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Editorial

Annus Horribilis- 2020

Marcel Bursztyn, Gabriela Litre, Melissa Curi, Carlos Hiroo Saito

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It was the year 1666. Superstitious feared calamities, given the combination 666, which according to old religious beliefs meant the number of the beast. In countries such as Spain, Portugal, and Italy, the Holy Inquisition imposed severe persecution on those who refused to confront the obscurantism of Catholic dogmas. Only a quarter of a century earlier, Galileo Galilei had to account to the inquisitors for his contribution to Copernicus' theory of heliocentrism. Calamities certainly happened, such as the Great Fire of London, when, in September 1666, and after 4 days, 1800 km2 of the city turned to ashes. The destruction of 13,200 homes has left 100,000 homeless. But despite the catastrophes, the year 1666 is known as *Annus Mirabilis* or the miraculous year. In the same country, England, Isaac Newton emerged with his remarkable contributions to the advancement of science. That year, he formulated the "law of gravity". The expression *Annus Mirabilis* was used again on other occasions, such as in 1905, when Einstein laid the foundations of the theory of relativity.

The reference is opportune because it puts us face to face with two poles that historically drive or slow the advance of human knowledge: imagination and dogmatic obscurantism; or the scientific spirit vs. the delay.

In this year of 2020, we are living an *Annus Horribilis*. The pandemic of the new coronavirus (COVID-19) spread throughout the world with the same speed and intensity as most of the flows that today connect different peoples, in different locations: information and communications, exchanges of goods, displacement of people.

Today, as in other times, we are facing a polarization between reason and delay. While the scientific community mobilizes to seek a way to face this tremendous challenge, we find, perplexed, the disconcerting presence of retrograde and negationist forces in the face of reality. And it is not just bizarre sects circumscribed to small groups. There are arguments for political actions aimed at concealing the problem and that cry out against scientific reason. They oppose the logic of business in the short term to the very principle of the perpetuity of life, which is (or should be) the major foundation of any ethical principle.

It is important to consider that this harsh reality is not a simple present issue: SeD, in its 2017-2 editorial (We will always have Paris), dealt with denialism and the withdrawal from the Paris Agreement by the USA. In the same edition, in an opinion article, the editors discussed the attack on science and the organized reaction, through Marches for Science, worldwide.

Heralds of delay achieve considerable audience and political legitimacy thanks to demagogic and "disinformant" gestures and arguments, conveyed through a formidable capillarity and speed of the media, many of which do not have moral or scientific filters. In the global context, Brazil appears as a negative example of the relationship between the world of politics, particularly in the sphere of the executive, and the real world. It is worth remembering that almost a third of Brazilians, between fifteen and sixty-four years, are "functionally illiterate", which means that they struggle to read more than keywords in most written texts[1].

1 | Fajardo, V. (2018). Como o analfabetismo funcional influencia a relação com as redes sociais no Brasil. BBC News Brasil. Available at: https://www.bbc.com/portuguese/brasil-46177957.

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These Brazilians are predominantly active on social media, with 86% using WhatsApp and 72% on Facebook. However, this segment of the population is particularly vulnerable to believing and disseminating fake news, especially those related to environmental sciences or human rights, given their preference for images, videos, audio messages, and simple and brief texts, common on social media. Members of this group are also less likely to verify the information they consume, to detect irony, malice, or embedded satire, or to question unfounded and exaggerated claims and sources[2].

In addition to the study of the massive "consumers" of obscure campaigns, some troubling questions arise to the debate about what is the explanation for such polarization of ideas and attitudes and what direction is to follow:

- Why does the world of politics consecrate so many troubled minds as leaders (since at least the times of Nero)?

- How did we come to this situation of political legitimacy of obscurantism and bestiality in the 21st century? Preaching that the Earth is flat sounds like something almost harmless or eccentric, compared to the refusal to accept that a pandemic is a serious thing.

- How can we expect the principle of solidarity with future generations to prevail, which serves as the basis for the environmental thinking, if we are not even able to apply this principle to the present time? It is incredible how some leaders refuse to act as statesmen, committed to the common good.

The COVID-19 pandemic points to political dilemmas, but, like every crisis, opens room for opportunity for path corrections.

The world experienced, in a very generalized way, from the end of the 1970s, a wave of reduction in state's regulatory action, which was based on the idea that the market regulates itself. Today, we are seeing that without the state and its protection mechanisms (of the economy, people, environment), the trend is disruptive. This is possibly the first lesson. And it's nothing new, since, almost ninety years ago, Keynes had already pointed this out in his proposal to leave the 1930s Great Depression.

Another lesson is that the ease and speed of circulation of information has positive but also negative implications. Without filters, distorted truth disinforms and crystallizes leaderships of braggarts and fanatics, immune to reason.

It would be assumed that the general increase in material well-being since the post-World War II would lead to a more empathetic and less individualistic societal order. That did not happen. Inequalities have grown. But the COVID-19 pandemic can contribute to building a more selfless path.

Anyone who deals with sustainability issues is familiar with the precautionary principle. But our society has not yet assimilated this idea into its practices. It is time to internalize precaution as a parameter of public decisions. Investments in social and environmental protection cannot be subjected only to the coldness and immediacy of the orthodox economic calculus. An idle hospital bed should not be treated as a bad investment, but as a safeguard for times of crisis, such as the current one.

It is also clear that complex problems require creative coping modes. Interdisciplinarity, so present in addressing topics such as sustainable development and relations between humans and the environment, is presented as a necessary and timely approach. Only in this way is it possible to establish a dialogue between different scientific fields. After all, the current pandemic is a subject for

2 | Harden, C. (2019) Brazil Fell for Fake News: What to Do About It Now? Blog Post, Wilson Center's Brazil Institute, Part of the Democracy and the Rule of Law, first published on February 21, 2019.

medical professionals, but also for sociology, engineering, economics, and a wide range of specialties, which must work in an integrated way.

Science has much to contribute to tackling the current crisis. It is not just its product (knowledge and solutions) that count. It is also important to the *modus operandi* of academic production (the use of method) and validation of the results (peer evaluation). Much has evolved in the sphere of public decisions over the last few decades. Advisory councils were created for decision makers, bringing together different segments of society. Spaces for social participation were opened in the sphere of public policies.

The same science that is called today to save humanity, has been budgetary depreciated, subdued to bureaucratic dictates of execution, and denied in its solidity. Today, the race against time shows the price of delay. We do not harvest fruits overnight; continuous investment and the creation of a scientific culture are needed.

The environmental area is exemplary in these aspects. Decisions regarding the tackling of problems with the severity of the COVID-19 pandemic cannot be confined to a handful of public agents who do not base their thinking on the rigor of the rites of scientific validation and the legitimacy of society's participation. In addition to the generation of scientifically validated and legitimate knowledge, we also need to think about the "society": the habits of consuming this information and education for good use of technology. Experts propose that the promotion of critical thinking and education in general (including scientific) is the only plausible solution, in the long run, to this information dilemma[3].

Thus, this crisis can also lead us to reflect on the mode of consumption of our society and rethink values. With ample investment in the promotion of new habits of information consumption, Brazil can reach a point where social media serves direct democracy, constructive debate, and the dissemination of more reliable information in fields so closely linked such as human health and the environment. Studies have shown that the destruction of the environment, with the transformation of landscapes and forms of contact with wildlife, can be at the origin of the spread of diseases.

Returning to the *Annus Mirabilis* of 1666, it is worth remembering a perhaps encouraging fact for the present situation: a year before Newton's great discoveries, on July 25, 1665, a five-year-old boy named John Morley had been found dead in his Holy Trinity Parish home in Cambridge, England. When city authorities examined his corpse, they noticed black spots on his chest, the unmistakable mark of the bubonic plague. Little Morley was the first known case and death of the disease in Cambridge that year: the sign that the London outbreak that spring advanced to the city where young Newton studied, at Trinity College.

Many people in the city rushed to isolate themselves in the field, including Newton, whose home was about 100 kilometers north of the university. Appropriately distant from the nearest city, it was there, in almost total solitude, where he invented calculus, created the science of movement, revealed gravity and more. Newton's forced isolation certainly did not give rise to his ideas, which he had been working on before, but certainly fuelled the conditions of reflection and contact with nature in which modern science could be created.

Just as in 1666, perhaps 2020 is the opportunity to transform COVID-19's *Annus Horribilis* and episodes of returning to obscurantism into a new *Annus Mirabilis*. It is worth remembering that, unlike Newton's time, we now have means of communication and interaction in real-time that allow combining physical distancing with virtual proximity, which opens wide possibilities of collective scientific production, even without physical contact. *Sustainability in Debate* moves forward to help illuminate this path.

This edition of *Sustainability in Debate* contains 10 articles in the *Varia* section. The first article, entitled "Permanent Preservation Areas scenarios in dairy farms in the Vale do Taquari against the forest code",

3 | Ferreira, P. (2018) The first step is to have critical sense and question,' says educator about combating fake news. Available at https://oglobo.globo.com/sociedade/educacao/educacao-360/o-primeiro-passo-ter-senso-critico-questionar-diz-educador-sobre-combate-noticias-falsas-23071727

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by the authors Caio Zart Daiello and Claudete Rempel, aims to analyze the implications of innovations in the regulation of permanent preservation areas implemented by the New Forest Code.

In the article "Territorial and environmental management in the indigenous lands of rio Paru de Leste: a collective challenge in the northern Brazilian Amazon", the authors Iori van Velthem Linke et al. analyze the sociopolitical scope and mobilization involved in the implementation of the National Policy for Environmental and Territorial Management of Indigenous Reserves - PNGAT with the indigenous peoples of the Paru de Leste River, in the north of the Amazon.

The authors Ana Cláudia Cardoso, Kamila Oliveira and Taynara Pinho, in the article "Mismatches between extended urbanization and everyday socioenvironmental conflicts in Santarém, Pará, Brazil", investigate the reasons for the non-flowering of the environmental debate in the contemporary urbanization of the Global South, through a study of the newly created Metropolitan Region of Santarém, located in the Brazilian Amazon.

The article "Economistic discourses of sustainability: determining moments and the question of alternatives", by the authors Esther Meyer and Ulli Vilsmaier, presents an analytical-discursive review of the concepts of sustainability in an intercultural perspective.

In the article "Globalization and consumption: a case study of cool roofs as socio-environmental alternative", the authors Anderson Belem, Bruno de Borowski and Mairon Machado analyze the effect of white roofs in the reduction of internal temperature in buildings in São Borja, RS. The study proves a considerable reduction in the average temperature, but reports that the financial return is only achieved in the long run.

The authors Jaqueline Koser, Celso Barbieri and Tiago Francoy, in the article "Legislation on meliponiculture in Brazil: social and environmental demand", propose a revision of the Brazilian legislation related to meliponiculture in the country, as well as its applicability, proposing changes in the Environmental Crimes Law.

In the article "Socio-environmental accounting system in health management: a case study at the Vision Institute", the authors Tatiana Abe and Simone Miraglia analyze the applicability of a socio-environmental management tool in Health Management, through the partial application of the Environmental Management Accounting System (SICOGEA) - Generation 3.

The article "Impacts of the Fomento Program on Family Farmers in the Brazilian Semi-Arid and its Relevance to Climate Change: A case study in the region of Sub medio São Francisco", by the authors Patrícia Mesquita et al. aims to present results on the perception of the impacts of the Program from the point of view of 24 family farmers, interviewed through qualitative research, in 2017, in four municipalities in the states of Bahia. In addition to the socio-productive aspects, the research sought to understand the impacts of the Program in the context of climate change.

The authors Mariana Adas et al., in the article "Reforest or perish: ecosystem services provided by riparian vegetation to improve water quality in an urban reservoir (São Paulo, Brazil)", study two scenarios in relation to the economic costs of ecosystem services provided by protected riparian vegetation (RPA) of the banks and tributaries of the Guarapiranga Dam, São Paulo, Brazil.

Finally, the article "Development of natural and innovative material for application as thermal insulation in buildings", by the authors Rodrigo Spinelli et al., aims to demonstrate the development of a façade cladding plate for buildings, with thermal insulation from the vacuum, and the corn cob.

We thank the authors who honor SeD with the submission of their works and the evaluators who collaborated with this edition. We hope you enjoy reading this issue.

The Editors

Editorial

Annus Horribilis- 2020

Marcel Bursztyn, Gabriela Litre, Melissa Curi, Carlos Hiroo Saito

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Era o ano de 1666. Supersticiosos temiam calamidades, dada a combinação 666, que segundo velhas crenças religiosas significava o *número da besta*. Em países como Espanha, Portugal e Itália, a Santa Inquisição impunha severa perseguição aos que ousassem afrontar o obscurantismo dos dogmas católicos. Apenas um quarto de século antes, Galileu Galilei precisou prestar contas aos inquisidores, a respeito de sua contribuição à teoria do heliocentrismo, de Copérnico. Calamidades certamente aconteceram, como o Grande Incêndio de Londres, quando, em setembro de 1666, e ao fim de 4 dias, 1800 km2 da cidade viraram cinzas. A destruição de 13.200 casas deixou 100 mil desabrigados. Mas, apesar das catástrofes, o ano de 1666 é conhecido como *Annus Mirabilis* ou ano miraculoso. No mesmo país, Inglaterra, Isaac Newton despontava com suas notáveis contribuições ao avanço da ciência. Naquele ano ele formulou a "lei da gravidade". A expressão *Annus Mirabilis* voltou a ser usada em outras ocasiões, como em 1905, quando Einstein lançou as bases da teoria da relatividade.

A referência é oportuna, pois nos coloca frente a frente com dois polos que historicamente impulsionam ou freiam o avanço do conhecimento humano: a imaginação e o obscurantismo dogmático; ou o espírito científico vs. o atraso.

Nesse ano de 2020 estamos vivendo um *Annus Horribilis*. A pandemia do novo coronavírus (Covid-19) se espalhou pelo mundo com a mesma rapidez e intensidade que a maioria dos fluxos que hoje conectam diferentes povos, em diferentes localidades: das informações e comunicações, das trocas de mercadorias, dos deslocamentos de pessoas.

Hoje, como em outras épocas, estamos diante de uma polarização entre a razão e o atraso. Ao mesmo tempo em que a comunidade científica se mobiliza para buscar um modo de enfrentamento desse grande desafio, constatamos, perplexos, a desconcertante presença de forças retrógradas e negacionistas frente à realidade. E não são apenas seitas bizarras e circunscritas a pequenos grupos. Há claramente argumentos a ações políticas que visam a escamotear o problema e que bradam contra a razão científica. Opõem a lógica dos negócios no curto prazo ao próprio princípio da perenidade da vida, que é (ou deveria ser) o fundamento maior de qualquer princípio ético.

É importante considerar que essa dura realidade não é de agora: a revista *SeD*, em seu editorial de 2017-2 (*Sempre teremos Paris*), tratou do negacionismo e da saída do Acordo de Paris pelos EUA. No mesmo número da revista, em artigo de opinião, os editores discutiram o ataque contra a ciência e a reação organizada por meio de Marchas pela Ciência, no mundo todo.

Arautos do atraso conseguem considerável audiência e legitimidade política graças a gestos e argumentos demagogos e "desinformadores", veiculados graças à formidável capilaridade e velocidade dos meios de comunicação, muitos dos quais não dispõem de filtros morais ou científicos. No contexto mundial, o Brasil aparece como exemplo negativo da relação entre o mundo da política, em particular na esfera do executivo, e mundo real. Vale lembrar que quase um terço dos brasileiros entre quinze e

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sessenta e quatro anos é "analfabeto funcional", o que significa que eles lutam para ler mais do que palavras-chaves na maioria dos textos escritos[1].

Esses brasileiros são predominantemente ativos nas mídias sociais, com 86% usando o WhatsApp e 72% no Facebook. No entanto, esse segmento da população é particularmente vulnerável a acreditar e divulgar notícias falsas, especialmente as referentes às ciências ambientais ou aos direitos humanos, dada sua preferência por imagens, vídeos, mensagens de áudio e textos simples e breves, comuns nas mídias sociais. Os membros desse grupo também têm menos probabilidade de verificar as informações que consomem, de detectar ironia, malícia ou sátira embutida ou de questionar alegações e fontes infundadas e exageradas[2].

Para além do estudo dos "consumidores" massivos de campanhas obscurantistas, algumas perguntas inquietantes se colocam ao debate sobre qual a explicação para tamanha polarização de ideias e atitudes e quais os rumos a serem seguidos:

- Por que o mundo da política consagra tantas mentes perturbadas como lideranças (desde, pelo menos, os tempos de Nero)?

- Como chegamos, em pleno século XXI, a esta situação de legitimação política do obscurantismo e da bestialidade? Pregar que a Terra é plana soa até como algo quase inofensivo ou excêntrico, diante da recusa em aceitar que uma pandemia é coisa séria.

- Como esperar que prevaleça o princípio da solidariedade com as futuras gerações, que serve de fundamento ao pensamento ambientalista, se sequer estamos conseguindo aplicar esse princípio ao tempo presente? É incrível o descaso como alguns dirigentes se recusam a atuar como estadistas, comprometidos com o bem comum.

A pandemia do Covid-19 nos aponta dilemas políticos, mas, como toda crise, abre espaço de oportunidade para correções de rumo.

O mundo viveu, de forma bem generalizada, a partir do final dos anos 1970, uma onda de redução da ação reguladora do Estado, que teve como fundamento a ideia de que o mercado se auto-regula. Hoje, estamos vendo que sem o Estado e seus mecanismos de proteção (da economia, das pessoas, do meio ambiente), a tendência é disruptiva. Esta é possivelmente a primeira lição. E não é novidade, já que quase noventa anos atrás Keynes já havia apontado isso, em sua proposta de saída para a Grande Depressão Americana do início dos anos 1930.

Outra lição é que a facilidade e a velocidade de circulação de informações tem implicações positivas, mas também negativas. Sem filtros, a verdade distorcida desinforma e cristaliza lideranças de fanfarrões e fanáticos, imunes à razão.

Seria de se supor que o aumento geral do bem-estar material, desde o pós-Segunda Guerra Mundial, levasse a uma ordem societal mais empática e menos individualista. Isto não aconteceu. As desigualdades cresceram. Mas a pandemia do Covid-19 pode contribuir para que seja pavimentada uma via em um sentido mais altruísta.

Quem lida com o pensamento sobre sustentabilidade está familiarizado com o princípio da precaução. Mas nossa sociedade ainda não assimilou esta ideia em suas práticas. É hora de internalizar a precaução como parâmetro das decisões de caráter público. Os investimentos em proteção social e ambiental

1 | Fajardo, V. (2018). Como o analfabetismo funcional influencia a relação com as redes sociais no Brasil. BBC News Brasil. Available at: https://www.bbc.com/portuguese/brasil-46177957.

2 | Harden, C. (2019) Brazil Fell for Fake News: What to Do About It Now? Blog Post, Wilson Center's Brazil Institute, Part of the Democracy and the Rule of Law, first published on February 21, 2019.

não podem estar submetidos apenas à frieza e imediatismo do cálculo econômico ortodoxo. Um leito hospitalar ocioso não pode ser tratado como mau investimento, mas sim como salvaguarda para momentos de crise, como a atual.

Fica também claro que problemas complexos demandam modos de enfrentamento criativos. A interdisciplinaridade, tão presente no tratamento de temas como o desenvolvimento sustentável e as relações entre os humanos e o meio ambiente, apresenta-se como abordagem necessária e oportuna. Só assim é possível estabelecer um diálogo entre diferentes campos científicos. Afinal, a pandemia atual é um assunto para profissionais das áreas médicas, mas também para os da sociologia, das engenharias, da economia e de uma ampla gama de especialidades, que devem trabalhar de forma integrada.

A ciência tem muito a contribuir com o enfrentamento da crise atual. Não é apenas o seu produto (conhecimentos e soluções) que contam. Importa também o *modus operandi* da produção acadêmica (do recurso ao método) e da validação dos resultados (a avaliação pelos pares). Muita coisa evoluiu na esfera das decisões públicas, ao longo das últimas décadas. Criou-se conselhos de assessoria aos decisores públicos, reunindo diferentes segmentos da sociedade. Foram abertos espaços de participação social na esfera das políticas públicas.

A mesma ciência que é chamada hoje a salvar a humanidade, foi desprestigiada orçamentariamente, subjugada a ditames burocráticos de execução e negada em sua solidez. Hoje, a corrida contra o tempo mostra o preço do atraso. Não se colhem frutos da noite para o dia; é preciso investimento contínuo e a criação de uma cultura científica.

A área ambiental é exemplar quanto a esses aspectos. Decisões referentes ao enfrentamento de problemas com a gravidade da pandemia do Covid-19 não podem se circunscrever a um punhado de agentes públicos que não estejam fundamentados no rigor dos ritos da validação científica e na legitimidade da participação da sociedade. Para além da geração de conhecimentos cientificamente validados e legítimos, também precisamos pensar na "sociedade": nos hábitos de consumo dessa informação e na educação para um bom uso da tecnologia. Especialistas propõem que a promoção do pensamento crítico e da educação em geral (inclusive científica) são a única solução plausível, no longo prazo, para esse dilema da informação[3].

Assim, a crise também pode nos levar a refletir sobre o modo de consumo de nossa sociedade e repensar valores. Com amplo investimento na promoção de novos hábitos de consumo de informações, o Brasil pode chegar a um ponto em que as mídias sociais sirvam à democracia direta, ao debate construtivo e à disseminação de informações mais confiáveis em campos tão intimamente vinculados como a saúde humana e o meio ambiente. Em efeito, estudos tem mostrado que a destruição do meio ambiente, com a transformação de paisagens e formas de contato com a vida silvestre, podem estar na origem da disseminação de doenças.

