and economically a large and visible group in Suriname throughout the colonial period. Around the end of the 17th century the Jews owned 40 sugar plantations with a total of 9,000 slaves and possessed 115 of a total of 400 plantations in Suriname (Menke; Menke, 2015, p. 266).

7 | In Brazil this disease is officially called Hanseníase.

8 | Lampe (1929, p. 548) explains that '*trefu-connoisseurs*' are nothing more than charlatans who squeeze money out of people who live in great fear due to leprosy.

9 | The belief that food somehow plays a role in the development of leprosy is certainly not an idea only among 'common' people. For example, Pandya (1998, p. 375) explains that In the 19th century the opposition to the idea that leprosy is contagious came from three scientific 'schools of thought': the hereditarian, the dietary, and the sanitarian. Furthermore Hutchinson (1906), the authoritative British physician and researcher, vigorously defended the view that leprosy was caused by eating fish. Trefu is contrary to these scientific explanatory concepts of leprosy researchers, a spiritual Surinamese explanation model based on African totemism.

10 | *Winti* is a Surinamese (Afro-American) religion, similar to Haitian *Voodoo*, Trinidadian *Shango*, Brazilian *Candomblé* and Cuban *Santeria* (Green, 1974, p.235).

11 | *Trefu* spots or *treef* spots are white spots on the skin.

12 | For example Sila, a 67 year old Hindostani (= East Indian) female leprosy patient explains that her general practitionerr (a Western trained physician) advised her to continue obeying her *trefus* (so, not eating the forbidden foods), because that would promote her healing (Ramdas *et al.*, 2019, p.161).

13 | Dju tongo means Language of the Jews.

14 | *Sranan* language is the local creole language spoken in Suriname.

15 | In the first decades of the 20th century, an avalanche of popular articles appeared in the newspapers in Suriname about the alleged relationship between *trefu* and leprosy, in which supporters and opponents debated fiercely. These newspaper articles are available at: delpher.nl.

16 | Physicians who encouraged their patients to stick to their *trefu*.

17 | The six Maroon groups are: *Saamaka* or *Saramaccaners* on the upper Suriname River, *Matawai* on the Saramacca River, *Kwinti* on the Coppename River, *Ndyuka* on the Marowyne and Cottica rivers, *Patamaccaners* on the Marowyne River and Boni's or *Aluku's* on the Lawa river.

18 | The *Ndyuka* are also called *Okanasi* or *Aucaners* by the Dutch (Eliza, 2017, p.22.).

19 | This *tyina* is related to a forbidden place (the river) and a forbidden action (splashing).

20 | Calculation based on data from tables 9 and 10, page 121 and table 1, page 251 in: Mozaiek van het Surinaamse Volk (Menke; Sno, 2016).

21 | The research was carried out by Orpheo Robert at the Anton de Kom University under supervision of Jack Menke. The study is laid down in Robert's batchelor thesis (Robert, 2022).

22 | *Podosiri* (Surinamese name) = acai (Brazilian name).

23 | *Pokai* (Surinamese name) = parrot.

24 | She says that a woman she fought with, threw earth (soil) on her and where the sand touched her body, leprosy bumps appeared. She claims that earth (soil) is her *tyina*.

25 | Personal communication from Karin Sewpersad, head of the leprosy control in Suriname.

26 | *Lota* spots are white spots on the skin, caused by a yeast (fungus). The spots resemble treef spots (see note 11).

27 | 'Receiving *pangi*' is a ritual that indicates the coming of age of a girl, whether or not related to the first menstruation.

28 | A *kunu* is a curse.

29 | '*Wānā*' is a type of wild boar and '*baaka wii*' is a vegetable.

30 | Personal information received from Orpheo Robert (see note 21).

31 | People of other ethnic groups, including people of Jewish descent, might also adhere to these taboos.

32 | Lampe does not provide a source, except for British Honduras; he received information from Dr. Burton, Principal Medical Officer in British-Honduras.

33 | Information received by e-mail on 27-05-2021 from Jean Casimir, referring to Haiti and on 24-05-2021 from Richenel Ansanoo, referring to Curacao.

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REFERENCES

BENJAMINS, H. D. Treef en lepra in Suriname. **De West-Indische Gids**. v. 11, p. 187-218, 1930. Available in: https://brill.com/view/journals/nwig/11/1/article-p187_18.xml. Access at: 14 Dec. 2023.