Voltando ao *Annus Mirabilis* de 1666, vale lembrar um fato talvez encorajador para os dias atuais: um ano antes das grandes descobertas de Newton, em 25 de julho de 1665, um menino de cinco anos chamado John Morley, tinha sido encontrado morto em sua casa da paróquia da Santíssima Trindade em Cambridge, Inglaterra,. Quando as autoridades da cidade examinaram seu cadáver, notaram manchas pretas em seu peito, a marca inconfundível da peste bubônica. O pequeno Morley foi o primeiro caso conhecido e a morte da doença em Cambridge naquele ano: o sinal de que o surto de Londres naquela primavera avançou para a cidade onde o jovem Newton estudava, no Trinity College.

Muitas pessoas da cidade correram para se isolar no campo, incluído Newton, cuja casa ficava a cerca de 100 quilômetros ao norte da universidade. Apropriadamente distante da cidade mais próxima, foi

3 | Ferreira, P. (2018) O primeiro passo é ter senso crítico e questionar', diz educador sobre combate a notícias falsas. Available at https://oglobo.globo.com/sociedade/educacao/educacao-360/o-primeiro-passo-ter-senso-critico-questionar-diz-educador-sobre-combate-noticias-falsas-23071727

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lá, em quase total solidão, onde ele inventava o cálculo, criava a ciência do movimento, revelava a gravidade e muito mais. O isolamento forçado de Newton certamente não deu origem às suas ideias, que ele já vinha trabalhando anteriormente, mas, com certeza, alimentou as condições de reflexão e de contato com a natureza em que a ciência moderna poderia ser criada.

Assim como em 1666, talvez 2020 seja a oportunidade de transformar o *Annus Horribilis* do COVID-19 e de episódios de retorno ao obscurantismo em um novo *Annus Mirabilis*. Vale lembrar que, diferentemente do tempo de Newton, dispomos hoje de meios de comunicação e interação em tempo real que permitem combinar o distanciamento físico com a proximidade virtual, o que abre amplas possibilidades de produção científica coletiva, mesmo sem contato físico. *Sustentabilidade em Debate* segue em frente para ajudar a iluminar esse caminho.

A presente edição de *Sustentabilidade em Debate* contém 10 artigos na seção *Varia*. O primeiro artigo, denominado "Cenário das áreas de preservação permanente em propriedades rurais produtoras de leite no Vale do Taquari ante o Código Florestal", dos autores Caio Zart Daiello e Claudete Rempel, tem como objetivo analisar as implicações das inovações no regramento das Áreas de Preservação Permanente implementadas pelo Novo Código Florestal.

No artigo "Gestão territorial e ambiental nas terras indígenas do Rio Paru de Leste: um desafio coletivo no Norte da Amazônia brasileira", os autores Iori van Velthem Linke et al. analisam o alcance sociopolítico e a mobilização envolvidas na implementação da Política Nacional de Gestão Ambiental e Territorial - PNGAT com os povos indígenas do rio Paru de Leste, do norte da Amazônia.

As autoras Ana Cláudia Cardoso, Kamila Oliveira e Taynara Pinho, no artigo "Descompassos entre a urbanização extensiva e os conflitos socioambientais cotidianos em Santarém, Pará, Brasil", investigam as razões para o não florescimento do debate ambiental na urbanização contemporânea do Sul Global, por meio de um estudo da recém-criada Região Metropolitana de Santarém, localizada na Amazônia brasileira.

O artigo "Discursos economicistas de sustentabilidade: momentos determinantes e a questão de alternativas", das autoras Esther Meyer, Ulli Vilsmaier, apresenta uma revisão analítica-discursiva dos conceitos de sustentabilidade em uma perspectiva intercultural.

No artigo "Globalização e consumo: um estudo dos telhados brancos como alternativa socioambiental", os autores Anderson Belem, Bruno de Borowski, Mairon Machado analisam o efeito dos telhados brancos para a redução de temperatura interna em edifícios de São Borja, RS. O estudo comprova uma redução considerável na temperatura média, mas relata que o retorno financeiro é alcançado a longo prazo.

Os autores Jaqueline Koser, Celso Barbieri e Tiago Francoy, no artigo "Legislação sobre meliponicultura no Brasil: demanda social e ambiental", propõem uma revisão da legislação brasileira em relação à meliponicultura no País, bem como sobre sua aplicabilidade, propondo alterações na Lei de Crimes Ambientais.

No artigo "Sistema contábil socioambiental para gestão em saúde: um estudo de caso no Instituto da Visão", as autoras Tatiana Abe e Simone Miraglia analisam a aplicabilidade de uma ferramenta gerencial socioambiental na Gestão em Saúde, por meio da aplicação parcial do Sistema Contábil Gerencial Ambiental (SICOGEA) - Geração 3.

O artigo "Impactos do Programa de Fomento sobre os Agricultores Familiares do Semiárido Brasileiro e sua Relevância frente às Mudanças Climáticas", dos autores Patrícia Mesquita et al. tem como objetivo apresenta resultados sobre a percepção dos impactos do Programa do ponto de vista de 24 agricultores familiares, entrevistados por meio de pesquisa qualitativa, em 2017, em

quatro municípios dos estados da Bahia. Além dos aspectos socioprodutivos, a pesquisa procurou compreender os impactos do Programa frente às mudanças climáticas.

Os autores Mariana Adas et al., no artigo “Refloreste ou pereça: serviços ecossistêmicos providos pela vegetação ripária para melhorar a qualidade da água em um reservatório urbano (São Paulo, Brasil)”, estudam dois cenários em relação aos custos econômicos dos serviços ecossistêmicos providos pela vegetação ripária protegida (RPA) das margens e afluentes da Represa Guarapiranga, São Paulo, Brasil.

Por fim, o artigo “Desenvolvimento de material natural e inovador para aplicação como isolamento térmico em edificações”, dos autores Rodrigo Spinelli et al., tem como objetivo demonstrar o desenvolvimento de uma placa de revestimento de fachada para edificações, com isolamento térmico partindo do vácuo, e do sabugo de milho.

Agradecemos aos autores que prestigiam SeD com o envio de seus trabalhos e aos avaliadores que colaboraram com esta edição. Desejamos uma boa leitura.

Os Editores

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Permanent Preservation Areas scenarios in dairy farms in the Vale do Taquari against the Forest Code

Cenário das áreas de preservação permanente em propriedades rurais produtoras de leite no Vale do Taquari ante o Código Florestal

Caio Zart Daiello[a]

Claudete Rempel[b]

[a]Master in Sustainable Environmental Systems, Universidade do Vale do Taquari - Univates, Lajeado, RS, Brazil.
E-mail: caiodaiello@universo.univates.br

[b]Doctor in Ecology, Universidade do Vale do Taquari - Univates, Lajeado, RS, Brazil.
E-mail: crempel@univates.br

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ABSTRACT

The present study sought to analyze the implications of innovations in the Permanent Preservation Areas (PPAs) regulation implemented by the New Forest Code (Law 12.651 / 2012). The use and cover of the PPAs of five milk producing rural properties, located in the Taquari Valley, RS, were identified and the rules of the Code were applied, in order to determine the areas that must be recovered and respected in each property. The research adopted the deductive approach, with a quali-quantitative methodological approach, and the technical procedures of field and case study were used. The results showed that the total areas to be respected represent 11.72%, 5.10%, 59.77%, 81.63% and 98.37% of the properties' PPAs, indicating that the innovations presented by the Code can cause significant reduction in the PPA to be respected, in addition to resulting in different protection measures among the properties, imposing greater burdens on those in which the native vegetation was more preserved.

Keywords: New Forest Code. Permanent Preservation Area. Consolidated Rural Area. Milk production. Taquari Valley.

RESUMO

O presente estudo buscou analisar as implicações das inovações no regramento das Áreas de Preservação Permanente (APPs) implementadas pelo Novo Código Florestal (Lei 12.651/2012). Foram identificados o uso e cobertura das APPs de cinco propriedades rurais produtoras de leite, localizadas no Vale do Taquari, RS, e aplicadas as regras do Código, a fim de determinar as áreas que devem ser recuperadas e respeitadas em cada propriedade. A pesquisa adotou o método dedutivo, com abordagem metodológica qualiquantitativa, e empregados os procedimentos técnicos de estudo de campo e estudo de caso. Os resultados apontaram que as áreas totais a serem respeitadas

representam 11,72%, 5,10%, 59,77%, 81,63% e 98,37% das APPs das propriedades, indicando que as inovações trazidas pelo Código podem ocasionar significativa redução na APP a ser respeitada, além de acarretarem medidas de proteção díspares entre as propriedades, impondo ônus maiores àquelas em que a vegetação nativa foi mais preservada.

Palavras-Chave: Novo Código Florestal. Área de Preservação Permanente. Área rural consolidada. Produção de leite. Vale do Taquari.

1 INTRODUCTION

According to Law 12.651/2012, which established the Law on the Protection of Native Vegetation, known as the New Forest Code (BRASIL, 2012a), Permanent Preservation Areas (APPs) are considered, in rural or urban areas, among other locations, the marginal strips of any natural watercourse, the areas around lakes, lagoons, springs, slopes higher than 45º, top of hills, paths.

These areas, which aim to protect places of great environmental importance, are, according to article 3, item II of the New Forest Code, essential for the conservation of natural resources, maintenance of biodiversity and ensuring the well-being of human populations (BRASIL, 2012a). Among the places considered PPAs, the marginal strips of watercourses are often used in rural properties with milk production as a place for watering the cattle.

Brazil is the third largest world producer of cow milk, behind the United States and India. According to data from the *Food and Agriculture Organization* - FAO (2019), in 2017 the country produced 33.49 million tons of cow milk, which represented 4.95% of world production. In economic terms, the value of production that year represented R$ 37.099 billion (IBGE, 2017), making the milk production chain a representative factor in the national economic scenario.

According to IBGE (2018), the national production is concentrated in the states of Minas Gerais, Rio Grande do Sul, Paraná, Goiás and Santa Catarina, which were responsible for approximately 72% of the total produced, using different systems of dairy cattle raising. The state of Rio Grande do Sul stands out in the sector, being the second largest milk producer in the country, responsible for 13.59% of the national production (IBGE, 2017). The Taquari Valley is the third region that most produces fresh milk in the state, handling 8% of state production (FEE, 2015a).

In a study on water quality in milk producing rural properties in the Taquari Valley, Bortoli et al. (2017) found that watercourse margin PPAs have free access to livestock, increasing the chances of contamination by coliforms from water sources due to the feces carried by the animal, in addition to the trampling of cattle in the seedlings and shoots of vegetation, which ends up not regenerating.

The vegetation cover in the watercourse margin PPAs works attenuating the erosive effects and the leaching of the soil, contributing to the regularization of the water flow, reducing the silting of the river courses and reservoirs, as well as bringing benefits to the fauna (COSTA, SOUZA and BRITES, 1996).

For Rodrigues, Campanhola and Kitamura (2003) the concept of sustainability is related to sustainable rural development, where an increase in production and income is expected, with the aim of improving the quality of life and work in the agricultural space, in addition to generating positive impacts for the environment.

The concept of sustainability, first coined at the Stockholm Conference in 1972 (COMISSÃO, 1991), refers to the principle of seeking a balance between the availability of natural resources and their exploitation by society. In other words, it aims to balance the preservation of the environment and what it can offer in line with the population's quality of life. This way, the preservation, conservation, and recovery of plant areas meet the search for sustainability.

Although the New Forest Code provides for specific extensions to be respected in each type of PPA, it also contemplates a series of exceptions, limitations, management possibilities and continuity of use in certain situations. Among these, there is the rule about the so-called Consolidated Rural Areas, which refer to the anthropic occupation of PPA on July 22, 2008. In such cases, the continuation of agroforestry, ecotourism and rural tourism activities is authorized, requiring only the recovery of a strip of the PPA next to the watercourse.

This research seeks to contribute to clarifying the implications that the innovations brought by the New Forest Code represent for PPAs in watercourses, as well as the possible consequent environmental damage. Considering that the deadline for joining the Environmental Regularization Program has not yet ended, it is even more necessary to examine how compliance with this law will take place.

The hypothesis of the present study is that, in the properties where the Consolidated Rural Area occupies a large portion of the PPA, the area that will have to be respected will be significantly reduced, since the width of the strip to be recomposed is determined solely by the size of the property, and not by the width of the watercourse.

2 METHODOLOGICAL PROCEDURES

2.1 AREA OF STUDY AND CHARACTERIZATION OF RURAL PROPERTIES IN THE TAQUARI VALLEY

The state of Rio Grande do Sul (RS) represents an important link in the national milk production chain throughout its territory. In 2014, *fresh milk production was mainly concentrated in* the northern half of the state. The regions with the highest production were Northwest Border (9.1%), Production (8.8%) and Taquari Valley (7.9%), in which are also the municipalities with the highest productivity indexes (IBGE, 2017).

The study area comprises the geopolitical region called Taquari Valley (TV), which consists of 36 municipalities and occupies approximately 2% of the State's territory (FEE, 2015a). Its physiognomic characteristics are varied, being partly in the lower slope of the Southern Plateau, partly in the Central Depression in the State of Rio Grande do Sul and another in the Campos de Cima da Serra (*REMPEL*, 2012). It has as vegetation formations Mixed Ombrophilous Forest and Deciduous Seasonal Forest, both components of the Atlantic Forest (BORTOLI et al., 2017).

Due to its importance for the regional economic dynamics, the production of milk and dairy products has played a prominent role in the development of the TV (FEIX, JORNADA; GASPERI, 2015). In its territory is also located approximately ¼ (a quarter) of the state's industrial employment in the activities of preparing milk and manufacturing dairy products and other derivatives (FEE, 2015a).

Milk producing rural properties that participate in the research "Sustainability of milk producing properties", developed at the Universidade do Vale do Taquari - Univates, were evaluated. The research group studies the sustainability (social, environmental and economic aspects) of 124 rural properties in all 36 municipalities in the TV region, the number of properties per city being determined according to the milk productivity percentage of each municipality. The properties participating in the research were indicated by the Agriculture Secretariats and Emater of each municipality. Figure 1 shows the location of the studied region, as well as the number of properties evaluated in each municipality. It is worth mentioning that the geographical position of each property is not mentioned due to a partnership agreement established between the researchers and the producers participating in the research.

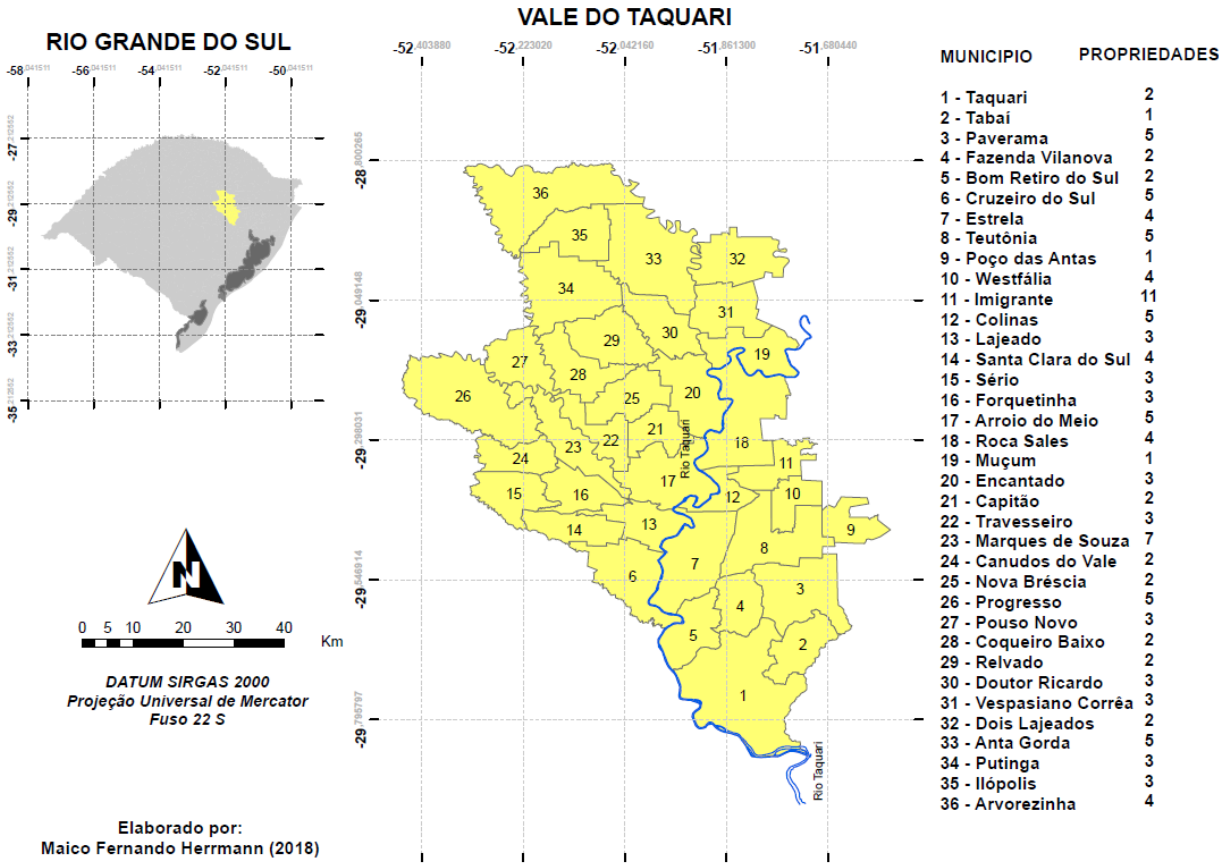

Figure 1 | Location of the Taquari Valley region with the determination of the number of properties evaluated in each municipality.

Source: Data from the Research group (2019).

Among the sustainability aspects assessed by the group, the use and cover of PPAs was one of the items of greatest value considered. Having 15 points as a maximum score (out of a total of 100 points), the average evaluation of this parameter reached 6.4 (SD 2.5). This low score occurred in a large part of the 36 municipalities of the TV, of which, 25 did not reach 50% of the maximum allowed score, a preoccupying fact, since if there is no preservation of native vegetation, all water resources of the properties will suffer impacts (REMPEL et al, 2017).

2.2 DATA COLLECTION

Initially, the current situation of land use and cover in PPA in the properties participating in the project, as previously mentioned, “Sustainability in milk producing rural properties”, by Univates, was established.

The methodology for making and characterizing the property maps, with the delimitations of their PPAs, followed the following steps: 1) Selection of properties; 2) Visit to the properties; 3) Data collection with the owner; 4) Taking of geographical coordinates and types of occupations; 5) Capture of the images of the properties in the Google Earth PRO software; 6) Making the map in AutoCAD software; 7) Tabulation of data in Microsoft Excel software; 8) Analysis of the use and occupation of properties and their PPAs; 9) Finalization of the map with the percentage of land occupations.

The project has already evaluated the environmental sustainability of 124 properties based on 9 parameters, including the status of their PPAs, as shown in Table 1.

Table 1 | Environmental sustainability assessment parameters.

Parameters	*Score*	*Subparameter*	*Score*	*%*
WASTE	20	Solid waste storage	10	20
		Storage of liquid waste	5	
		Disposal of animal waste	5	
WATER	10	Water source for animal consumption Water source for human consumption	5 5	10
PPA	15	Percentage of use of PPAs	10	15
		Predominant use in the PPA	5	
LEGAL RESERVE	10	Percentage of native vegetation for annotation in legal reserve	10	10
PESTICIDES AND FERTILIZERS	15	Use of chemical fertilizers and pesticides	10	15
		Pesticide packaging storage	5	
SLOPE	10	Land slope	10	10
EROSION	5	Evidence of eroded soil	5	5
BURNINGS	5	Evidence of burnings	5	5
LAND USES	10	Cover diversity	10	10
TOTALS	-	-	**100**	**100**

Source: Adapted from Rempel et al. (2012) and Verona (2008).

The score given to the situation of PPAs was made up of two subparameters: the percentage of use of PPAs and their predominant use. The result determined a rate among five categories: Excellent, Good, Regular, Bad and Very bad.

Table 2 | Subparameter percentage of use of PPAs.

Status	*Score*	*Rate*
0%	10	Excellent
1 to 30%	7.5	Good
31 to 55%	5	Regular
56 to 80%	2.5	Bad
81 to 100%	0	Very Bad

Source: Adapted from Rempel et al. (2012) and Verona (2008).

Table 3 | Subparameter of the predominant use of PPA.

Status	*Score*	*Rate*
Native Forest	5	Excellent
Permanent crops and exotic forest	3.75	Good
Pasture areas	2.5	Regular
Agriculture	1.25	Bad
Improvements	0	Very Bad

Source: Adapted from Rempel et al. (2012) and Verona (2008).

After examining the results obtained by the project, one property rated in each of the five categories mentioned in the PPA parameter was selected by lot. Only one property was rated Excellent in this parameter, which made its choice compelling, eliminating the need to draw for this rate.

Once the properties were selected, a second map of each property was made in order to ascertain the status of the use and cover of their PPAs on July 22, 2008. For this, images of the properties were collected through the application called "Registration Module", provided on the website of the Rural Environmental Registry (CAR). The system uses images obtained until July 22, 2008, which is the date provided for in the New Forest Code for the characterization of consolidated rural areas.