BOSMAN, W. A. **New and accurate description of the coast of Guinea, divided into the Gold, the Slave, and the Ivory coasts**. Printed for Sir Alfred Jones, K. C. M. G. by Ballantyne and co. Limited at the Ballantyne Press, London. 1907. p. 154-155. Available in: https://archive.org/details/newaccuratedescr00bosm/page/200/mode/2up?q=145 Access at: 14 Dec. 2023.

DAVIS, N. Z. Regaining Jerusalem: eschatology and Slavery in Jewish Colonization in Seventeeth-Century Suriname. **Cambridge Journal of Postcolonial Literary Inquiry**. v. 3, n. 1, p. 11-38, 2016. DOI: 10.1017/pli.2015.29.

DE BEET, C.; STERMAN, M. **People in between**: the Matawai Maroons of Suriname. PhD Thesis Utrecht University, Repro, Meppel, 1981. Available in: https://www.dbnl.org/tekst/beet027peop01_01/beet027peop01_01_0028.php. Access at: 14 Dec. 2023.

DROGNAT LANDRE, C. L. **De la contagion, seule cause de la propagation de la lèpre**. Baillière, Paris, 1869. 80p. Available in: https://wellcomecollection.org/works/hurf4g3n. Access at: 14 Dec. 2023.

ELIZA, F. R. **Language, culture and sustainability**: the case of the Ndyuka in Diitabiki, Suriname. (MSc Thesis) – Universidade de Brasília – UNB. Centro de Desenvolvimento Sustentável, Brasília, 2017.

FERMIN, P. **Nieuwe algemeene beschryving van de Colonie van Suriname, eerste deel**. Harlingen 1770, Ter Drukkerye van V. van der Plaats Junior, Harlingen, 2017. p.123-124. Available in: https://www.dbnl.org/tekst/ferm001nieu01_01/index.php. Access at: 14 Dec. 2023.

FLU, P. C. Verslag van een studiereis naar Suriname (Nederlandsch Guyana) Sept. 1927-Dec. 1927, en beschouwingen dienaangaande. Report on Investigations in Surinam (South America), September 1927 - December 1927). **Acta Leidensia**, v. 3, p. 1-188, 1928.

GIRVAN, N. Constructing the Greater Caribbean. *In:* LEWIS, P. et al (ed.), **Pan-Caribbean Integration**. Routledge, New York, 2018, 312 p.

GREEN, E. C. **The Matawai Maroons**: an Acculturating Afro American Society (of Suriname). (PhD Thesis) – George Washington University, 1974.

HERSKOVITS, M. J. Preliminary report of an ethnological expedition to Suriname. **De West-Indische Gids**. v. 10, p. 385-390, 1928.

HERSKOVITS, M. J.; HERSKOVITS, F. S. **Suriname folklore**. Columbia University Press, New York,1936. Available in: https://www.dbnl.org/tekst/hers005suri01_01/hers005suri01_01_0047.php. Access at: 14 Dec. 2023.

HUTCHINSON, J. **On leprosy and fish eating**. A statement of facts and explanations. Archibald Constable & Co., LD., London, 1906, 420p.

JUNKER, L. De Godsdienst der boschnegers III. **De West – Indische Gids**. v. 7, p. 152-164, 1925.

LAMPE, P. H. J. 'Het Surinaams treefgeloof' Een volksgeloof betreffende het ontstaan van de melaatschheid. **De West-Indische Gids**. v. 10, p. 545-568, 1929.

LANDRÉ, C. **Over de oorzaken van de verspreiding van lepra**. Een waarschuwend woord hoofdzakelijk gericht tot de bewoners van Suriname. Martin Nijhoff, 's-Gravenhage, 1889, 15 p.

MENKE, J. Ethnicity between Nation-building and Nation-creation. *In:* MEEKS, B. (ed.) **Caribbean Reasonings-M. G. Smith**: social theory and anthropology in the Caribbean and beyond. Ian Randle Publishers, Kingston, p. 196-220, 2011. 341 p.

MENKE, J.; MENKE, H. Decolonizing social sciences in Suriname: a strategic view in favor of regionalism. **Sustentabilidade em Debate**, v. 6, p. 260-275, 2015. DOI: https://10.18472/SustDeb.v6n2.2015.14725.

MENKE, J.; SNO, I. Ras en etniciteit in volkstelling van Suriname. *In:* MENKE, J. (ed.) **Mozaïek van het Surinaamse volk, volkstellingen in demografisch, economisch en sociaal perspectief**. ABS en IGSR, Paramaribo, 2016, 423 p.

MENKE, H.; PIETERS, T.; MENKE, J. How colonial power, colonized people and nature shaped leprosy settlements in Suriname. **Societies**. v. 10, n. 2, p. 32, 2020. DOI: https://doi.org/10.3390/soc10020032.

MENKE, H.; SNELDERS, S.; PIETERS, T. Leprosy control and contagionism in Suriname. **Academic Journal of Suriname**, v. 2, p. 168-175, 2011.

NGWENYAMA, C. N. **Material beginnings of the Saramaka maroons**: an archaeological investigation. PhD dissertation, Graduate school of the university of Florida, 2007.

PANDYA, S. S. Anticontagionism in leprosy, 1844–1897. **Int J Lepr Other Mycobact Dis**, v. 66, p. 374–384, 1998.

PECHUËLL LOESCHE, E. **Volkskunde von Loango**. Verlag von Strecker & Schröder, Stuttgart, 1907. Reissued in 2016 by Literaricon Verlag Inhaber Roswitha Werding, Uhlbergstr. 18, 91757 Treuchtlingen, 2016, 503 p.

RAMDAS, S. *et al.* Deel 3 De wereld van de Surinaamse leprapatiënt II Analyse: over stigma, pluralisme, treef en *tyina*. *In:* MENKE, H. *et al.* (ed.) **De Tenen van de Leguaan Verhalen uit de Wereld van Surinaamse Leprapatiënten**. LM Publishers, Volendam, 2019, 200 p.

REYME, M.; MENKE, J. Deel 2 De wereld van de Surinaamse leprapatiënt I Verhalen over liefde en haat, geloof en vloek, medeleven en uitsluiting. *In:* MENKE, H. *et al.* (ed.) **De Tenen van de Leguaan Verhalen uit de Wereld van Surinaamse Leprapatiënten**. LM Publishers, Volendam, 2019, 200 p.

ROBERT, O. ***Trefu* en *tyina***. De rol en betekenis van complexe taboeconcepten in het leven van bewoners van de buurt Sophia's Lust in Suriname. (BSc Thesis) –Anton de Kom University, Paramaribo, 2022.

SCHILLING, G. W. **Dissertatio medica inauguralis de lepra**. PhD dissertation Utrecht University, 1769.

SNELDERS, S. Leprosy and Slavery in Suriname: Godfried Schilling and the Framing of a Racial Pathology in the Eighteenth Century. **Soc. Hist. Med**. v. 26, p. 432–450, 2013. DOI: https://doi.org/10.1093/shm/hkt040.

SNELDERS, S. **Leprosy and colonialism Suriname under Dutch rule**, 1750-1950. Manchester University Press, 2017, 288 p.

SOINI, K.; BIRKELAND, I. Exploring the scientific discourse on cultural sustainability. **Geoforum**, v. 51, p. 213-223, 2014. DOI: https://doi.org/10.1016/j.geoforum.2013.12.001.

STEDMAN, J. G. **Narrative of a Five Years' Expedition against the Revolted Negroes of Surinam, in Guiana on the Wild Coast of South America from the years 1772 to 1777, vol II**. Publisher: J. ohnson, St Paul's Church Yard & J. Edwards, PallMall. 1796. Available in: https://books.google.nl/books?hl=nl&lr=&id=cm1dAAAAcAAJ&oi =fnd&pg=PR5&dq=Stedman,+JG+narrative+original+text&ots=cYyEq1kgLh&sig=IMhBdhmEekCejdXG2DEEcedkVMc#v=o nepage&q&f=false. Access at: 23 Dec. 2023.

TEENSTRA, M. D. **De landbouw in kolonie Suriname, tweede deel**. H. Eekhoff, Groningen, 1835.

TROUILLOT, M. R. Culture on the Edges: creolization in the Plantation Context. *In:* **Cahier ICF-2006**: the African diaspora & creolization literary forum. A.C.T.I.O.N. Foundation, Inc., Broward County, 2006.