In the application, the image of the municipality in which the property is located was first downloaded, from which the entire area of the property is delimited, which provides options for characterizing their occupations, which are: Ground Cover (fallow areas, remnant of native vegetation and consolidated areas), Administrative easement (public works), PPA or Restricted Use and Legal Reserve.

Once this identification was made, the property maps were finalized, and their data tabulated. In order to make them, the same delineations of the properties and their current PPAs were used, since their characterization in face of the provisions of the New Forest Code, especially the size of the properties and the location of their consolidated rural areas, result from their current situation.

Once the existence of a consolidated rural area on the property was found, it was necessary to investigate the use and cover of the recovery strips, according to the limits set forth in Article 61-A of the Code. For this, the same images used to check the current status of their PPAs, collected between November and December 2018, were used, applying the same procedures described at the beginning of this section to identify the use and cover in these strips, with the making of respective maps and data tabulation.

2.3 DATA ANALYSIS

In order to identify the situation of the properties in view of the rules related to the PPAs foreseen in the New Forest Code, as well as any necessary recovery measures, the starting point was the analysis of the maps of the current condition of their PPAs, based on images of the properties collected between November and December 2018. The maps show the delimitations of the PPAs of the five properties in accordance with the general rule of PPAs in marginal strips of water courses, provided for in item I of article 4 of the New Forest Code.

If any property was fully in accordance with the general rule, that is, that its PPAs were fully covered by native vegetation, the analysis would be closed at this stage, since no recovery measures would be necessary. In this case, the property should respect its current situation, maintaining native vegetation throughout its PPAs. However, no property had this condition, which is why it was necessary to apply the following steps to all of them.

Since the property is not in full compliance with the general rule of PPAs protection, the analysis of maps containing the use and cover of their PPAs in 2008 was carried out. In this stage, the existence of a consolidated rural area in the PPAs was verified, defined by article 3, item IV of the New Forest Code as the "rural area with pre-existing human occupation on July 22, 2008, with buildings, improvements or agroforestry activities, admitted, in the latter case, the adoption of the fallow regime" (BRASIL, 2012a), which was observed in all properties.

Once the presence of a consolidated rural area was verified, the next step was the analysis of the maps containing the use and cover of the restoration strips required by Article 61-A of the New Forest Code, elaborated based on the images of the properties from 2018. In order to determine the width of the strips, the number of fiscal modules representing the total area of the property

was identified, observing the limits that the recovery area can reach in relation to the size of the property, in accordance with articles 61-A and 61-B of the New Forest Code, and article 19 of Decree 7830/2012, outlined in Chart 1.

Chart 1 | Measures to recompose PPAs in marginal strips of watercourses for properties with consolidated rural areas.

Property Size	*Recovery to be performed*	*Maximum percentage of the property that the recomposed area can represent*
Up to 1 fiscal module	5 meters	10%
1 to 2 fiscal modules	8 meters	
2 to 4 fiscal modules	15 meters	20%
4 to 10 fiscal modules, in watercourses up to 10 meters wide	20 meters	No limitation
Other cases	Half the width of the watercourse	

Source: Own elaboration, adapted from articles 61-A and 61-B of the New Forest Code (BRASIL, 2012a), and article 19, paragraph 4 of Decree 7830 (BRASIL, 2012f).

Based on these maps, the area to be recomposed was identified, excluding the area that is already covered by native vegetation within this range, considered as already recovered.

After determining the area to be recovered in the recovery strips, the identification of the area of the PPAs that must be respected outside these strips began. To this end, excluding the area of the recovery strips, the area occupied in the PPAs in 2008 and 2018 was compared, by activities that constitute a consolidated rural area. If there was an increase in this area, it was considered that this difference should be repaid and, therefore, should be counted as an area to be respected. If there was a reduction, its current situation was considered as an area to be respected, since the reconversion of the area recovered after 2008 is not allowed.

After that, the area to be recomposed within the recovery strip was added to the area to be respected outside that strip, in order to determine the total area of the PPA to be respected in each property. Figure 2 shows the data analysis flowchart.

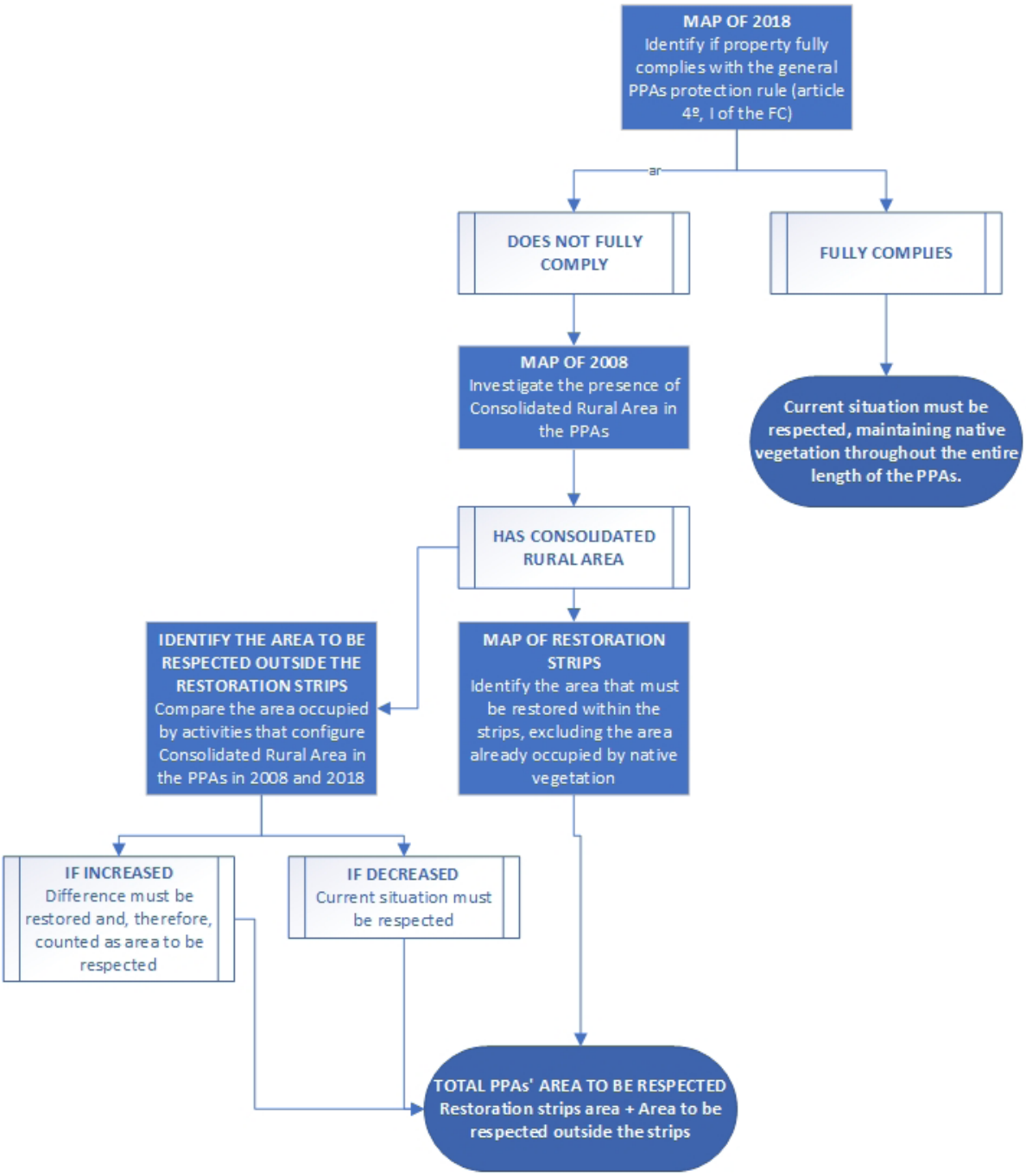

Figure 2 | Flowchart of the data analysis process.

Source: Own elaboration.

3 RESULTS

The situation of the PPAs in the five selected milk producing properties, participating in the project "Sustainability in milk producing rural properties", was investigated through the data obtained through three maps of each.

The first, made from its 2018 image, portrayed the current situation of the use and cover of the PPAs. The second, made using the 2008 image, presented the use and cover of the PPAs in 2008. The third, also made from the 2018 image of each property, demonstrated the use and cover of the recovery strips provided for in Article 61-A of the New Forest Code.

Considering that the fiscal module in the Taquari Valley region varies between 18 and 20 hectares (INCRA, 2013), its average, 19 hectares, was considered as a fiscal module for the classification of properties in the provisions of the Code, in order to preserve confidentiality about the location of the properties.

3.1 PROPERTY RATED VERY BAD

Table 4 presents the situation of the use and cover of PPAs of the property rated Very Bad in the PPA parameter, in the project "Sustainability in milk producing rural properties", in 2018 and 2008.

Table 4 | Use of PPAs in the property rated Very Bad in the PPA parameter.

	Status in 2018		*Status in 2008*	
USE OF PPAS	Area (m²)	Percentage	Area (m²)	Percentage
PASTURE	9,659.57	50,66%	15,621.61	81.94%
CORN	2,125.43	11.14%	2,596.30	13.61%
IMPROVEMENTS	7,280.02	38.18%	847.11	4.45%

Source: Research data (2019).

In 2008, the property's PPAs did not have any area with native forest, being used, in its entirety, in agroforestry activities and with improvements. Therefore, the use of APPs, in all its extension, is characterized as a consolidated rural area, according to item IV of article 3 of the New Forest Code. The 2018 data show that its destination remains unchanged, with variation only in the proportions of its use.

Once there is a consolidated rural area, represented by agroforestry activities, it is necessary to verify the measure to be recomposed according to the transition rule provided for in article 61-A of the New Forest Code. All the property's PPAs result from the presence of watercourses.

The property has between 1 and 2 fiscal modules, making the restoration of the marginal strips to be at 8 meters, counting from the channel of the regular bed of the watercourses, as shown in Table 1. Table 5 shows the use and cover of these strips on the property.

Table 5 | Use of recovery strips in the property rated Very Bad in the PPA parameter.

Use of the strips	*Area (m²)*	*Percentage*
PASTURE	1,097.20	49.09%
CORN	293.11	13.12%
IMPROVEMENTS	844.54	37.79%

Source: Research data (2019).

Considering that the recovery strips do not have any native vegetation, they must be fully recovered. According to Table 5, the areas of these strips add up to 2,234.85 m², which corresponds to 11.72% of the total area of the property's PPAs, of 19,065.02 m².

All the rest of its PPAs are in a consolidated rural area and continue to be used, which is why the recovery strips will be the only part of its PPAs that will need to be respected, and activities can be maintained for the rest of its extension.

3.2 PROPERTY RATED BAD

Table 6 shows the percentages and the area of use and cover of PPAs in the property rated Bad, in 2018 and 2008.

Table 6 | Use of PPAs in the property rated Bad in the PPA parameter.

	Status in 2018		*Status in 2008*	
USE OF PPAS	Area (m²)	Percentage	Area (m²)	Percentage
EXOTIC FOREST	10,541.79	29.13%	14,495.16	40.06%
PASTURE	25,642.53	70.87%	21,689.16	59.94%

Source: Research data (2019).

The property's PPAs presented, in 2008, areas occupied by exotic forest and destined to pasture, without any native forest. Its destination in 2018 remained the same, only changing the percentages of its use.

Thus, with agroforestry activities being developed in the PPAs in 2008, the property presents a consolidated rural area. Both the portions occupied by pasture and by exotic forest were considered as a consolidated rural area, mainly because the latter is located next to the watercourse, often used for cattle watering on milk producing rural properties in the TV, as verified by Bortoli et al. (2017).

The property has between 1 and 2 fiscal modules, and a strip of 8 meters of its PPAs must be recomposed, starting from the edge of the regular bed of the watercourses. Table 7 presents data on the use and cover of these strips.

Table 7 | Use of recovery strips in the property rated Bad in the PPA parameter.

Use of the strips	*Area (m²)*	*Percentage*
PASTURE	1,846.14	100%

Source: Research data (2019).

The 8-meter strips are occupied exclusively by pasture and must, therefore, be fully recomposed. The total area of these strips is 1,846.14 m², which corresponds to 5.10% of the total area of its PPAs, of 36,184.32 m².

Bearing in mind that the entire extension of the property's PPAs is a consolidated rural area, the only area to be respected will be that represented by the strips to be restored, and agroforestry activity in the rest of the PPAs can be maintained.

3.3 PROPERTY RATED REGULAR

The use and cover situation of the PPAs of the property rated Regular, in 2018 and 2008, is presented in Table 8.

Table 8 | Use of PPAs in the property rated Regular in the PPA parameter.

	Status in 2018		*Status in 2008*	
USE OF PPAS	*Area (m²)*	*Percentage*	*Area (m²)*	*Percentage*
NATIVE FOREST	10,487.99	49.70%	9,711.29	46.00%
PASTURE	9,164.91	43.4%	9,956.08	47.20%
IMPROVEMENTS	1,308.30	6.20%	1,293.88	6.10%

Source: Research data (2019).

In 2008, the use and cover of the property's PPAs had pasture and improvements, considered consolidated rural areas, in addition to native forest. The situation in 2018 presented the same destinations for PPAs, varying only the proportions of their uses.

The extension of the property represents between 1 and 2 fiscal modules, which requires the recovery of a strip of 8 meters, from the regular bed of its watercourses. The situation of these strips is shown in Table 9.

Table 9 | Use of recovery strips in the property rated Regular in the PPA parameter.

Use of the strips	*Area (m²)*	*Percentage*
PASTURE	2,162.97	58.19%
NATIVE FOREST	1,553.88	41.81%

Source: Research data (2019).

The data show that, in these 8 meters, 1,553.87m² already have native forest, while 2,162.97 m² are occupied by pasture. Therefore, only this last area must be recomposed, since in the other portion of the strips the native vegetation is already preserved.

Regarding the area to be respected outside the recovery ranges, Table 8 reveals that the area occupied by native forest in the APPs increased in relation to 2008, therefore, its current situation should be maintained. Given that part of the native vegetation is within the 8-meter strips, it is observed that the area outside these strips that contains this coverage and, therefore, must be respected, reaches 8,934.12 m².

Adding this area to the total extension of the 8 meters strips next to the watercourses that must be preserved, with 3,716.85 m², it is concluded that the total area to be respected in the property results in 12,650.97 m², the which represents 59.77% of the total area of its PPAs, which is 21,116.38 m². In the rest of its PPAs, agroforestry activity can be maintained.

3.4 PROPERTY RATED GOOD

The data found on the use and cover of the PPAs of the property rated Good, in 2018 and in 2008, are shown in Table 10.

Table 10 | Use of PPAs in the property rated Good in the PPA parameter.

	Status in 2018		*Status in 2008*	
USE OF PPAS	*Area (m²)*	*Percentage*	*Area (m²)*	*Percentage*
NATIVE FOREST	23,514.43	74.96%	16,315.43	52.01%
PASTURE	5,760.54	18.36%	11,396.03	36.33%
SWAMP	2,091.77	6.66%	3,655.27	11.65%

Source: Research data (2019).

In 2008, its PPAs had a pasture area, considered a consolidated rural area, in addition to native and wetland, which is configured as a PPA, in accordance with Article 4, item VI of the New Forest Code. Regarding its use in 2018, there was an increase in its native vegetation, while the wetland area and the area destined to pasture reduced.

Considering the existence of a consolidated rural area, and that the property has between 3 and 4 fiscal modules, a 15-meter strip in the watercourse present in the property, starting from the edge of the channel of the regular bed of the watercourse, should be recomposed. The property also has two other areas considered PPAs, one swamp (palm swamp) and two springs. In relation to the first, the strip to be recomposed is 30 meters, according to article 61-A, paragraph 7, item I of the New Forest Code, while the recovery of the spring must be of a 15 meters radius in its surroundings, as determined in paragraph 5 of the same article. Table 11 shows the use and cover of these strips to be recomposed.

Table 11 | Use of recovery strips in the property rated Good in the PPA parameter.

Use of the strips	*Area (m²)*	*Percentage*
NATIVE FOREST	5,350.77	100%

Source: Research data (2019).

The data found reveal that these strips, which add up to 5,350.77m², are already completely covered by native vegetation, which is why no recovery is necessary, since they are already preserved.

Considering that there was an increase in the area occupied by native forest in the PPAs compared to 2008, its current situation (2018) must be respected. Therefore, in this property, the portion currently covered by native vegetation must be respected, together with the area occupied by the swamp, which is considered APP. Together, these areas reach 25,606.20 m², representing 81.63% of the extension of the property's PPAs, with 31,366.74 m². In the rest of its area, intended for pasture, livestock activity can be maintained.

3.5 PROPERTY RATED EXCELLENT

The data found on the situation of the PPA in the property rated Excellent, in 2018 and 2008, are shown in Table 12.

Table 12 | Use of PPA in the property rated Excellent in the PPA parameter.

	Status in 2018		*Status in 2008*	
PPA USE	*Area (m²)*	*Percentage*	*Area (m²)*	*Percentage*
NATIVE FOREST	24,669.18	98.37%	24,459.36	97.54%
CORN	408.20	1.63%	618.00	2.46%

Source: Research data (2019).

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In this property, its PPA contained native forest in almost all its extension in 2008, and a small area with agricultural activity, which characterizes a consolidated rural area. Its situation in 2018 has hardly changed, only its use proportions varied.

The property has an area of less than 1 fiscal module, which requires the recovery of a 5-meter strip, counting from the margin of the watercourse present in the property, as shown in Table 1. Table 13 represents the use and cover of this strip.

Table 13 | Use of the recovery strips in the property rated Excellent in the PPA parameter.

Use of the strips	*Area (m²)*	*Percentage*
NATIVE FOREST	1,804.04	100%

Source: Research data (2019).

Given that the recovery strip, which has 1,804.04 m², is already preserved, being fully occupied by native vegetation, no recovery is necessary.

Therefore, with an increase in native vegetation compared to 2008, the area of the PPA to be protected is that currently containing this coverage, with 24,669.18 m², corresponding to 98.37% of its total extension, of 25,077.36 m². Agroforestry activity may be maintained in the rest of the PPA, and new suppressions are prohibited.

3.6 LIMITS TO THE RECOVERY IMPOSED BY ARTICLE 61-B OF THE NEW FOREST CODE

As shown in Table 1, Article 61-B of the New Forest Code imposes limitations on the maximum percentage of the property that the strips to be recomposed, provided for in Article 61-A, can represent. However, in none of the properties where recovery is necessary, the percentages were reached, as shown in Table 14. The legal limits vary between 10% and 20%, while the highest percentage found in the surveyed properties was 1.12%.

Table 14 | Percentages of property areas to be recomposed in the strips provided for in Article 61-A of the New Forest Code.

Property rate	*Total area of the property (m²)*	*Area of the strips according to article 61-A of the FC (m²)*	*Percentage of the property area that the strips represent*	*Area of the strips not covered by native vegetation, to be recomposed*	*Percentage of the property area to be recomposed*
VERY BAD	198,205.86	2,234.85	1.02%	2,234.85	1.12%
BAD	304,418.94	1,846.14	0.60%	1,846.14	0.60%
REGULAR	271,113.76	3,716.85	1.37%	2,162.97	0.79%
GOOD	600,852.07	5,350.77	0.89%	0.00	0.00%
EXCELLENT	158,176.30	1,804.04	1.11%	0.00	0.00%

Source: Research data (2019).

4 DISCUSSION OF DATA

The application of the transitional rules of the New Forest Code, related to consolidated rural areas, to the situation of the properties' PPAs, revealed a significant variation in the area of the PPAs of each property that must remain respected. To illustrate the situation, Table 15 shows the following data for each property: percentages of PPAs with native vegetation in 2008 and 2018, in relation to the measures provided for in the general rule of article 4, item I of the New Forest Code; area of PPAs that must be recomposed in the strips provided for in article 61-A of the Code; area of PPAs to be respected outside these strips; percentage of the area of the PPAs that must be respected after the application of the Code's rules, in comparison with the general protection measures.

Table 15 | Evolution of the native vegetation coverage in PPAs and areas to be preserved and recomposed based on the rules of the New Forest Code.

Property Rate	*Percentage of PPAs with native vegetation in 2008*	*Percentage of PPAs with native vegetation in 2018*	*Area of PPAs to be recomposed according to article 61-A of FC (m²)*	*Area to be respected outside the strips determined by art. 61-A of FC (m²)*	*Percentage of PPAs to be respected, applying the FC rules*
VERY BAD	0.00%	0.00%	2,234.85	0.00	11.72%
BAD	0.00%	0.00%	1,846.14	0.00	5.10%
REGULAR	46.00%	49.70%	2,162.97	8,934.12	59.77%
GOOD	52.01%	74.96%	0.00	18,163.66	81.63%
EXCELLENT	97.54%	98.37%	0.00	22,865.14	98.37%

Source: Research data (2019).

The result of the total area of the PPAs to be respected, in relation to its measures according to the general rule of article 4 of the Code, varied between 5.10% and 98.37%, that is, an amplitude of 93.27%.

The two properties in which there is no native vegetation, and neither there was in 2008, rated Very Bad and Bad, were those with the lowest percentages, with 11.72% and 5.10%, respectively. In these, the only portions to be respected will be those of the recovery strips next to the watercourses, while all the rest of its PPAs, as they are a consolidated rural area, may continue to be used in agroforestry activities.

In the other three properties, rated Regular, Good and Excellent, in addition to the recovery strips, the portion that currently contains native vegetation should also be preserved, resulting, respectively, in 59.77%, 81.63% and 98.37 % of the total of their PPAs that must be respected. Of the three, only the one rated Regular does not have the restoration strips already fully covered by native vegetation, but only a part, which must be recomposed.

It was also observed that, in these three properties with better rates, the area covered by native forest in their PPAs has increased since 2008. This evolution of the preserved area ended up representing the corresponding increase in the portion to be respected. This is because Article 61-A of the New Forest Code only authorizes the continued use of areas that were intended for agroforestry activities on July 22, 2008, but not the return of use in areas where activities were stopped after that, in which the advance of native vegetation was observed.

Therefore, the results of the cases studied indicate that the greater the area of PPAs preserved, and the more this portion has increased since 2008, the greater the area of PPAs to be respected will be. On the other hand, the lack of native vegetation in the PPAs, with the entire area destined to agroforestry activities, and the maintenance of this situation since 2008, has resulted in the need to respect only the recovery strip along the watercourse.

Thus, the application of the rules of the New Forest Code relating to PPAs, notably their temporary provisions regarding the consolidated rural area, entails different obligations, and even paradoxical

ones, for the owners. In general, it was observed that those that most preserved their native vegetation are subject to greater restrictions on the use of the property, with greater areas to be respected, while to those that most suppressed it, the area that can continue to be used is larger, and its variation may depend on the size of the property.

Therefore, it is possible to affirm that the results found confirmed the hypothesis of the present research. In properties where the consolidated rural area occupies a large portion of their PPAs, which was observed especially in those rated Very Bad and Bad, the area of their PPAs to be respected was significantly reduced, representing only 11.72% and 5.10 % of their respective total areas.

The situation of these properties demonstrated the direct impact of linking the extension of the recovery strips exclusively to the size of the property, disregarding the width of the watercourse. In both, these strips represent the only portion of their PPAs to be respected.

On the other hand, the property rated Excellent, which in 2008 had consolidated rural area in only 2.46% of its PPAs, must respect almost all its extension, 98.37%.

When comparing the classifications of the properties studied in the PPA parameter, used in the present work for their draw, with the general scores obtained by them in the project "Sustainability in milk producing rural properties", no relation was observed. As shown in Table 1, the project parameters evaluated: Waste, Water, PPA, Legal Reserve, Pesticides and Fertilizers, Declivity, Erosion, Burnings and Land Use.

The general score indicated that those rated Very Bad and Good in the PPA parameter were the best classified, both with 71.25 points, followed by those rated Bad and Regular, with 67.25 points, the worst score being given precisely to that rated Excellent, with 61.25 points. This shows that the situation of the properties' PPAs is not directly related to the practices adopted by the owners regarding the other sustainability parameters evaluated. It is possible that the use and conservation of PPAs are the result of vicissitudes, such as the location of the watercourse on the property or the production system used, and not practices deliberately focused on sustainability.

Comparing the results of the recovery areas found in this research with other works, Bonamigo et al. (2017) analyzed 68 properties in the Santa Catarina state southern plateau. In rural properties that have between 1 and 2 fiscal modules, and that present a consolidated rural area, they found that the area to be recomposed represents, on average, 9% of the property area. For those properties that have between 2 and 4 fiscal modules, the average to be recomposed corresponds to 17.2% of the property.

Okuyama et al. (2017), in a study with the same objective carried out on 147 family farms located in the Central-Eastern and Southeast regions of Paraná, observed that the areas to be recovered in the properties' PPAs represent, on average, 4.9% of the real estate area.

The percentages higher than those found in the present study may result from the amount of PPAs present in the properties, as highlighted by Okuyama et al. (2017), as well as the possible presence of different sorts of PPA, which imply different recovery measures. The referred studies also did not consider the portions of the recovery strips that may already be occupied by native vegetation, that do not need to be recomposed, which could imply a decrease in the percentages.

The high presence of areas destined to pasture in PPAs, and reduced native vegetation coverage, observed especially in properties rated Very Bad and Bad, can cause damage not only to the environmental function of their PPAs, but also to milk production.

In a study on water quality in 15 milk producing rural properties in the TV, Bortoli et al. (2017) found that cattle are raised loose, with free access to the place of watering, which is carried out in watercourses on the properties where this resource was present. Access to these sites was related to the presence

of pasture areas and potters close to the watercourses, a characteristic observed, in the present study, in properties rated Very Bad, Bad and Regular, which present pasture areas both in the PPAs and in the recovery strips along the watercourses.

Bortoli et al. (2017) observed that this access result in trampling on the margin, causing siltation, compaction and erosion, in addition to contamination of the water with coliforms by the defecation of cattle on the site, which affects water quality and contributes to the spread of diseases. The absence of native vegetation also contributes to the transport of waste to water resources, increasing contamination.

The results of the water samples analyzed in that research showed that, of the 15 properties studied, the 5 in which the samples met legal quality standards present native vegetation in a proportion greater than 50% of their PPAs, in addition to revealing an association between the variables coliform, present in the samples, and vegetation cover of PPAs (BORTOLI et al., 2017).

Bortoli et al. (2017) also stated that the water quality impacts on animal health and milk production, since the observed contamination, in addition to reducing production, increases the risk of disease spread.

Corroborating this study, in research on the tree community of riparian forests in three milk producing properties in the Taquari Valley, Markus et al. (2018) verified that the diversity found was lower than that observed by studies in other regions of the state. They concluded that the high pressure caused by cattle grazing and trampling, verified in the study, may be influencing on this reduction in tree diversity.

Therefore, the development of activities on the properties object of the present study, with the raising of cattle for milk production, when associated with the occupation of areas next to watercourses for the management and grazing of the cattle, and the consequent animal watering on the site, leads to deterioration of the margin, suppression of vegetation, contamination of the water resource and consequent damage to milk productivity.

Thus, it can be concluded that banning access of cattle to watercourses and restoring riparian forest with native vegetation are determining factors for the restoration of plant diversity, recovery of the margin conditions and avoid its erosion, as well as to improve water quality.

Considering the results found, it is indicated that the producers do not limit themselves to comply with the legal minimum required, especially when it is only necessary to recompose the strips next to watercourses, whose maximum percentage found in this research reached 11.72% of the PPAs total area. The recovery of at least 50% of the PPAs can contribute decisively for the water resource to reach satisfactory quality standards, leading to a gain in milk productivity.

5 FINAL CONSIDERATIONS

Although the New Forest Code has implemented a direct reduction in the area of the PPA to be protected along watercourses, since the widths of the protection strips are now counted from the channel of the regular bed, and no longer from their highest level, as provided for in the New Forest Code of 1965, the results of the present study demonstrate that this reduction can be much more significant. When the transitional rules regarding consolidated rural areas were applied to the properties studied, it was observed that the smallest area to be respected represents only 5.10% of the PPAs of the property rated Bad.

Consequently, the application of the Code's transitional rules can result in such a small percentage to be respected, that it is unable to fulfill the socio-environmental functions of the PPA, as shown by the studies mentioned above.

In milk producing rural properties, direct access by cattle to water courses for watering can cause various damage to vegetation and soil on the margins, in addition to contamination of water resources. Banning cattle access and the appropriate recovery of native vegetation in the PPA of watercourses are decisive factors for the vegetation and margin restoration and may contribute to the water reaching satisfactory quality standards and consequent gain in milk productivity.

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Cenário das áreas de preservação permanente em propriedades rurais produtoras de leite no Vale do Taquari ante o Código Florestal

Permanent Preservation Areas scenarios in dairy farms in the Vale do Taquari against the Forest Code

Caio Zart Daiello[a]

Claudete Rempel[b]

[a]Mestre em Sistemas Ambientais Sustentáveis, Universidade do Vale do Taquari – Univates, Lajeado, RS, Brasil.
End. Eletrônico: caiodaiello@universo.univates.br

[b]Doutora em Ecologia, Universidade do Vale do Taquari – Univates, Lajeado, RS, Brasil.
End. Eletrônico: crempel@univates.br

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RESUMO

O presente estudo buscou analisar as implicações das inovações no regramento das Áreas de Preservação Permanente (APPs) implementadas pelo Novo Código Florestal (Lei 12.651/2012). Foram identificados o uso e cobertura das APPs de cinco propriedades rurais produtoras de leite, localizadas no Vale do Taquari, RS, e aplicadas as regras do Código, a fim de determinar as áreas que devem ser recuperadas e respeitadas em cada propriedade. A pesquisa adotou o método dedutivo, com abordagem metodológica qualiquantitativa, e empregados os procedimentos técnicos de estudo de campo e estudo de caso. Os resultados apontaram que as áreas totais a serem respeitadas representam 11,72%, 5,10%, 59,77%, 81,63% e 98,37% das APPs das propriedades, indicando que as inovações trazidas pelo Código podem ocasionar significativa redução na APP a ser respeitada, além de acarretarem medidas de proteção díspares entre as propriedades, impondo ônus maiores àquelas em que a vegetação nativa foi mais preservada.

Palavras-Chave: Novo Código Florestal. Área de Preservação Permanente. Área rural consolidada. Produção de leite. Vale do Taquari.

ABSTRACT

The present study sought to analyze the implications of innovations in the Permanent Preservation Areas (PPAs) regulation implemented by the New Forest Code (Law 12.651 / 2012). The use and cover of the PPAs of five milk producing rural properties, located in the Taquari Valley, RS, were identified and the rules of the Code were applied, in order to determine the areas that must be recovered and respected in each property. The research adopted the deductive approach, with a quali-quantitative methodological approach, and the technical procedures of field and case study were used. The results showed that the total areas to be respected represent 11.72%, 5.10%, 59.77%, 81.63% and 98.37%

of the properties' PPAs, indicating that the innovations presented by the Code can cause significant reduction in the PPA to be respected, in addition to resulting in different protection measures among the properties, imposing greater burdens on those in which the native vegetation was more preserved.

Keywords: New Forest Code. Permanent Preservation Area. Consolidated Rural Area. Milk production. Taquari Valley.

1 INTRODUÇÃO

De acordo com a Lei 12.651/2012, que instituiu a Lei de Proteção à Vegetação Nativa, conhecida como Novo Código Florestal (BRASIL, 2012a), são consideradas Áreas de Preservação Permanente (APPs), em zonas rurais ou urbanas, entre outras localidades, as faixas marginais de qualquer curso d'água natural, as áreas no entorno de lagos, lagoas, nascentes, encostas com declividade superior a 45º, topo de morros e veredas.

Essas áreas, que visam proteger locais de grande importância ambiental, são, conforme o artigo 3º, II do Novo Código Florestal, essenciais para a conservação dos recursos naturais, manutenção da biodiversidade e para assegurar o bem-estar das populações humanas (BRASIL, 2012a). Entre os locais considerados APPs, as faixas marginais de cursos d'água são muitas vezes utilizadas em propriedades rurais com produção leiteira como local onde o gado realiza sua dessedentação.

O Brasil é o terceiro maior produtor mundial de leite de vaca, ficando atrás dos Estados Unidos e Índia. Segundo dados da *Food and Agriculture Organization* – FAO (2019), em 2017 o País produziu 33,49 milhões de toneladas de leite de vaca, o que representou 4,95% da produção mundial. Em termos econômicos, o valor da produção naquele ano representou R$ 37,099 bilhões (IBGE, 2017), tornando a cadeia produtiva do leite um fator de representatividade no cenário econômico nacional.

Segundo o IBGE (2018), a produção nacional está concentrada nos estados de Minas Gerais, Rio Grande do Sul, Paraná, Goiás e Santa Catarina, os quais foram responsáveis por aproximadamente 72% do total produzido, usando de distintos sistemas de criação de bovinos de leite. O estado do Rio Grande do Sul destaca-se no ramo, sendo o segundo maior produtor de leite do País, responsável por 13,59% da produção nacional (IBGE, 2017). O Vale do Taquari é a terceira região que mais produz leite *in natura* no estado, respondendo por 8% da produção estadual (FEE, 2015a).

Em estudo sobre a qualidade da água em propriedades rurais produtoras de leite no Vale do Taquari, Bortoli et al. (2017) constataram que as APPs de margem de cursos d'água possuem acesso livre ao gado, aumentando as chances de contaminação por coliformes dos mananciais hídricos devido às fezes carregadas pelo animal, além do pisoteio do gado nas mudas e brotos da vegetação, que acabam por não se regenerar.

A cobertura vegetal nas APPs de margem de cursos d'água serve para atenuar os efeitos erosivos e a lixiviação dos solos, contribuindo para a regularização do fluxo hídrico, redução do assoreamento dos cursos fluviais e reservatórios, bem como trazendo benefícios para a fauna (COSTA; SOUZA; BRITES, 1996).

Para Rodrigues, Campanhola e Kitamura (2003), o conceito de sustentabilidade está relacionado ao desenvolvimento rural sustentável onde se prevê aumento de produção e renda, com intuito de melhoria da qualidade de vida e de trabalho no espaço agrícola, além de gerar também impactos positivos para o meio ambiente.

O conceito de sustentabilidade, alcunhado primeiramente na Conferência de Estocolmo em 1972 (COMISSÃO, 1991), refere-se ao princípio da busca pelo equilíbrio entre a disponibilidade dos recursos naturais e a exploração deles por parte da sociedade, ou seja, visa equilibrar a preservação do meio ambiente e o que ele pode oferecer em consonância com a qualidade de vida da população. Dessa forma, a preservação, conservação e a recuperação de áreas vegetais vão ao encontro da busca pela sustentabilidade.

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Embora o Novo Código Florestal preveja as extensões específicas a serem respeitadas em cada modalidade de APP, também contempla uma série de exceções, limitações, possibilidades de manejo e continuidade de usos em certas situações. Entre estas, destaca-se a regra acerca das chamadas Áreas Rurais Consolidadas, que remetem à ocupação antrópica da APP em 22 de julho de 2008. Em tais casos, é autorizada a continuidade de atividades agrossilvipastoris, de ecoturismo e de turismo rural, sendo exigida somente a recuperação de uma faixa da APP junto ao curso d'água.

A presente pesquisa busca contribuir para o esclarecimento das implicações que as inovações trazidas pelo Novo Código Florestal representam para as APPs em cursos d'água, bem como os possíveis danos ambientais consequentes. Considerando que o prazo para adesão ao Programa de Regularização Ambiental ainda não foi finalizado, torna-se ainda mais necessário o exame da forma como se dará o cumprimento dessa lei.

A hipótese do presente estudo é que, nas propriedades em que a Área Rural Consolidada ocupar uma grande porção da APP, a área desta que precisará ser respeitada será significativamente reduzida, já que a largura da faixa a ser recomposta é determinada unicamente pelo tamanho do imóvel, e não pela largura do curso d'água.

2 PROCEDIMENTOS METODOLÓGICOS

2.1 ÁREA DE ESTUDO E CARACTERIZAÇÃO DAS PROPRIEDADES RURAIS DO VALE DO TAQUARI

O estado do Rio Grande do Sul (RS) representa um elo importante da cadeia produtiva do leite nacional em todo seu território. Em 2014, a produção leiteira in natura se mostrou concentrada principalmente na metade norte do estado. As regiões com maior produção foram Fronteira Noroeste (9,1%), Produção (8,8%) e Vale do Taquari (7,9%), nas quais também se encontram os municípios com os maiores índices de produtividade (IBGE, 2017).

A área de estudo compreende a região geopolítica denominada Vale do Taquari (VT), que é constituído por 36 municípios e ocupa aproximadamente 2% do território do estado (FEE, 2015a). Suas características fisionômicas são variadas, encontrando-se, em parte, na encosta inferior do Planalto Meridional, parte na Depressão Central Gaúcha e outra nos Campos de Cima da Serra (REMPEL, 2012). Tem como formações vegetais Floresta Ombrófila Mista e Floresta Estacional Decidual, ambas componentes da Mata Atlântica (BORTOLI et al., 2017).

Por sua importância para a dinâmica econômica regional, a produção de leite e derivados tem ocupado papel de destaque no desenvolvimento do VT (FEIX; JORNADA; GASPERI, 2015). Em seu território, também está situado aproximadamente ¼ (um quarto) do emprego industrial gaúcho nas atividades de preparação do leite e de fabricação de laticínios e de outros derivados (FEE, 2015a).

Foram avaliadas propriedades rurais produtoras de leite que participam da pesquisa "Sustentabilidade de propriedades produtoras de leite", desenvolvida na Universidade do Vale do Taquari – Univates. O grupo de pesquisa estuda a sustentabilidade (aspectos sociais, ambientais e econômicos) de 124 propriedades rurais em todos os 36 municípios da região do VT, sendo o número de propriedades por cidade determinado de acordo com o percentual de produtividade de leite de cada município. As propriedades participantes da pesquisa foram indicadas pelas Secretarias de Agricultura e Emater de cada município. A Figura 1 apresenta a localização da região de estudo, bem como a quantidade de propriedades avaliadas em cada município. Cabe ressaltar que a posição geográfica de cada propriedade não é mencionada devido a um acordo de parceria estabelecido entre os pesquisadores e os produtores participantes da pesquisa.

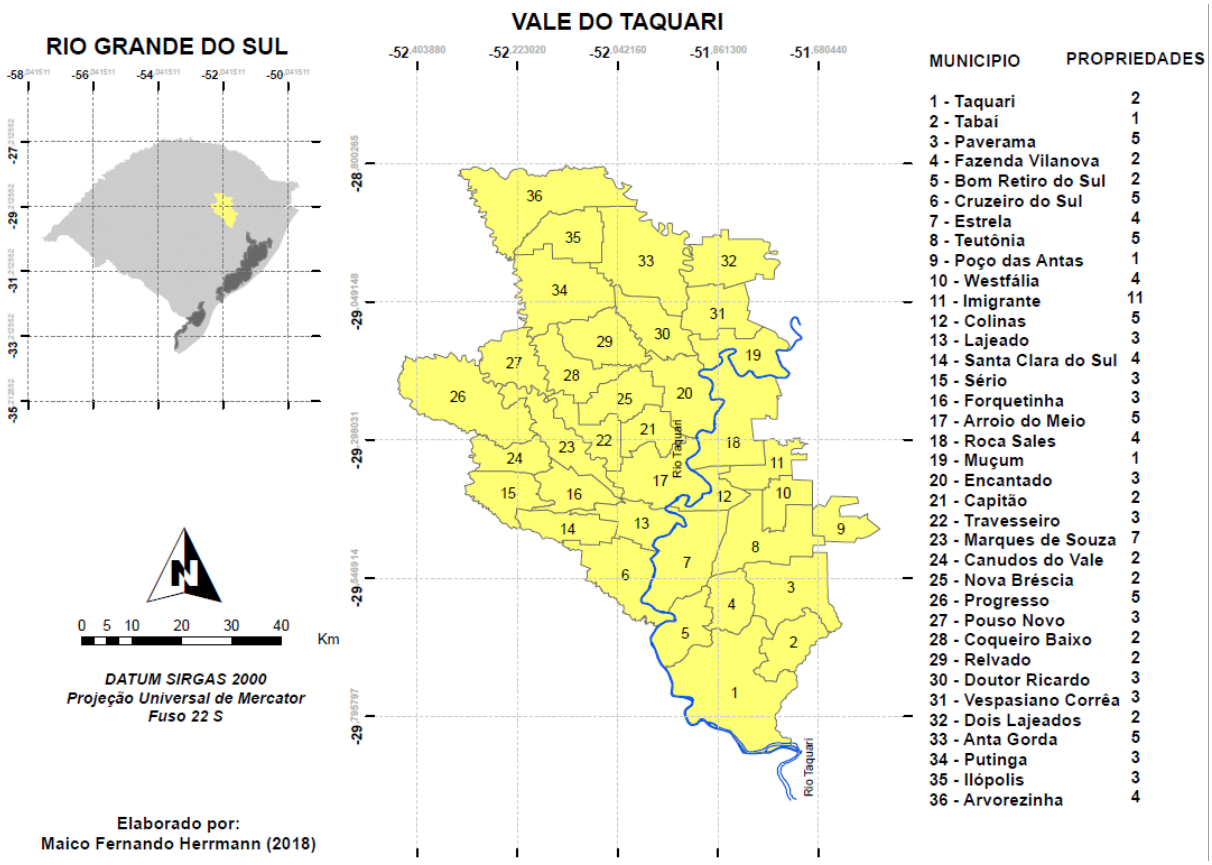

Figura 1 | Localização da região do Vale do Taquari com a determinação da quantidade de propriedades avaliadas em cada município.

Fonte: Dados do grupo de Pesquisa (2019).

Entre os aspectos de sustentabilidade avaliados pelo grupo, o uso e cobertura das APPs foi um dos quesitos de maior valor considerado. Podendo chegar a uma pontuação máxima de 15 pontos (de um total de 100 pontos), a avaliação média desse parâmetro alcançou 6,4 (DP 2,5). Essa baixa pontuação se deu em grande parte dos 36 municípios do VT, dos quais 25 não atingiram 50% da pontuação máxima admitida, fato que preocupa, pois não ocorrendo a preservação de vegetação nativa, todos os recursos hídricos das propriedades sofrerão impactos (REMPEL et al., 2017).

2.2 COLETA DE DADOS

Inicialmente, foi estabelecida a situação atual de uso e cobertura das terras em APP nas propriedades participantes do projeto, como já mencionado, "Sustentabilidade em propriedades rurais produtoras de leite", da Univates.