VAN ANDEL, T. R. *et al.* Local plant names reveal that enslaved Africans recognized substantial parts of the New World flora. **Proceedings of the National Academy of Sciences**. v. 111, n. 50, 2015. E5346-E5353. DOI: https://doi.org/10.1073/pnas.1418836111.

VAN HAAREN, M. *et al.* Illness perceptions of leprosy-cured individuals in Surinam with residual disfigurements – "I am cured, but still I am ill." **Chronic Illness**, v. 13, n. 2, p. 117-127, 2017. DOI: 10.1177/1742395316657398.

VINK, W. **Creole Jews**: negotiating community in colonial Suriname. KITLV Press, Leiden, 2010.

WARNER-LEWIS, M. **Central Africa in the Caribbean**: transcending time, transforming cultures. University of the West Indies Press, Kingston, 2003.

WHITE, C. Explaining a Complex Disease Process: talking to patients about Hansen's disease (Leprosy) in Brazil. **Med Anthropol Q.**, v. 19, p. 310–330, 2008. DOI: https://doi.org/10.1525/maq.2005.19.3.310.

WHO. Global leprosy (Hansen disease) update, 2021: moving towards interruption of transmission. **Weekly epidemiological record global leprosy situation by WHO region, country and territories**. Available in: https://www.who.int/publications/i/item/who-wer9736-429-450. Access at: 14 Dec. 2023.

In this first issue of 2024, Sustainability in Debate, in its editorial, reflects on the responsibility of scientific journals and the community of authors, reviewers, and readers in its field of interest in the AI era.

Firstly, Fagundes and Schreiber discuss the main greenhouse gas emissions (GHG) sources in the Brazilian footwear industry. Following this, Meurer and van Bellen analyse how countries disclose their environmental-economic accounting for water through the SEEA-Water methodology. Barbosa and Ribeiro present an analysis of water conflicts and the governance structure of the Paraguay River Basin (South America). Monteiro *et al.* provide an overview of Science and Technology in the Amazon, discussing the role of various institutions and addressing the challenges of mobilising them for sustainable territorial development. Oliveira-Monteiro *et al.* assess the environmental perception, pro-ecological behaviours, and quality of life of the caiçara community of Praia do Perequê, located in Guarujá (SP). Lastly, Brites analyses the different environmental urban problems in the city of Posadas (Argentina). Ronquim *et al.* discuss the main factors favouring the regeneration of native vegetation in two regions of the state of São Paulo, while Budiyoko *et al.* investigate sustainable livelihood strategies of communities in the Monte Slamet region in the Central Java Province, Indonesia. Finally, Menke and Menke discuss traditional taboos present in Suriname in the context of the recent convergence of various groups in the capital Paramaribo and surrounding areas.

Nesta primeira edição de 2024, Sustainability in Debate*, em seu editorial, reflete sobre a responsabilidade das revistas científicas e da comunidade de autores, revisores e leitores em seu campo de interesse, na era da inteligência artificial.*

*Primeiramente, Fagundes e Schreiber discutem as principais fontes de emissões de gases de efeito estufa (GEE) nas indústrias brasileiras de calçados. Em seguida, Meurer e van Bellen apresentam uma análise de como diferentes países divulgam sua contabilidade Ambiental-econômica para água por meio da metodologia SEEA-*Water*. Barbosa e Ribeiro apresentam uma análise dos conflitos e da estrutura de governança da água na Bacia do Rio Paraguai (América do Sul). Monteiro* et al. *fornecem uma visão geral da Ciência e Tecnologia na Amazônia, discutindo o papel de diversas instituições e abordando os desafios de mobilizá-las para o desenvolvimento territorial sustentável. Oliveira-Monteiro* et al. *avaliam a percepção ambiental, os comportamentos pró-ecológicos e a qualidade de vida da comunidade caiçara da Praia do Perequê, localizada na cidade de Guarujá (SP). Por fim, Brites analisa os diferentes problemas ambientais urbanos na cidade de Posadas (Argentina). Ronquim* et al. *discutem os principais fatores que favorecem a regeneração da vegetação nativa em duas regiões do estado de São Paulo, enquanto Budiyoko* et al. *investigam estratégias de subsistência sustentável de comunidades na região do Monte Slamet, na Província de Java Central, Indonésia. Por último, Menke e Menke discutem tabus tradicionais presentes no Suriname no contexto da recente convergência de diversos grupos na capital Paramaribo e áreas circundantes.*

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