A metodologia para a confecção e caracterização dos mapas das propriedades, com as delimitações de suas APPs, seguiu as seguintes etapas: 1) Seleção das propriedades; 2) Visita aos imóveis; 3) Coleta de dados com o proprietário; 4) Tomada das coordenadas geográficas e dos tipos de ocupações; 5) Captação das imagens das propriedades no software Google Earth PRO; 6) Confecção do mapa no software AutoCAD; 7) Tabulação dos dados no software Microsoft Excel; 8) Análise do uso e ocupação das propriedades e de suas APPs; 9) Finalização do mapa com os percentuais de ocupações da terra.

O projeto já avaliou a sustentabilidade ambiental de 124 propriedades a partir de 9 parâmetros, entre os quais a situação de suas APPs, conforme Tabela 1.

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Tabela 1 | Parâmetros de avaliação da sustentabilidade ambiental.

Parâmetro	*Pontuação*	*Subparâmetro*	*Pontuação*	*%*
DEJETOS	20	Armazenamento do dejeto sólido	10	20
		Armazenamento do dejeto líquido	5	
		Destinação do dejeto animal	5	
ÁGUA	10	Fonte de água para consumo animal	5	10
		Fonte de água para consumo humano	5	
APP	15	Percentual de utilização das APPs	10	15
		Uso predominante na APP	5	
RESERVA LEGAL	10	Percentual de vegetação nativa para averbação em reserva legal	10	10
AGROTÓXICOS E FERTILIZANTES	15	Utilização de Fertilizantes químicos e agrotóxicos	10	15
		Armazenamento de embalagens de agrotóxicos	5	
DECLIVIDADE	10	Declividade do terreno	10	10
EROSÃO	5	Evidências de solo erodido	5	5
QUEIMADAS	5	Evidências de queimadas	5	5
USOS DE TERRA	10	Diversidade de coberturas	10	10
TOTAIS	**-**	**-**	**100**	**100**

Fonte: Adaptado de Rempel et al. (2012) e Verona (2008).

A pontuação conferida à situação das APPs foi constituída por dois subparâmetros: o percentual de utilização das APPs e seu uso predominante. O resultado destes determinou uma classificação entre cinco conceitos: Excelente, Bom, Regular, Ruim e Péssimo.

Tabela 2 | Subparâmetro percentual de utilização das APPs.

Situação	*Pontuação*	*Conceito*
0%	10	Excelente
1 a 30%	7,5	Bom
31 a 55%	5	Regular
56 a 80%	2,5	Ruim
81 a 100%	0	Péssimo

Fonte: Adaptado de Rempel et al. (2012) e Verona (2008).

Tabela 3 | Subparâmetro do uso predominante da APP.

Situação	*Pontuação*	*Conceito*
Mata Nativa	5	Excelente
Culturas permanentes e mata exótica	3,75	Bom
Áreas de pastagem	2,5	Regular
Agricultura	1,25	Ruim
Benfeitorias	0	Péssimo

Fonte: Adaptado de Rempel et al. (2012) e Verona (2008).

Depois de examinados os resultados obtidos pelo projeto, foi selecionada, por meio de sorteio, uma propriedade classificada em cada um dos cinco conceitos mencionados no parâmetro APP. Apenas uma propriedade alcançou o conceito Excelente nesse parâmetro, o que tornou forçosa a sua escolha, eliminando a necessidade de sorteio para esse conceito.

Selecionadas as propriedades, foi confeccionado um segundo mapa de cada imóvel, a fim de averiguar a situação do uso e cobertura de suas APPs em 22 de julho de 2008. Para isso, foram coletadas imagens das propriedades por meio do aplicativo denominado "Módulo de Cadastro", fornecido na página na internet do Cadastro Ambiental Rural (CAR). O sistema utiliza imagens obtidas até 22 de julho de 2008, que é a data prevista no Novo Código Florestal para a caracterização das áreas rurais consolidadas.

No aplicativo, primeiramente foi realizado o *download* da imagem do município em que a propriedade se situa, a partir da qual é feita a delimitação de toda a área do imóvel, o que disponibiliza opções de caracterização de suas ocupações, que são: Cobertura do Solo (áreas de pousio, remanescente de vegetação nativa e áreas consolidadas), Servidão Administrativa (obras públicas), APP ou Uso Restrito e Reserva Legal.

Realizada essa identificação, os mapas das propriedades foram finalizados e seus dados tabulados. Para sua confecção, foram utilizadas as mesmas delimitações das propriedades e de suas APPs atuais, já que sua caracterização diante das disposições do Novo Código Florestal, especialmente o tamanho dos imóveis e a localização de suas áreas rurais consolidadas, parte de sua situação atual.

Uma vez constatada a existência de área rural consolidada na propriedade, foi necessário averiguar o uso e cobertura das faixas de recomposição, conforme delimitações previstas no artigo 61-A do Código. Para isso, foram utilizadas as mesmas imagens usadas para verificar a situação atual de suas APPs, coletadas entre novembro e dezembro de 2018, aplicando-se os mesmos procedimentos descritos no início dessa seção para identificar os usos e coberturas nessas faixas, com a confecção dos respectivos mapas e tabulação dos dados.

2.3 ANÁLISE DOS DADOS

Para identificar a situação das propriedades diante das normas relativas às APPs previstas no Novo Código Florestal, bem como das eventuais medidas de recuperação necessárias, partiu-se da análise dos mapas da condição atual de suas APPs, confeccionados a partir de imagens coletadas entre novembro e dezembro de 2018 dos imóveis. Os mapas apresentam as delimitações das APPs das cinco propriedades em conformidade à regra geral das APPs em faixas marginais de cursos d'água, prevista no inciso I do artigo 4º do Novo Código Florestal.

Caso alguma propriedade estivesse plenamente de acordo com a regra geral, ou seja, que suas APPs estivessem totalmente cobertas por vegetação nativa, a análise se encerraria nessa etapa, já que não seria necessária nenhuma medida de recuperação. Nessa hipótese, a propriedade deveria respeitar sua situação atual, mantendo a vegetação nativa em toda a extensão de suas APPs. Entretanto, nenhuma propriedade apresentou essa condição, razão pela qual foi necessário aplicar as etapas seguintes a todas elas.

Não estando a propriedade em plena conformidade com a regra geral de proteção das APPs, passou-se à análise dos mapas contendo os usos e coberturas de suas APPs em 2008. Nessa etapa, averiguou-se a existência de área rural consolidada nas APPs, definida pelo artigo 3º, inciso IV do Novo Código Florestal como a "área rural com ocupação antrópica preexistente a 22 de julho de 2008, com edificações, benfeitorias ou atividades agrossilvipastoris, admitida, neste último caso, a adoção do regime de pousio" (BRASIL, 2012a), o que foi observado em todas as propriedades.

Uma vez constatada a presença de área rural consolidada, passou-se ao exame dos mapas contendo os usos e coberturas das faixas de recomposição exigidas pelo artigo 61-A do Novo Código Florestal, elaborados a partir das imagens de 2018 das propriedades. Para determinar a largura das faixas, identificou-se a quantidade de módulos fiscais que representa a área total da propriedade, observando os limites que a área de recomposição pode alcançar em relação ao tamanho do imóvel, em conformidade aos artigos 61-A e 61-B do Novo Código Florestal, e artigo 19 do Decreto 7.830/2012, esquematizados no Quadro 1.

Quadro 1 | Medidas de recomposição das APPs em faixas marginais de cursos d'água para imóveis com áreas rurais consolidadas.

Tamanho do imóvel	*Recomposição a ser realizada*	*Percentual máximo da propriedade que a área recomposta poderá representar*
Até 1 módulo fiscal	5 metros	10%
1 a 2 módulos fiscais	8 metros	
2 a 4 módulos fiscais	15 metros	20%
4 a 10 módulos fiscais, em cursos d'água com até 10 metros de largura	20 metros	Não há limitação
Demais casos	Metade da largura do curso d'água	

Fonte: Elaboração própria, adaptado dos artigos 61-A e 61-B do Novo Código Florestal (BRASIL, 2012a), e artigo 19, parágrafo 4º do Decreto 7.830 (BRASIL, 2012f).

A partir desses mapas, identificou-se a área a ser recomposta, excluindo-se a área que já é ocupada por vegetação nativa dentro dessa faixa, considerada como já recuperada.

Depois de determinada a área a ser recuperada nas faixas de recomposição, passou-se à identificação da área das APPs que deve ser respeitada fora dessas faixas. Para isso, excluindo-se a área das faixas de recomposição, comparou-se a área ocupada nas APPs, em 2008 e em 2018, por atividades que configuram área rural consolidada. Se houve aumento nessa área, foi considerado que essa diferença deve ser restituída e, portanto, deverá ser computada como área a ser respeitada. Já se houve redução, foi considerada como área a ser respeitada sua situação atual, eis que não é permitida a reconversão da área recuperada após 2008.

Após isso, foi somada a área a ser recomposta dentro da faixa de recomposição à área a ser respeitada fora dessa faixa, de forma a determinar a área total da APP a ser respeitada em cada propriedade. A Figura 2 apresenta o fluxograma da análise dos dados.

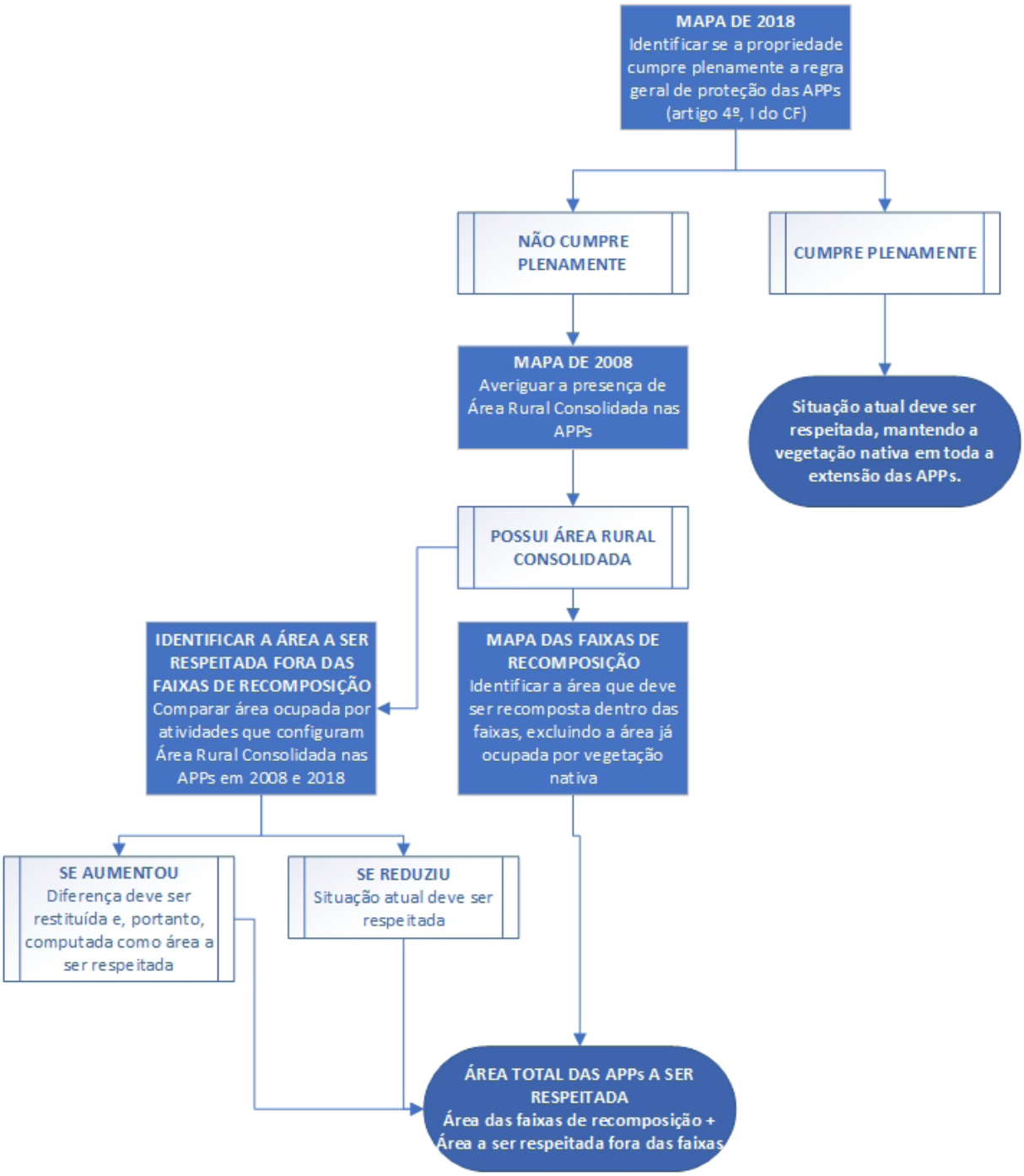

Figura 2 | Fluxograma do processo de análise dos dados.

Fonte: Elaboração própria.

3 RESULTADOS

A situação das APPs nas cinco propriedades produtoras de leite selecionadas, participantes do projeto "Sustentabilidade em propriedades rurais produtoras de leite", foi investigada através dos dados obtidos por meio de três mapas de cada uma delas.

O primeiro, feito a partir de sua imagem de 2018, retratou a situação atual do uso e cobertura das APPs. O segundo, confeccionado por meio da imagem de 2008, apresentou o uso e cobertura das APPs em 2008. O terceiro, também feito a partir da imagem de 2018 de cada propriedade, demonstrou o uso e cobertura das faixas de recomposição previstas no artigo 61-A do Novo Código Florestal.

Considerando que o módulo fiscal na região do Vale do Taquari varia entre 18 e 20 hectares (INCRA, 2013), foi considerado como módulo fiscal sua média, 19 hectares, para o enquadramento das propriedades nas determinações do Código, de forma a preservar o sigilo sobre a localização dos imóveis.

3.1 PROPRIEDADE COM CONCEITO PÉSSIMO

A Tabela 4 apresenta a situação dos usos e coberturas das APPs da propriedade classificada com o conceito Péssimo no parâmetro APP, no projeto "Sustentabilidade em propriedades rurais produtoras de leite", em 2018 e 2008.

Tabela 4 | Uso das APPs na propriedade classificada com o conceito Péssimo no parâmetro APP.

	Situação em 2018		*Situação em 2008*	
USO DAS APPS	*Área (m²)*	*Percentual*	*Área (m²)*	*Percentual*
PASTAGEM	9.659,57	50,66%	15.621,61	81,94%
MILHO	2.125,43	11,14%	2.596,30	13,61%
BENFEITORIAS	7.280,02	38,18%	847,11	4,45%

Fonte: Dados da pesquisa (2019).

Em 2008, as APPs da propriedade não apresentavam nenhuma área com mata nativa, sendo utilizadas, em sua totalidade, em atividades agrossilvipastoris e com benfeitorias. Portanto, o uso das APPs, em toda sua extensão, se caracteriza como área rural consolidada, de acordo com o inciso IV do artigo 3° do Novo Código Florestal. Já os dados de 2018 mostram que sua destinação permanece inalterada, havendo variação apenas nas proporções de seu uso.

Uma vez havendo área rural consolidada, representada por atividades agrossilvipastoris, é necessário verificar a medida a ser recomposta de acordo com a regra de transição prevista no art. 61-A do Novo Código Florestal. Todas as APPs da propriedade decorrem da presença de cursos d'água.

O imóvel tem entre 1 e 2 módulos fiscais, fazendo com que a recomposição das faixas marginais deva ser em 8 metros, a contar da calha do leito regular dos cursos d'água, conforme Quadro 1. A Tabela 5 apresenta os usos e coberturas dessas faixas na propriedade.

Tabela 5 | Uso das faixas de recomposição na propriedade classificada com o conceito Péssimo no parâmetro APP.

Uso das faixas	*Área (m²)*	*Percentual*
PASTAGEM	1.097,20	49,09%
MILHO	293,11	13,12%
BENFEITORIAS	844,54	37,79%

Fonte: Dados da pesquisa (2019).

Considerando que as faixas de recomposição não apresentam qualquer vegetação nativa, deverão ser recompostas em sua integralidade. De acordo com a Tabela 5, as áreas dessas faixas somam 2.234,85 m², o que corresponde a 11,72% da área total das APPs do imóvel, de 19.065,02 m².

Todo o restante de suas APPs configura área rural consolidada e continua sendo utilizado, motivo pelo qual as faixas de recomposição serão a única parte de suas APPs que precisarão ser respeitadas, podendo ser mantidas as atividades no restante de sua extensão.

3.2 PROPRIEDADE COM CONCEITO RUIM

A Tabela 6 mostra os percentuais e a área do uso e coberturas das APPs na propriedade classificada com o conceito Ruim, em 2018 e 2008.

Tabela 6 | Uso das APPs na propriedade classificada com o conceito Ruim no parâmetro APP.

	Situação em 2018		*Situação em 2008*	
USO DAS APPS	*Área (m²)*	*Percentual*	*Área (m²)*	*Percentual*
MATA EXÓTICA	10.541,79	29,13%	14.495,16	40,06%
PASTAGEM	25.642,53	70,87%	21.689,16	59,94%

Fonte: Dados da pesquisa (2019).

As APPs da propriedade apresentavam, em 2008, áreas ocupadas por mata exótica e destinadas a pastagem, sem qualquer mata nativa. Sua destinação em 2018 permaneceu a mesma, somente alterando os percentuais de seu uso.

Assim, sendo desenvolvidas atividades agrossilvipastoris nas APPs em 2008, o imóvel apresenta área rural consolidada. Foram consideradas como área rural consolidada tanto a porção ocupada por pastagem quanto por mata exótica, sobretudo porque esta última se encontra junto ao curso d`água, muitas vezes utilizado para dessedentação do gado nas propriedades rurais produtoras de leite no VT, conforme constatado por Bortoli et al. (2017).

O imóvel possui entre 1 e 2 módulos fiscais, devendo ser recomposta uma faixa de 8 metros de suas APPs, a contar da borda do leito regular dos cursos d'água. A Tabela 7 apresenta os dados do uso e cobertura dessas faixas.

Tabela 7 | Uso das faixas de recomposição na propriedade classificada com o conceito Ruim no parâmetro APP.

Uso das faixas	*Área (m²)*	*Percentual*
Pastagem	1.846,14	100%

Fonte: Dados da pesquisa (2019).

As faixas de 8 metros são ocupadas exclusivamente por pastagem, devendo, portanto, ser integralmente recompostas. A área total dessas faixas tem 1.846,14 m², o que corresponde a 5,10% da área total de suas APPs, de 36.184,32 m².

Tendo em vista que toda a extensão das APPs da propriedade configura área rural consolidada, a única área a ser respeitada será aquela representada pelas faixas a serem recompostas, podendo ser mantida a atividade agrossilvipastoril no restante das APPs.

3.3 PROPRIEDADE COM CONCEITO REGULAR

A situação do uso e cobertura das APPs da propriedade classificada com o conceito Regular, em 2018 e 2008, é apresentada na Tabela 8.

Tabela 8 | Uso das APPs na propriedade classificada com o conceito Regular no parâmetro APP.

	Situação em 2018		*Situação em 2008*	
USO DAS APPS	*Área (m²)*	*Percentual*	*Área (m²)*	*Percentual*
MATA NATIVA	10.487,99	49,70%	9.711,29	46,00%
PASTAGEM	9.164,91	43,4%	9.956,08	47,20%
BENFEITORIAS	1.308,30	6,20%	1.293,88	6,10%

Fonte: Dados da pesquisa (2019).

Em 2008, o uso e a cobertura das APPs da propriedade apresentavam pastagem e benfeitorias, consideradas áreas rurais consolidadas, além de mata nativa. A situação em 2018 apresentou as mesmas destinações às APPs, variando apenas as proporções de seus usos.

A extensão da propriedade representa entre 1 e 2 módulos fiscais, o que impõe a recomposição de uma faixa de 8 metros, a partir do leito regular de seus cursos d'água. A situação dessas faixas é representada na Tabela 9.

Tabela 9 | Uso das faixas de recomposição na propriedade classificada com o conceito Regular no parâmetro APP.

Uso das faixas	*Área (m²)*	*Percentual*
Pastagem	2.162,97	58,19%
Mata Nativa	1.553,88	41,81%

Fonte: Dados da pesquisa (2019).

Os dados demonstram que, nessas faixas de 8 metros, 1.553,87 m2 já apresentam mata nativa, enquanto 2.162,97 m2 são ocupados por pastagem. Portanto, apenas esta última área deve ser recomposta, já que na outra porção das faixas a vegetação nativa já está preservada.

Em relação à área a ser respeitada fora das faixas de recomposição, a Tabela 8 revela que a área ocupada por mata nativa nas APPs aumentou em relação a 2008, devendo, portanto, ser mantida sua situação atual. Tendo em vista que parte da vegetação nativa encontra-se dentro das faixas de 8 metros, observa-se que a área fora dessas faixas que contém essa cobertura e, por conseguinte, deve ser respeitada, alcança 8.934,12 m².

Somando-se essa área à extensão total das faixas de 8 metros junto aos cursos d'água que devem ser preservadas, com 3.716,85 m², conclui-se que a área total a ser respeitada na propriedade resulta em 12.650,97 m², o que representa 59,77% da área total de suas APPs, que é de 21.116,38 m². No restante de suas APPs poderá ser mantida a atividade agrossilvipastoril.

3.4 PROPRIEDADE COM CONCEITO BOM

Os dados encontrados dos usos e coberturas das APPs da propriedade classificada com conceito Bom, em 2018 e em 2008, constam na Tabela 10.

Tabela 10 | Uso das APPs na propriedade classificada com o conceito Bom no parâmetro APP.

	Situação em 2018		*Situação em 2008*	
USO DAS APPS	*Área (m²)*	*Percentual*	*Área (m²)*	*Percentual*
MATA NATIVA	23.514,43	74,96%	16.315,43	52,01%
PASTAGEM	5.760,54	18,36%	11.396,03	36,33%
BANHADO	2.091,77	6,66%	3.655,27	11,65%

Fonte: Dados da pesquisa (2019).

Em 2008, suas APPs apresentavam área de pastagem, considerada área rural consolidada, além de mata nativa e banhado, o qual configura-se como APP, de acordo com o artigo 4º, inciso VI do Novo Código Florestal. Constatou-se, em seu uso em 2018, que houve um aumento de sua vegetação nativa, enquanto a área do banhado e a destinada a pastagem reduziram.

Considerando a existência de área rural consolidada, e que o imóvel possui entre 3 e 4 módulos fiscais, deverá ser recomposta uma faixa de 15 metros no curso d'água presente na propriedade, a contar da calha da borda do leito regular. O imóvel também apresenta outras duas áreas consideradas APPs: um banhado (vereda) e duas nascentes. Em relação ao primeiro, a faixa a ser recomposta é de 30 metros, conforme artigo 61-A, parágrafo 7º, inciso I do Novo Código Florestal, enquanto a recomposição da nascente deve ser de um raio de 15 metros no seu entorno, como determina o parágrafo 5º do mesmo artigo. A Tabela 11 apresenta o uso e a cobertura dessas faixas a serem recompostas.

Tabela 11 | Uso das faixas de recomposição na propriedade classificada com o conceito Bom no parâmetro APP.

Uso das faixas	*Área (m²)*	*Percentual*
Mata Nativa	5.350,77	100%

Fonte: Dados da pesquisa (2019).

Os dados encontrados revelam que essas faixas, que somam 5.350,77 m2, já são totalmente cobertas por vegetação nativa, motivo pelo qual não será necessária qualquer recomposição, eis que já preservadas.

Considerando que se observou o aumento da área ocupada por mata nativa nas APPs em relação a 2008, sua situação atual (2018) deve ser respeitada. Logo, nesse imóvel deverá ser respeitada a porção atualmente coberta por vegetação nativa, juntamente com a área ocupada pelo banhado, o qual é considerado APP. Somadas, essas áreas alcançam 25.606,20 m2, representando 81,63% da extensão das APPs da propriedade, com 31.366,74 m2. No restante de sua área, destinada a pastagem, poderá ser mantida a atividade pecuária.

3.5 PROPRIEDADE COM CONCEITO EXCELENTE

Os dados encontrados sobre a situação da APP na propriedade classificada com o conceito Excelente, em 2018 e 2008, constam na Tabela 12.

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Tabela 12 | Uso da APP na propriedade classificada com o conceito Excelente no parâmetro APP.

	Situação em 2018		*Situação em 2008*	
USO DA APP	*Área (m²)*	*Percentual*	*Área (m²)*	*Percentual*
MATA NATIVA	24.669,18	98,37%	24.459,36	97,54%
MILHO	408,20	1,63%	618,00	2,46%

Fonte: Dados da pesquisa (2019).

Nessa propriedade, sua APP continha em 2008, na quase totalidade de sua extensão, mata nativa, e uma pequena área com atividade agrícola, que caracteriza área rural consolidada. Sua situação em 2018 pouco se alterou, variando somente as proporções de seus usos.

A propriedade possui área inferior a 1 módulo fiscal, o que obriga a recomposição de uma faixa de 5 metros, a contar da margem do curso d'água presente no imóvel, conforme exposto no Quadro 1. A Tabela 13 representa o uso e a cobertura dessa faixa.

Tabela 13 | Uso das faixas de recomposição na propriedade classificada com o conceito Excelente no parâmetro APP.

Uso das faixas	*Área (m²)*	*Percentual*
Mata Nativa	1.804,04	100%

Fonte: Dados da pesquisa (2019).

Tendo em vista que a faixa de recomposição, que possui 1.804,04 m², já está preservada, sendo ocupada integralmente por vegetação nativa, não será necessária nenhuma recomposição.

Assim, tendo havido o aumento da vegetação nativa em relação a 2008, a área da APP a ser protegida é aquela atualmente contendo essa cobertura, com 24.669,18 m², correspondente a 98,37% de sua extensão total, de 25.077,36 m². Poderá ser mantida a atividade agrossilvipastoril no restante da APP, sendo vedadas novas supressões.

3.6 LIMITES À RECOMPOSIÇÃO IMPOSTOS PELO ARTIGO 61-B DO NOVO CÓDIGO FLORESTAL

Conforme exposto no Quadro 1, o artigo 61-B do Novo Código Florestal impõe limitações ao percentual máximo da propriedade que as faixas a serem recompostas, previstas em seu artigo 61-A, podem representar. Entretanto, em nenhuma das propriedades em que a recomposição seja necessária os percentuais foram atingidos, conforme dados apresentados na Tabela 14. Os limites legais variam entre 10% e 20%, enquanto o maior percentual encontrado nas propriedades pesquisadas foi de 1,12%.

Tabela 14 | Percentuais das áreas das propriedades a serem recompostos nas faixas previstas no artigo 61-A do Novo Código Florestal

Conceito da propriedade	*Área total da propriedade (m²)*	*Área das faixas segundo artigo 61-A do CF (m2)*	*Percentual da área da propriedade que representam as faixas*	*Área das faixas não coberta por vegetação nativa, a ser recomposta*	*Percentual da área da propriedade a ser recomposta*
PÉSSIMO	198.205,86	2.234,85	1,02%	2.234,85	1,12%
RUIM	304.418,94	1.846,14	0,60%	1.846,14	0,60%
REGULAR	271.113,76	3.716,85	1,37%	2.162,97	0,79%
BOM	600.852,07	5.350,77	0,89%	0,00	0,00%
EXCELENTE	158.176,30	1.804,04	1,11%	0,00	0,00%

Fonte: Dados da pesquisa (2019)

4 DISCUSSÃO DOS DADOS

A aplicação das normas transitórias do Novo Código Florestal, relativas às áreas rurais consolidadas, à situação das APPs das propriedades, revelou significativa variação na área das APPs de cada propriedade que deve permanecer respeitada. Para ilustrar a situação, na Tabela 15 são apresentados os seguintes dados de cada propriedade: percentuais das APPs com vegetação nativa em 2008 e em 2018, em relação às medidas previstas na regra geral do artigo 4º, inciso I do Novo Código Florestal; área das APPs que deve ser recomposta nas faixas dispostas no artigo 61-A do Código; área das APPs a ser respeitada fora dessas faixas; percentual da área das APPs que deve ser respeitado após a aplicação das normas do Código, em comparação com as medidas gerais de proteção.

Tabela 15 | Evolução da cobertura de vegetação nativa nas APPs e áreas a serem preservadas e recompostas a partir das normas do Novo Código Florestal.

Conceito da Propriedade	*Percentual das APPs com vegetação nativa em 2008*	*Percentual das APPs com vegetação nativa em 2018*	*Área das APPs a ser recomposta segundo art. 61-A do CF (m2)*	*Área a ser respeitada fora das faixas determinadas pelo art. 61-A do CF (m²)*	*Percentual das APPs a ser respeitado, aplicadas as normas do CF*
PÉSSIMO	0,00%	0,00%	2.234,85	0,00	11,72%
RUIM	0,00%	0,00%	1.846,14	0,00	5,10%
REGULAR	46,00%	49,70%	2.162,97	8.934,12	59,77%
BOM	52,01%	74,96%	0,00	18.163,66	81,63%
EXCELENTE	97,54%	98,37%	0,00	22.865,14	98,37%

Fonte: Dados da pesquisa (2019).

O resultado da área total das APPs a ser respeitada, em relação às suas medidas segundo a regra geral do artigo 4º do Código, variou entre 5,10% e 98,37%, ou seja, uma amplitude de 93,27%.

As duas propriedades em que não há qualquer vegetação nativa, e tampouco havia em 2008, com conceitos Péssimo e Ruim, foram as que apresentaram os menores percentuais, com 11,72% e 5,10%, respectivamente. Nelas, as únicas porções a serem respeitadas serão aquelas das faixas de recomposição junto aos cursos d'água, enquanto todo o restante de suas APPs, por configurarem área rural consolidada, poderá continuar sendo utilizado em atividades agrossilvipastoris.

Já nas outras três propriedades, com conceitos Regular, Bom e Excelente, além das faixas de recomposição, também deverá ser preservada a porção que atualmente contém vegetação nativa, resultando, respectivamente, em 59,77%, 81,63% e 98,37% do total de suas APPs que devem ser respeitadas. Das três, somente aquela com conceito Regular não apresenta as faixas de recomposição já totalmente cobertas por vegetação nativa, mas apenas uma parte, que deverá ser recomposta.

Também se observou que, nessas três propriedades com melhor conceito, a área coberta por mata nativa em suas APPs aumentou desde 2008. Essa evolução da área preservada acabou por representar o correspondente aumento da porção a ser respeitada. Isso porque o artigo 61-A do Novo Código Florestal autoriza apenas a continuidade da utilização das áreas que eram destinadas a atividades agrossilvipastoris em 22 de julho de 2008, mas não o retorno do uso nas áreas em que foram cessadas as atividades depois disso, em que se observou o avanço da vegetação nativa.

Os resultados dos casos estudados, portanto, apontam que quanto maior a área das APPs preservada, e quanto mais essa porção aumentou desde 2008, maior será a área das APPs a ser respeitada. Por outro lado, a inexistência de vegetação nativa nas APPs, com a destinação de toda sua área a atividades agrossilvipastoris, e a manutenção dessa situação desde 2008, acarretaram a necessidade de respeitar apenas a faixa de recomposição junto ao curso d'água.

Assim, pode-se constatar que a aplicação das normas do Novo Código Florestal relativas às APPs, notadamente suas disposições transitórias acerca da área rural consolidada, acarreta obrigações discrepantes, e até paradoxais, aos proprietários. De forma geral, observou-se que àqueles que mais preservaram sua vegetação nativa são impostas maiores restrições ao uso da propriedade, com maiores áreas a serem respeitadas, enquanto para aqueles que mais a suprimiram, maior será a área que poderá continuar sendo utilizada, cuja variação poderá depender do tamanho do imóvel.

Diante disso, é possível afirmar que os resultados encontrados confirmaram a hipótese da presente pesquisa. Nas propriedades em que a área rural consolidada ocupa uma grande porção de suas APPs, o que foi observado especialmente naquelas com conceitos Péssimo e Ruim, a área de suas APPs a ser respeitada foi significativamente reduzida, representando apenas 11,72% e 5,10% de suas respectivas áreas totais.

A situação dessas propriedades demonstrou o impacto direto da vinculação da extensão das faixas de recomposição exclusivamente ao tamanho do imóvel, desconsiderando a largura do curso d'água. Em ambas, essas faixas representam a única porção de suas APPs a ser respeitada.

Em contrapartida, a propriedade com conceito Excelente, que em 2008 continha área rural consolidada em apenas 2,46% de suas APPs, deve respeitar quase a totalidade de sua extensão, 98,37%.

Já ao se confrontar as classificações das propriedades estudadas no parâmetro APP, utilizado no presente trabalho para seu sorteio, com as notas gerais obtidas por estas no projeto "Sustentabilidade em propriedades rurais produtoras de leite", não se observou qualquer relação. Conforme exposto na Tabela 1, os parâmetros do projeto avaliaram: Dejetos, Água, APP, Reserva Legal, Agrotóxicos e Fertilizantes, Declividade, Erosão, Queimadas e Usos de Terra.

A pontuação geral indicou que aquelas com conceitos Péssimo e Bom no parâmetro APP foram as melhores classificadas, ambas com 71,25 pontos, seguidas por aquelas com conceitos Ruim e Regular, com 67,25 pontos, sendo a pior pontuação conferida justamente àquela com conceito Excelente, com 61,25 pontos. Isso demonstra que a situação das APPs das propriedades não tem relação direta com as práticas adotadas pelos proprietários quanto aos demais parâmetros de sustentabilidade avaliados. É possível que o uso e a conservação das APPs decorram de vicissitudes, como a localização do curso d'água na propriedade ou o sistema produtivo utilizado, e não de práticas deliberadamente voltadas para a sustentabilidade.

Comparando os resultados das áreas de recomposição encontrados nesta pesquisa com outros trabalhos, Bonamigo et al. (2017) analisaram 68 imóveis na região serrana de Santa Catarina. Nas propriedades rurais que possuem entre 1 e 2 módulos fiscais, e que apresentam área rural consolidada, constataram que a área a ser recomposta representa, em média, 9% da área do imóvel. Já para aqueles imóveis que têm entre 2 e 4 módulos fiscais, a média a ser recomposta corresponde a 17,2% do imóvel.

Okuyama et al. (2017), em estudo com o mesmo objetivo realizado em 147 propriedades rurais familiares localizadas nas regiões centro-oriental e sudeste do Paraná, observaram que as áreas a serem recuperadas nas APPs das propriedades representam, em média, 4,9% da área do imóvel.

Os percentuais superiores aos encontrados no presente trabalho podem decorrer da quantidade de APPs presentes nas propriedades, como destacaram Okuyama et al. (2017), bem como da possível presença de diferentes espécies de APP, que implicam em distintas medidas de recomposição. Os estudos referidos também não consideraram as porções das faixas de recomposição eventualmente já ocupadas por vegetação nativa, que não necessitam ser recompostas, o que poderia implicar na diminuição dos percentuais.

A elevada presença de áreas destinadas a pastagem nas APPs e a reduzida cobertura por vegetação nativa, observadas especialmente nas propriedades com conceito Péssimo e Ruim, podem acarretar danos não apenas à função ambiental de suas APPs, como também à produção de leite.

Em estudo sobre a qualidade da água em 15 propriedades rurais produtoras de leite no VT, Bortoli et al. (2017) constataram que o gado é criado solto, com acesso livre ao local de dessedentação, a qual é realizada nos cursos d'água nas propriedades em que esse recurso estava presente. O acesso a esses locais estava relacionado à presença de áreas de pastagem e potreiros próximos aos cursos fluviais, característica observada, na presente pesquisa, nas propriedades com conceitos Péssimo, Ruim e Regular, que apresentam área de pastagem tanto nas APPs como nas faixas de recomposição junto aos cursos d'água.

Esse acesso, observaram Bortoli et al. (2017), acarreta o pisoteio da margem, causando seu assoreamento, compactação e erosão, além da contaminação da água com coliformes pela defecação do gado no local, o que prejudica a qualidade da água e colabora para a disseminação de doenças. A ausência de vegetação nativa ainda contribui para o carreamento dos dejetos aos recursos hídricos, aumentando a contaminação.

Os resultados das amostras de água analisadas naquela pesquisa apontaram que, das 15 propriedades estudadas, as 5 em que as amostras atenderam aos padrões legais de qualidade apresentavam vegetação nativa em proporção superior a 50% de suas APPs, além de revelarem uma associação entre as variáveis coliforme, presentes nas amostras, e cobertura vegetal das APPs (BORTOLI et al., 2017).

Bortoli et al. (2017) ainda referiram que a qualidade da água impacta na saúde animal e na produção de leite, já que a contaminação observada, além de reduzir a produção, eleva o risco de disseminação de doenças.

Corroborando esse estudo, em pesquisa sobre a comunidade arbórea de matas ciliares em três propriedades produtoras de leite no Vale do Taquari, Markus et al. (2018) constataram que a diversidade encontrada foi menor do que aquela observada por estudos em outras regiões do estado. Concluíram que a grande pressão por pastejo e pisoteio do gado, verificada no estudo, pode estar influenciando para essa redução na diversidade arbórea.

Assim, constata-se que o desenvolvimento das atividades nas propriedades objetos do presente estudo, com a criação de bovinos para produção de leite, quando associadas à ocupação das áreas junto aos cursos d'água para o manejo e pastejo do gado, e a consequente dessedentação animal no local, acarreta a deterioração da margem, supressão da vegetação, contaminação do recurso hídrico e consequentes danos à produtividade de leite.

Dessa forma, pode-se concluir que a vedação do acesso do gado aos cursos d'água e a recomposição da mata ciliar com vegetação nativa são fatores determinantes para a restauração da diversidade vegetal, a recuperação das condições da margem e para evitar sua erosão, bem como para a melhora da qualidade da água.

Considerando os resultados encontrados, é indicado que os produtores não se limitem a cumprir com o mínimo legal exigido, sobretudo quando for necessária apenas a recomposição das faixas junto aos cursos d'água, cujo percentual máximo encontrado nesta pesquisa alcançou 11,72% da área total das APPs. A recuperação de, ao menos, 50% das APPs pode contribuir decisivamente para que o recurso hídrico alcance padrões satisfatórios de qualidade, colaborando para o ganho de produtividade do leite.

5 CONSIDERAÇÕES FINAIS

Embora o Novo Código Florestal tenha implementado uma redução direta na área da APP a ser protegida ao longo dos cursos d'água, já que as larguras das faixas de proteção passaram a ser contadas da calha do leito regular, e não mais de seu nível mais alto, como previa o Novo Código Florestal de 1965, os resultados do presente estudo demonstram que essa redução pode ser muito mais significativa. Ao serem aplicadas às propriedades estudadas as regras transitórias acerca das áreas rurais consolidadas, foi constatado que a menor área a ser respeitada representa apenas 5,10% das APPs da propriedade com conceito Ruim.

Como consequência, foi observado que a aplicação das normas transitórias do Código pode resultar em um percentual tão ínfimo a ser respeitado, que não é capaz de cumprir as funções socioambientais da APP, como demonstram os estudos anteriormente mencionados.

Em propriedades rurais produtoras de leite, o acesso direto do gado aos cursos d'água para dessedentação pode causar diversos danos à vegetação e ao solo das margens, além da contaminação do recurso hídrico. A vedação do acesso do gado e a adequada recuperação da vegetação nativa na APP dos cursos fluviais são fatores decisivos para a restauração da vegetação e da margem, podendo contribuir para que a água alcance padrões satisfatórios de qualidade e o consequente ganho de produtividade do leite.

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Territorial and environmental management in the indigenous lands of Paru de Leste river: a collective challenge in the northern Brazilian Amazon

Gestão territorial e ambiental nas terras indígenas do Rio Paru de Leste: um desafio coletivo no Norte da Amazônia brasileira

Iori van Velthem Linke[a]

Cecília Awaeko Apalai[b]

Ima Célia Guimarães Vieira[c]

Roberto Araújo Santos Jr.[d]

[a]Doutor em Ciências Ambientais, Fundação Nacional do Índio - Funai, Santaém, PA, Brasil.
End. Eletrônico: linke.iori@gmail.com

[b]Presidente da Associação dos Povos Indígenas Wayana e Aparai - APIWA, Macapá, AP, Brasil.
End. Eletrônico: ceciliaawaeko@gmail.com

[c]Doutora em Ecologia, Museu Paraense Emilio Goeldi, Belém, PA, Brasil.
End. Eletrônico: ima@museu-goeldi.br

[d]Doutor em Etnologia, Museu Paraense Emilio Goeldi, Belém, PA, Brasil
End. Eletrônico: araujo.roberto808@gmail;.com

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ABSTRACT

The National Policy for Environmental and Territorial Management of Indigenous Reserves – (PNGATI in Portuguese) aims to promote quality of life in a sustainable way for indigenous peoples in their lands, respecting socio-cultural autonomy and their own forms of territoriality. This text shows and discusses its socio-political reach and mobilization involved in the implementation of PNGATI with the indigenous peoples of the Paru de Leste River, northern Amazon. Data were collected during the construction stages and execution of the Territorial and Environmental Management Plan through 2014 to 2018. The data suggest that despite some permanent implementation challenges, the management plan was built in order to respect the constitutional precepts of autonomy and collective well-being, empowering, within the limits of this public policy, the indigenous peoples of the region.

Keywords: PNGATI. Amazon. Paru de Leste. Wayana. Aparai.

RESUMO

A Política Nacional de Gestão Ambiental e Territorial - PNGATI objetiva promover a qualidade de vida de forma sustentável aos povos indígenas em suas terras, respeitando a autonomia sociocultural e suas próprias formas de territorialidade. Discute-se nessas linhas seu alcance sociopolítico e mobilização envolvidas na implementação da PNGATI com os povos indígenas do rio Paru de Leste, norte da Amazônia. Dados foram levantados durante as etapas de construção execução do Plano de Gestão Territorial e Ambiental, de 2014 a 2018. Os resultados sugerem que, apesar de alguns desafios permanentes de implementação, o plano de gestão foi construído de forma a respeitar os preceitos constitucionais da autonomia e bem-estar coletivo, empoderando, dentro dos limites da política pública, os povos indígenas da região.

Palavras-Chave: PNGATI. Amazônia. Paru de Leste. Wayana. Aparai.

1 INTRODUCTION

Indigenous rights in Brazil, before 1988, had as their foundation and objective the guarantee the integration process of the indigenous people into the national society, or even its suppression, as occurred in several cases to make room for national economic and territorial expansion projects (CUNHA, 1987; 1992; RIOS, 2002; HEMMING, 2009; BANIWA, 2012). Until then national indigenous agencies, such as the Indian Protection Service (in portuguese: SPI), succeeded by the National Indian Foundation (FUNAI), had the mission of providing the indigenous people with assistance, always from the relative indigenous incapacity perspective, with a tutelar view of their territories and livelihoods, as the indigenous and indigenist history asserts (OLIVEIRA, 2002; 2008; OLIVEIRA; FREIRE, 2006; CUNHA, 2009; LISBOA, 2017; GRUPIONI; OLIVEIRA; LINKE, 2018; ARAÚJO; SILVA; HERNÁNDEZ, 2019).

The Brazilian Federal Constitution approved in 1988 changed the course of this story though. As seen in Chapter VIII on the caput of its initial article number 231 the rupture with the past surpassing the tutelage and the assimilationist assumption, opened way for legitimation and recognition of sociocultural difference societal autonomy of indigenous peoples in Brazil, guaranteeing their original rights over the territory, according to their present and future collective projects (RIOS, 2002; BANIWA; CUNHA; DUPRAT; 2012).

Thus, the Indigenous Lands (IL, in portuguese “Terra Indígena”: TI) came about which are administratively delimited areas whose objective is to serve as a material and symbolic substrate for the exclusive and inalienable enjoyment of a determined people (or ethnic collective), so that they can live with autonomy and self-determination in their own forms of “physical and cultural reproduction”, “according to their uses, customs and traditions” (CUNHA, 2009; 2013; BANIWA, 2012; DUPRAT, 2012; CUNHA; BARBOSA, 2018). Autonomy and determination were further strengthened when Brazil became a signatory to Indigenous and Tribal People 169 Convention of the International Labor Organization (ORGANIZAÇÃO DAS NAÇÕES UNIDAS, 1989), (RIOS, 2002; BANIWA; DUPRAT; 2012).

However, the physical delimitation of space in closed polygons watertighted areas with finite and limited natural resources, forcing indigenous peoples to appropriate a new paradigm of territoriality with direct implications on traditional ways of life, cultural and physical reproduction as mentioned in the Federal Constitution (CUNHA, 2009; COMANDULLI, 2012; INGLÊS-DE-SOUZA; ALMEIDA, 2012; ARAÚJO; SILVA; HERNÁNDÉZ, 2019).

As Little (2002) points out, the native territoriality needed to be revised, since the demarcation of indigenous lands brought the physical discontinuities of the lived territory to the heart of the villages

(LITTLE, 2002). Therefore the transfigured territory had to be relearned, reoccupied and reidentified (LITTLE, 2002; OLIVEIRA, 2002, 2008; ARAÚJO; SILVA; HERNANDÉZ, 2019). From this point on, urgent questions regarding the guarantee of survival and physical and cultural reproduction, customs and continent traditions of a geographical space delimited over time became urgent.

In order to get this issue solved in 2012 the National Policy for Environmental and Territorial Management of Indigenous Lands (in Portuguese PNGATI: Política Nacional de Gestão Ambiental e Territorial de Terras Indígenas) (Presidential Decree nº 7.747 June 5th, 2012) (COMANDULLI, 2012; INGLÊS-DE-SOUZA, 2012; INGLÊS-DE-SOUZA; ALMEIDA, 2012; FUNAI, 2013).

Evidently indigenous peoples already lived and managed their territories in their own ways, which are considered low impact activities, seasonal related, where there are specific eating habits, territorial use and occupation and classification systems of different beings and representations for space and time. (POSEY 1997a; 1997b; 2002; VELTHEM, 2003; LIMA; POZZOBON, 2005; SMITH; ALMEIDA, 2012; BALÉE, 1994; 2013).

It is argued that one of the greatest achievements of PNGATI was to bring a regulatory framework state to the constitutional guarantees of indigenous peoples, reiterating the right to exclusive usufruct of their traditionally occupied lands, while striving to ensure that such demarcated territories correspond to the needs and specificities of each indigenous people (INGLÊS-DE-SOUZA, 2012; ARAÚJO; SILVA; HERNÁNDEZ, 2019).

To this end, the Decree provides two instruments for the local application. In its Article 2 is written "the ethnomapping and ethno-zoning are tools for the territorial and environmental management" (PNGATI, 2012, Article 2). According to FUNAI's guidelines (FUNAI, 2013), these two instruments aim to generate mobilization and systematize information and knowledge within an intercultural dialogue in order to support discussions in collective management forums, which can be organized and synthesized in a territorial and environmental management plan (in Portuguese: Plano de Gestão Territorial e Ambiental - PGTA, also known as "Life Plans" or "Action Plans" in Brazil) (APIO, 2012; APINA; AWATAC; IEPÉ, 2017).

It is observed that PNGATI has the potential to take the State's relations with indigenous peoples to another level. It is important to know what kind and nature of social empowerment the application of this policy reflects within the indigenous communities. Measuring the "empowerment", however, is not a simple task, considering the multiple meanings that this term may have (FREIRE, 1981, 1987; LABONTE, 1994; SAITO, 2002; BARQUERO, 2012; DOMICIANO, 2012). The social empowerment, as pointed out by Labonte, can be constructed and understood from two verbal forms, the transitive and the intransitive (LABONTE, 1994). In the first case, empowerment involves a subject that acts on an object by the donation of power from an entity to third parties, necessarily within limits that are given (LABONTE, 1994; MEIRELLES; INGRASSIA, 2006; BARQUERO, 2012). The second case involves the subject's own action on himself (LABONTE, 1994; BARQUERO, 2012).

Within a Freirean perspective, it is possible to analyze the local application of PNGATI by adapting the conception worked by Barquero (2005), where the application the PNGATI, as a caudatory policy of the Federal Constitution of 1988 really solidifies the indigenous tutelage break, triggering "a process of social action in which individuals take possession of their own lives through interaction with other individuals, generating critical thinking in relation to reality, favoring the construction of personal and social capacity and enabling transformation social power relations", or not (BARQUERO, 2005, p. 76).

In order to contribute to this discussion, this article aims to present and discuss a PGTA framework, in this specific case the plan of the indigenous peoples that inhabit the high and medium course of the Paru de Leste River, northern Pará.

2 METHODOLOGICAL ROUTE

2.1 THE INDIGENOUS PEOPLES OF PARU DE LESTE RIVER

The Wayana, Aparai, Tiriyó, Akuriyó, Txikiyana among others people are speakers of Karib languages and live immemorially in the triple border area of Suriname, French Guiana and Brazil in peaceful communion established through relationship networks, commercial and interethnic marriage, including some Tupi peoples (VELTHEM, 2003; BARBOSA, 2004; GALLOIS; GRUPIONI, 2009; GRUPIONI; OLIVEIRA; LINKE, 2018).

In Brazil, they currently number around 1,100 people from 220 family nuclei, scattered through 24 villages located on the banks of the high and medium course of the Paru de Leste River, in northern Pará (GRUPIONI; OLIVEIRA; LINKE, 2018).

Their territory is concentrated in the eastern portion of the "Tumucumaque Complex", also known as "Paru de Leste region", being composed by two contiguous lands: Terra Indígena (IL, in Portuguese: TI) Parque do Tumucumaque and TI Rio Paru D'Este (Figure 1). Both areas were approved by Presidential Decree in November 3rd of 1997, and the total area surpass 4.2 million hectares containing different Amazonian vegetation types (VELTHEM, 2003; GRUPIONI, 2010; VELTHEM; LINKE, 2010, 2014a).

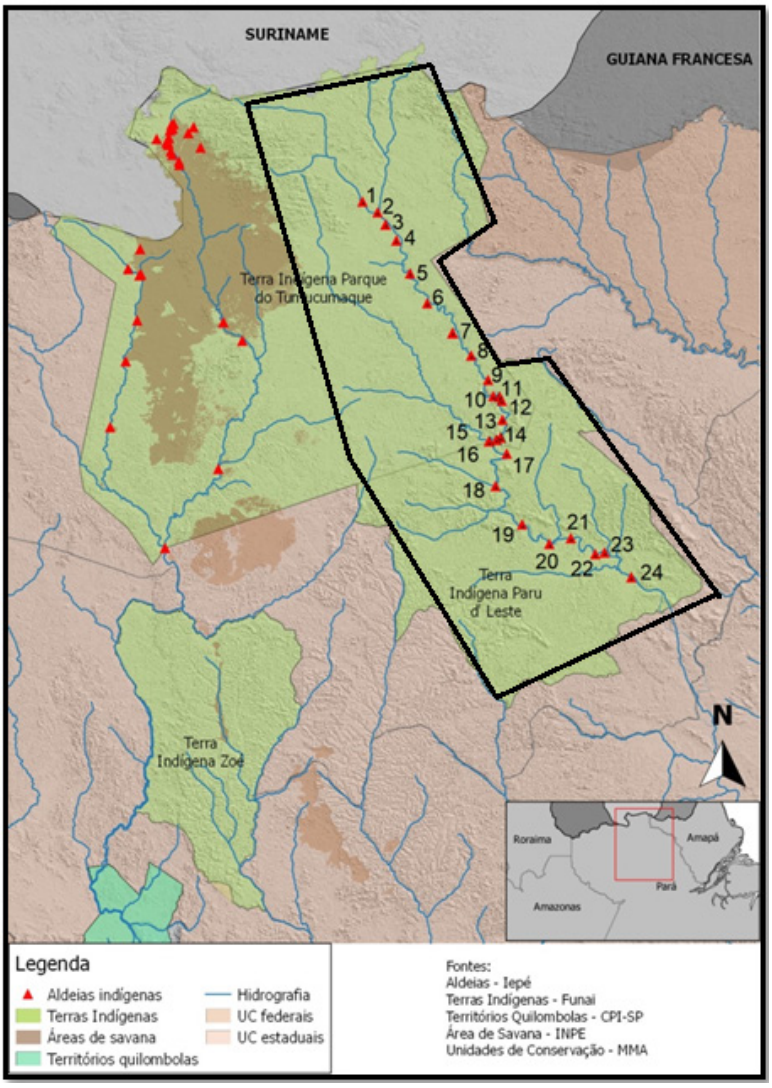

Figure 1 | Map of the Indigenous Lands Parque do Tumucumaque and Rio Paru D'Este. Polygon in black: channel of the Paru de Leste river, the area covered by the Paru de Leste PGTA.

Source: Fabrício Amorim, 2019.

Table 1 | List of indigenous villages on the Paru de Leste river channel.

Village map n.	*Name*	*Estimated population (2018)*
1	Pakupinan	16
2	Cachoeirinha	33
3	Mataware	110
4	Taunumai	13
5	Jahelai	43
6	Manau	16
7	Tyryryman	14
8	Iliwa	11
9	Maxipurimo	33
10	Bona	288
11	Murei	21
12	Kurieukuru	21
13	Aramapuku	20
14	Arawaka	37
15	Tapauku	54
16	Sitale Kumnta	12
17	Kurupohpano	38
18	Xuixuimene	74
19	Jolokoman	20
20	Ananapiare	36
21	Kurumurihpano	37
22	Itapeky	25
23	Pururé	60
24	Parapara	46

Source: Authors, 2019.

Their productive activities are based on swidden crop systems where great agrobiodiversity is cultivated with an emphasis on bitter cassava (Manihot esculenta Crantz). The hunting activity is concentrated in the winter season (from January to August), while fishing is in the summer (from August to January), the forest gathering is done all year long (GRUPIONI; GALLOIS, 2009; VELTHEM; LINKE, 2010; 2014a; LINKE; VELTHEM, 2017; GRUPIONI; OLIVEIRA; LINKE, 2018).

In the last hundred years, these people have undergone a series of external interventions that transfigured territorial areas and therefore their forms of settlement in physical space (LAPOINTE, 1970; SCHOEPF, 1972; GALLOIS, 1986; VELTHEM, 2003; BARBOSA, 2004; GRUPIONI, 2010; LINKE; VELTHEM, 2017).

After the promulgation of the Brazilian Federal Constitution in 1988, the lands of Paru de Leste people have regularized bringing to the communities public policies developed by the Special Secretariat for Indigenous Health (Portuguese: Secretaria Especial de Saúde Indígena: SESAI), Formal education by the Indigenous Nucleus in the Education Secretariat of the Amapá (Portuguese: NEI / SEED-AP), and the local monitoring held by the national indigenous foundation (Portuguese: Fundação Nacional do Índio: FUNAI), all with bureaus located in Macapá in Amapá State (GALLOIS; GRUPIONNI, 2009; LINKE; VELTHEM, 2017; GRUPIONI; OLIVEIRA; LINKE, 2018).

In order to monitor these policies and organizing the regional indigenous mobilization and representation, a first association was created in 1996, the Association of Indigenous Peoples of Tumucumaque (Portuguese: APITU). This was dismembered years later in two associations: in 2009 the Association of Indigenous Peoples Tiriyó, Katxuyana and Txikyana (Portuguese: APITIKATXI), to serve the people concentrated in the western region of the Tumucumaque Complex and, in 2010, in the Association of Indigenous Peoples Wayana and Apalai (Portuguese: APIWA), which, despite its name, represents the entire eastern portion, including peoples of other ethnicities (GRUPIONI; OLIVEIRA; LINKE, 2018).

The traditional indigenous leadership is played by the adult and elder men, especially those responsible for founding a village. Today, the leadership condition is more fluid, with an increasing participation of women and young people, notably the indigenous teachers and Indigenous Health Agents (Portuguese: AIS), all with a large participation in the APIWA affairs and the local forums and assemblies (GRUPIONI; OLIVEIRA; LINKE, 2018).

2.2 DOCUMENTAL AND FIELD RESEARCH

The data were collected during fourteen PGTA construction and execution workshops held in the Paru de Leste River region, carried out between 2014 and 2019, totaling a sampling effort of more than 100 days. Information was obtained from participant observation, informal conversations and semi-structured interviews, following guidelines and methods enshrined in the ethnographic literature (BALÉE, 1994, 2013; POSEY, 1997a; BEGOSSI et al., 2002; CAMPOS, 2002; ALBUQUERQUE; LUCENA; CABALZAR, 2010; CUNHA, 2010; VIERTLER, 2002).

The semi-structured interview sought to discuss knowledge and practices about the environment, the history of territorial occupation and census surveys; counting on destined spaces to note manifestations on local problematic experiences, as well as ideas and suggestions of resolutions, many of which were integrated to the PGTA.

In September 2014 three collective workshops were held with a one-week duration each. The first took place in the Xuixuimene village (TI Rio Paru D'Este), a second in the Matawaré village and a third in the Bona village (both in TI Parque do Tumucumaque). In the first workshop, semi-structured interviews were conducted with eight leaders from the eight villages present in the middle course of the Paru de Leste River (inside the T I Rio Paru d'Este).

In the second workshop, interviews were conducted with six representatives from the six villages on the upper Paru de Leste River (TI Parque do Tumucumaque). In the third workshop, 10 leaders from the 10 villages in the middle of the river were interviewed, concluding all 24 villages existing in the region (of the two IL). A few months later, in Bona village all he 24 leaders met again in order to discuss and validate the whole process.

Thus, from 2015 to 2019 we moved to the PGTA execution phase, where the rest of the information was collected, especially during seven indigenous researchers training modules with a one-week duration each.

This research was approved by the indigenous leaders in two moments: 1) Paru de Leste River ordinary leaders assembly, promoted by APIWA, FUNAI and Instituto Iepé, which took place in November 2014, and 2) an extraordinary assembly in February 2019. Both have written records.

3 HISTORY OF CONSTRUCTION OF THE TERRITORIAL AND ENVIRONMENTAL MANAGEMENT PLAN

In the Paru de Leste region, many territorial and environmental management experiences, such as natural resource management, cultural enhancement actions, territorial protection activities, school booklets production, links with surrounding protected areas, were carried out even before the PNGATI publication, etc. (VELTHEM; LINKE, 2010; 2014b, 2014c; LINKE; VELTHEM, 2017; GRUPIONI; OLIVEIRA; LINKE, 2018).

All of these experiences were accumulated in the villages, being periodically revisited in subsequent meetings and assemblies, included in the final PGTA discussion and construction. It is important to searchk such history to understand the taken paths and the options made over time (see box 2 below).

Table 2 | Historical picture of the main actions for the environmental and territorial management of Paru de Leste region.

Data	*Actions*	*Participanting Public*	*Results and innovations*
1997	Homologations of the two indigenous lands	The indigenous people	Indigenous lands homologated and registered
1999	Territorial protection and reoccupation project	The indigenous people of both lands	Were open 14 new villages on Paru de Leste river.
2005 to 2008	Cultural valorization workshops	Five workshops of a one-week each, with the participation of all indigenous leaders. Total audience of more than 300 people (men, women, adults and children).	Beginning of discussions on material and immaterial cultural heritage. Discussion for handling raw materials needs used in traditional objects. Publications.
2007 to 2008	Socio-environmental survey workshops.	Five workshops and two meetings with the presence of indigenous leaders from all villages. Survey of the main socio-environmental problems in the communities.	Survey of the main socio-environmental problems in the communities. Beginning of discussions of collective land management.
2008 to 2009	Experimental game and fishing survey done in ancient villages	Five workshops in Bona, Murei and Maxipurimo villages. Target audience: about 300 people. Inventory, survey and diagnosis of hunting and fishing done in the region.	Beginning of debates on management of shared hunting and fishing territories.
2009 to 2015	Wayana and Aparai research training.	Fourteen one-week workshops for 15 young Wayana and Aparai (women and men) from eight different villages.	Instrumentalization of the youth in documentation and cultural research forms on native livelihood in their own languages. The results are discussed at APIWA assemblies.
2009 to 2013	Formation of the Consultative Council for the Protected Areas of Amapá and Northern Pará Mosaic	A dozen meetings comprising leaders from all villages in the Tumucumaque Complex, non indigenous people and public agents from federal and state agencies (Pará and Amapá).	Integrated environmental and territorial management concern for the region, beyond the indigenous boarders.
2010 to 2014	Community management experience: arumã (Ischosiphon spp.)	Four technical field visits lasting 2 weeks each, involving more than 30 Wayana and Aparai (men, youth and adults) from 3 villages. Interchange to Baniwa villages (Rio Negro, AM).	More than 10 experimental management modules in 3 villages. Publication.
2012	PNGATI Decree No. 7,747 of June 5th, 2012 published	Indigenous lands declared by FUNAI	PNGATI Institution.
2014 to 2015	Socioenvironmental Diagnosis	Three regional workshops (check methodology)	General diagnosis, including information on previous actions and activities. PGTA's first version.
2016 to 2018	PGTA execution project	Agreements and actions foreseen in the plan are carried out involving all villages.	Paru de Leste PGTA starts to run.

Source: Authors, 2019.

The PGTA organization process itself begins in 2014 (see methodology). At this time, there was close monitoring of the leaders, APIWA's directors, FUNAI and Iepé Institute technicians in all stages (figure 2). In possession of the collected and organized information, in late 2014 a large indigenous assembly was held in Bona village when the diagnosis results were presented, discussed, rectified and validated by all. In addition to the problems raised, and in many reiterated points, possible strategies and solutions were presented and discussed, which many became agreements between that forum participants, including the participation of each institution according to their competencies (APIWA, FUNAI, Iepé), and community members (leaders, AIS, indigenous teachers). Once this stage was completed, a first edition of the PGTA was considered done. Subsequently, these data were refined and published in book format (GRUPIONI; OLIVEIRA; LINKE, 2018).

Figure 2 | Socio-environmental diagnosis workshop on Bona village, 2014.

Source: LINKE, 2014.

For historical, geographical and, mainly, sociocultural reasons, the indigenous leaders of the Tumucumaque Complex decided to organize their PGTA in two components, following the dichotomy present in the indigenous organizations: i) western portion (APITIKATXI); ii) eastern portion (APIWA), which is representative of the 24 villages on the Paru de Leste River: as know as the "Paru de Leste PGTA".

Although there are many points in common, there is no political preponderance nor overlap between the sides. Central issues, such as health, are dealt with jointly. For more local issues, such as resource management, there is independence in the decisions made and in the execution of activities.

4 THE PARU DE LESTE PGTA AND THE PNGATI

The Paru de Leste PGTA was organized by the indigenous leaders in six thematic axes inspired by precursor plans, much exemplified in the discussions, such as the Life Plan of the Indigenous Peoples of Oiapoque and the Kaxinawá and Ashaninka Indigenous Land PGTA of the Breu River (APIO, 2009; GAVAZZI, 2007). The axes seek to encompass dimensions that go beyond environmental and territorial management, namely: 1) Territorial Protection; 2) Governance and Empowerment; 3) Management and sustainable use of natural resources; 4) Culture; 5) School education and 6) Health.

Following FUNAI guidelines, the PGTA was built to be cyclical to facilitate future revisions during the process, with the following steps: 1) mobilization, 2) discussion of problems and agreements / possible solutions, 3) activity planning, 4) execution of activities, 5) results monitoring and appreciation, returning to the starting point (FUNAI, 2013).

Figure 3 | A PGTA meeting held inside the Maxipurimo's communal house.

Source: LINKE, 2018.

Table 3 shows in a summarized format the Rio Paru de Leste PGTA based on its constitutive axes, including the objectives, problems and the main strategies and solutions agreed by the indigenous leaders. For all axes the actors directly involved are the communities, the APIWA, FUNAI, and the Iepé Institute. For more details, check the PGTA publication (GRUPIONI; OLIVEIRA; LINKE, 2018).

Table 3 | Paru de Leste PGTA summarized.

	Objectives	*Problems*	*Strategies*
1) TERRITORIAL PROTECTION	To guarantee the physical integrity of indigenous lands.	Distant boundaries of villages are areas at risk of invasion.	• Ostensibly occupy the limits with new villages and surveillance bases; • Constant surveillance and monitoring actions, including competent bodies; • Communication system; • Regularize landing strips; • Destine appropriate waste disposal.
2) GOVERNANCE AND EMPOWERMENT	Strengthen the PGTA decision and deliberation bodies.	Qualify the participation and social control of traditional leaders and the representative association face incoming new challenges	• Qualify and strengthen indigenous leaders and the association to monitor the PGTA and other indigenous policies; • Build local plan for free, prior and informed consultation; • Exchanges visits with other peoples; • Articulate with surrounding protected areas;

	Objectives	*Problems*	*Strategies*
3) MANAGEMENT AND SUSTAINABLE USE	Guarantee stocks of natural resources for the survival and sovereignty of the population	Loss of agrobiodiversity in fields and villages patios. Increasing scarcity of hunting, fishing and some raw materials.	• Promote intercultural dialogues on natural resource management; • Strengthen the exchange of native seedlings and seeds; • Locally observe climate change; • Zoning "savings" areas free from hunting, fishing, gathering and agriculture activities. • Do not bring or use genetically modified seeds or pesticides in IL.
4) CULTURE	Ensure a strong and active culture, walking together with external cultural elements.	Discontinuity and disinterest in traditional knowledge and its forms of transfer.	• Promote cultural events; • Search for ways to reconnect the transfer of intergenerational knowledge; • Produce cultural materials for internal and external circulation (books, videos, etc.) • Training of youth. • Registration of cultural heritage.
5) EDUCATION	Ensure differentiated and quality school education, which serves for life inside and outside the villages.	Absence of political-pedagogical program (PPP) for the region. Poor infrastructure, few indigenous teachers, non-indigenous professionals who are poorly qualified and / or discouraged.	• Creation of PPP for the region with wide indigenous participation; • Creation of local school calendar; • Lunch with local foods; • Production of differentiated material; • Improve infrastructure; • Training of indigenous and non-indigenous teachers. • Qualify the monitoring of the local leaders.
6) HEALTH CARE	Ensure quality and contextualized medical care, focused on prevention.	Poor infrastructure; few indigenous and non-indigenous health professionals to the demand; lack of medicines in the villages.	• Improve infrastructure; • Training of Indigenous Health Agents; • Regularize the health professional schedules; • Qualify the monitoring of the local leaders.

Source: Adapted from GRUPIONI; OLIVEIRA; LINKE, 2018).

5 TERRITORIAL MANAGEMENT AND THE SOCIO-POLITICAL REACH OF PNGATI IN PARU DE LESTE

The Paru de Leste PGTA presents a series of challenges linked by various issues of different natures, such as the area remote access, regional high socio-cultural diversity, intergenerational issues, consumption of manufactured products and settlements established outside traditional standards (GRUPIONI; OLIVEIRA; LINKE, 2018).

Each PGTA carries the aspirations and priorities of its people, within unique histories and mobilization processes (COMANDULLI; INGLÊS-DE-SOUZA; ALMEIDA, 2012). This, however, does not prevent analogies and intersection points. The PGTA of the Xingu Indigenous Park (PIX), in Mato Grosso, for example, allocates a large part of its efforts to the territorial protection of the Xingu springs that were left out of bounds and today drain vast pastures and huge soy crops (ATIX; ISA, 2016).

Territorial boudaries are also addressed in the Paru de Leste PGTA, but in a different way, as the territorial contexts are not the same. The strategy is based on the review and occupation of indigenous lands vulnerable points, through the opening of villages and monitoring bases, associated with articulated

expeditions involving the communities and official organizations, an effective communication system, and landstrips regularization. Additionally, handles proper waste disposal. Such strategies are interesting, as they mean the cartographic limits incorporation into the native logic (GUIMARÃES, 2014). This can be faced as political resistance and rights guarantee act, mainly to live in peace in their own land.

Regarding territorial protection, the PGTA the Wajãpi in Amapá, provides strategies with the surroundings that are populated by rural settlements, besides, aims to strengthen traditional Wajãpi mobility (APINA; AWATAC; IEPÉ, 2017). However, many parallels are found between the Wajãpi and Paru de Leste PGTAs, as both belong to the indigenous movement historically linked to Macapá, where decentralized state units are located, and partners organizations, such as Iepé which operate in both regions (GALLOIS; GRUPIONI, 2009; GRUPIONI; KAHN, 2013; APINA; AWATAC; IEPÉ, 2017).

Thus, perhaps the central point that links both PGTAs is the constant search for strengthening internal governance, through the qualification and legitimation of local leadership and their associations, involving the construction of many political bridges, such as those that deal with management beyond limits and the youth training (APINA; AWATAC; IEPÉ, 2017; GRUPIONI; OLIVEIRA; LINKE, 2018).

Therefore, this axis is fundamental and transversal, since, in the Freirean sense of empowerment, it is only with qualified participation, transposing the historical power by alienation that it will be possible fulfill the achievement of the public policies, such as PNGATI and others, like those linked in the health and school education axes (FREIRE, 1987; BARQUERO, 2012).

The youth formation mentioned is also the flagship of other PGTAs, such as those of the TI Kaxinawa of Rio Humaitá and TI Mamoadate, both in Acre. In such plans there is the figure of the "indigenous agroforestry agent" as key players in intercultural dialogue, appearing on all of their plan axes (GAVAZZI; ROCHA 2015; ALMEIDA; OCHOA; GAVAZZI, 2016). It also occurs in Paru de Leste, where the training empowerment instrument to the knowledge and epistemological systems dialogue, internal and external to the communities, collaborating and connecting all axes (LINKE; VELTHEM, 2017; GRUPIONI; OLIVEIRA; LINKE, 2018).

The PGTA the Indigenous Lands of northwest Negro River also focuses on the intercultural dialogue of research, combining outside knowledge and techniques with traditional knowledge forms (FOIRN; ISA, 2017, 2018). Among several, we can mention as successful the experiences of fisheries management, started years ago, in the Negro River tributaries Tiquié and Içana (CABALZAR, 2005; 2010).

Similarly, the axis of management and sustainable use of natural resources focuses on the productive systems of the peoples of the Paru de Leste River, adopting measures that mix traditional forms with adaptations of rural extension techniques, within a knowledge dialogue. This point is also observed in the PGTA of TI Kaxinawá and Ashaninka of the Breu River, in Acre, with ethno-zoning tools and rules for the use of the environment (GAVAZZI, 2007).

We see, therefore, that PNGATI brought to the Paru de Leste River a great mobilizing potential by allowing people not only to know indigenous policies, but also the possibility to collectively think and organize the territory, identities, and interfaces with the outside world (LITTLE, 2002; GALLOIS, 2004).

Although the data indicate that the Paru de Leste PGTA construction was anchored in the wide and historical participation of the locals, we believe it is premature to judge the degree of social empowerment given by the local development of the PNGATI. It is clear, on the other hand, that the creative processes of the plan objectively sought to naturalize and internalize concerns about life in physically limited territories, opening up different possibilities. Among the successes, the process enabled the indigenous people to think critically of the current political moment, to raise awareness about threats to their rights and discuss mobilization strategies. It is not by chance that there is a specific axis for governance and local empowerment. This critical look, of self-recognition, taking possession of the real, as Freire said, was catalyzed by the local implementation of PNGATI, and the PGTA can be understood as a corollary of the process started in 1997, when indigenous lands were regularized (FREIRE, 1981; 1987).

But when we return to the authors who celebrate Freire's criticism, Horochovski and Meirelles, for instance, claim that the intransitive aspect of empowerment brings visibility, influence and capacity for action and decision to the communities and organizations involved (HOROCHOVSKI; MEIRELLES, 2007). This, however, according to Barquero, would demand a detachment, an emancipation of civil society (in this case, the indigenous people as a whole) from the State, being, in this hypothetical case, the PGTA a space for the emancipation of the excluded ones: the indigenous people (BARQUERO, 2012). As seen, PNGATI has mechanisms in its wording that seek more symmetrical dialogues, overcoming the tutelary paradigm. Following the line of some authors, this is undoubtedly a form of intransitive empowerment, as it is possible to conclude that with PNGATI the indigenous peoples of Brazil gain influence and control over their lives in their territories (WALLERSTEIN; BERSTEIN, 1994; INGLÊS-DE-SOUZA, 2012).

On the other hand, we cannot avoid remembering that PNGATI remains a state policy, organized within a bureaucratic framework that is alien to indigenous communities, constituting a challenge also for the responsible technical body (GUIMARÃES, 2014). Besides, PNGATI focuses on at least declared indigenous lands, which ultimately remain Union lands, as clearly stated in Article 231 of the Federal Constitution. Although the application of PNGATI is not an imposition, it ends up being in practice since it centralizes all the actions of "territorial and environmental management in indigenous lands" given in the State X indigenous peoples interface. At this point, it is necessary to remember that indigenous lands safeguard large territorial extensions, being fundamental components in strategies for environmental conservation in Brazil, especially in the Amazon (SANTILLI, 2005; FERREIRA; VENTICINQUE; ALMEIDA, 2007; NOLTE et al. 2013; CRISOSTOMO et. Al., 2015; BONANOMI et al. 2019).

Regarding the traditional livelihood forms identified as drivers of such conservation, it is necessary to return to the initial question of the Rousseauian "good savage" since we must ask the indigenous if placing so much responsibility on their shoulders would not be, as Cunha points out, a great misunderstood, "(...) a case of western projection of ecological concerns about a good savage ad hoc built?" (CUNHA, 2009, p. 277).

Thus, by limiting and framing the political action area, it is possible to conclude that PNGATI can also represent a transitive form of organizational empowerment for indigenous peoples, including those on the Paru de Leste River (BARQUERO, 2012).

6 FINAL CONSIDERATIONS

PNGATI is a very recent policy in the historical framework of relations between the national state and indigenous peoples in Brazil. It proposes to change paradigms that have long been ingrained, such as tutelary leading. Thus, doubts regarding the effects and natures of this policy development within the communities will take some time to be fully understood by all the involved actors, indigenous or not. That is why, as we have seen, it is possible to today view PNGATI in such different ways.

On the issue of empowerment, PNGATI may reach different spectra depending on the context of its local implementation. PGTAs represent different forms of local empowerment, depending on many factors that sometimes go beyond community dynamics and the interfaces given with external agents and partners. The history of the people and the territory in question weighs heavily in the assessment.

In the case of the Paru de Leste PGTA the data and records show that the arrival of PNGATI led to a more acute critical eye, a reflection that generated mobilizations.

Its PGTA, as we see in the tables, basically points out ways to seek improvements in living conditions in the villages, seeking to create bridges between the actions of indigenous leaders, state agencies and civil society partners. Besides, the PGTA aims at strengthening internal and external policy, premises internalized in an axis with this specific objective. Such an end indicates a real path for local empowerment through the internal and external mobilization and social control strengthening, instrumentalizing the indigenous people for the execution of PNGATI and other public policies.

There is always work to be done, and this being a recent and under construction policy, there is still a lot of room for improvement. In the PGTA observed, there are still many outstanding issues, mainly those related to the future functioning of the different actors involved in the planning, execution, monitoring and evaluation of the proposed actions and arrangements. Also, problems that have not yet been identified may arise in the course of implementing the plan, and it is plausible that previously priority issues cease to be them in the course of the process.

We must not lose sight of the fact that concepts of "life quality" and "well-being" in indigenous lands, practically PNGATI premises, are equally susceptible to internal transformations and reframing in the time flow. And these transformations are fit for evaluations that, ultimately, belong only to the interested indigenous people. In any case, monitoring mechanisms for the continuous improvement of the plan's functioning are provided for in the PGTA, following FUNAI guidelines.

Finally, these and other issues that are intended to measure degrees of ownership need to be continuously monitored and studied. Given the high degree of dynamism and complexity of this subject, future studies on the themes of this text are very welcome. We hope that this first look at the Paru de Leste PGTA will contribute to this process.

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Gestão territorial e ambiental nas terras indígenas do Rio Paru de Leste: um desafio coletivo no norte da Amazônia brasileira

Territorial and environmental management in the indigenous lands of Paru de Leste river: a collective challenge in the northern Brazilian Amazon

Iori van Velthem Linke[a]

Cecília Awaeko Apalai[b]

Ima Célia Guimarães Vieira[c]

Roberto Araújo Santos Jr.[d]

[a]Doutor em Ciências Ambientais, Fundação Nacional do Índio – Funai, Santarém, PA Brasil.
End. Eletrônico: linke.iori@gmail.com

[b]Presidente da Associação dos Povos Indígenas Wayana e Aparai – Apiwa, Macapá, AP, Brasil.
End. Eletrônico: ceciliaawaeko@gmail.com

[c]Doutora em Ecologia, Museu Paraense Emilio Goeldi, Belém, PA, Brasil.
End. Eletrônico: ima@museu-goeldi.br

[d]Doutor em Etnologia, Museu Paraense Emilio Goeldi, Belém, PA, Brasil.
End. Eletrônico: araujo.roberto808@gmail.com

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ARTICLE- VARIA

RESUMO

A Política Nacional de Gestão Ambiental e Territorial – PNGATI objetiva promover a qualidade de vida de forma sustentável dos povos indígenas em suas terras, respeitando a autonomia sociocultural e suas próprias formas de territorialidade. Discute-se, nessas linhas, seu alcance sociopolítico e a mobilização envolvidos na implementação da PNGATI com os povos indígenas do Rio Paru de Leste, norte da Amazônia. Dados foram levantados durante as etapas de construção e execução do Plano de Gestão Territorial e Ambiental, de 2014 a 2018. Os resultados sugerem que, apesar de alguns desafios permanentes de implementação, o PGTA foi construído de forma a respeitar os preceitos constitucionais da autonomia e bem-estar coletivo, empoderando, dentro dos limites da política pública, os povos indígenas da região.

Palavras-Chave: PNGATI. Amazônia. Paru de Leste. Wayana. Aparai.

ABSTRACT

The National Policy for Environmental and Territorial Management of Indigenous Reserves – PNGATI (in Portuguese) aims to promote quality of life in a sustainable way for indigenous peoples in their lands, respecting socio-cultural autonomy and their own forms of territoriality. This text shows and discusses its socio-political reach and mobilization involved in the implementation of PNGATI with the indigenous peoples of the Paru de Leste River, northern Amazon. Data were collected during the construction stages and execution of the Territorial and Environmental Management Plan through 2014 to 2018. The data suggest that despite some permanent implementation challenges, the PGTA was built in order to respect the constitutional precepts of autonomy and collective well-being, empowering, within the limits of this public policy, the indigenous peoples of the region.

Keywords: PNGATI. Amazon. Paru de Leste. Wayana. Aparai.

1 INTRODUÇÃO

Os direitos indígenas no Brasil, antes de 1988, tiveram como fundamento e fim a garantia do processo de integração dos índios à sociedade envolvente, ou até mesmo a sua supressão, como ocorreu em vários casos, a fim de abrir espaço aos projetos de expansão econômica e territorial (BANIWA, 2012; CUNHA, 1987; 1992; HEMMING, 2009; RIOS, 2002). Até então, órgãos indigenistas, como o Serviço de Proteção aos Índios (SPI), sucedido pela Fundação Nacional do Índio (Funai), tinham enquanto missão prover os índios de ações assistencialistas, sempre sob a ótica da relativa incapacidade indígena, tutelando-os em seus territórios e meios de vida, como assevera a história indígena e indigenista (ARAÚJO; SILVA; HERNÁNDEZ, 2019; CUNHA, 2009; GRUPIONI; OLIVEIRA; LINKE, 2018; LISBOA, 2017; OLIVEIRA, 2002; 2008; OLIVEIRA; FREIRE, 2006).

A Constituição Federal homologada em 1988, contudo, mudou o rumo dessa história. No Capítulo VIII "dos Índios", vemos a ruptura com o passado já no caput de seu artigo inicial, o de número 231, superando a tutela e o pressuposto assimilacionista, abrindo caminho para a legitimação e o reconhecimento à diferença sociocultural e da autonomia societária dos povos autóctones e, com isso, garantindo-lhes o direito originário sobre seu território, de acordo com seus projetos coletivos presentes e futuros (BANIWA; CUNHA; DUPRAT; 2012; RIOS, 2002).

Advieram, assim, as Terras Indígenas (TI) que são áreas administrativamente delimitadas cujo objetivo é servir de substrato material e simbólico, inalienável e de usufruto exclusivo a um determinado (ou coletivo de) povo(s), para que ali habite(m) e possa(m) realizar – com autonomia e autodeterminação – suas formas de "reprodução física e cultural, segundo seus usos, costumes e tradições" (BANIWA, 2012; CUNHA, 2009; 2013; CUNHA; BARBOSA, 2018; DUPRAT, 2012). A autonomia e a determinação fortaleceram-se mais quando o Brasil passou a ser signatário da Convenção 169 da Organização Mundial do Trabalho (ORGANIZAÇÃO DAS NAÇÕES UNIDAS, 1989), (BANIWA; DUPRAT; 2012; RIOS, 2002).

Contudo, a delimitação física do espaço em polígonos fechados, como áreas estanques com recursos naturais finitos e limitados, forçou os povos indígenas a se apropriarem de um novo paradigma de territorialidade com implicações diretas às suas formas de vida tradicional, a sobrevivência e reprodução física e cultural mencionadas na Carta Magna (ARAÚJO; SILVA; HERNÁNDEZ, 2019; COMANDULLI, 2012; CUNHA, 2009; INGLÊS-DE-SOUZA; ALMEIDA, 2012). Como aponta Little (2002), a territorialidade nativa precisou ser revista, pois a demarcação das terras indígenas trouxe para o seio das aldeias as descontinuidades físicas do território vivido (LITTLE, 2002). Portanto, esse território transfigurado teve que ser reaprendido, reocupado e reidentificado (ARAÚJO; SILVA; HERNÁNDEZ, 2019; LITTLE, 2002; OLIVEIRA, 2002; 2008). A partir desse ponto, tornam-se urgentes questões a respeito da garantia da sobrevivência e reprodução física e cultural, costumes e tradições continentes de um espaço geográfico delimitado ao longo do tempo.

Em busca da resolução dessa questão, foi instituída em 2012 a Política Nacional de Gestão Ambiental e Territorial de Terras Indígenas – PNGATI (Decreto Presidencial nº 7.747, de 05 de junho de 2012) (COMANDULLI, 2012; FUNAI, 2013; INGLÊS-DE-SOUZA, 2012; INGLÊS-DE-SOUZA; ALMEIDA, 2012).

Evidentemente, povos indígenas já viviam e manejavam seus territórios a partir de formas próprias, consideradas de baixo impacto, que se relacionam diretamente à sazonalidade, aos seus hábitos alimentares, uso e ocupação territorial e sistemas de classificação dos diferentes seres e representações para o espaço e tempo (BALÉE, 1994; 2013; LIMA; POZZOBON, 2005; POSEY 1997a; 1997b; 2002; SMITH; ALMEIDA, 2012; VELTHEM, 2003).

Argumenta-se que um dos grandes feitos da PNGATI foi o de trazer um marco regulador do Estado às garantias constitucionais dos povos indígenas, reiterando o direito de usufruto exclusivo das terras tradicionalmente ocupadas, ao tempo em que se empenha para que tais territórios demarcados correspondam às necessidades e especificidades de cada povo (ARAÚJO; SILVA; HERNÁNDEZ, 2019; INGLÊS-DE-SOUZA, 2012).

Para tal, o Decreto prevê dois instrumentos de aplicação local da política; em seu Artigo 2º "são ferramentas para a gestão territorial e ambiental de terras etnomapeamento e o etnozoneamento" (PNGATI, 2012). Segundo orientações expressas pela própria Funai (2013), esses dois instrumentos visam gerar mobilização e sistematizar informações e conhecimentos dentro de um diálogo intercultural, a fim de subsidiar discussões em fóruns coletivos de gestão, podendo ser organizados e sintetizados em um plano de gestão territorial e ambiental (PGTA, também conhecidos por "Planos de Vida" ou "Planos de Ação") (APINA; AWATAC; IEPÉ, 2017; APIO, 2012).

Observa-se que a PNGATI tem o potencial de levar as relações do Estado com os povos indígenas a outro patamar. É importante saber, contudo, se a aplicação dessa política reflete em um real empoderamento social, isto é, de que ordem e natureza se tratam as transformações engendradas por essa política no seio das comunidades indígenas. Medir o "empoderamento", contudo, não constitui tarefa simples, considerando as várias acepções que esse termo pode ter (BARQUERO, 2012; DOMICIANO, 2012; FREIRE, 1981; 1987; LABONTE, 1994; SAITO, 2002). O empoderamento social, como apontado por Labonte, pode ser construído e compreendido a partir de duas formas verbais, a transitiva e intransitiva (LABONTE, 1994). No primeiro caso, o empoderar envolve um sujeito que age sobre um objeto, isto é, a doação de poder de um ente a terceiros, necessariamente dentro de limites que são dados pelo doador (BARQUERO, 2012; LABONTE, 1994; MEIRELLES; INGRASSIA, 2006). O segundo caso envolve a ação do próprio sujeito sobre si mesmo (BARQUERO, 2012; LABONTE, 1994).

Dentro de uma perspectiva freireana, é possível analisar a aplicação local da PNGATI ao adaptarmos a concepção trabalhada por Barquero (2005), isto é, verificando, em estudos de casos, se a aplicação dessa política caudatária da Constituição Federal de 1988 realmente solidifica a ruptura com a tutela dos povos indígenas, desencadeando "um processo de ação social no qual indivíduos tomam posse de suas próprias vidas pela interação com outros indivíduos, gerando pensamento crítico em relação à realidade, favorecendo a construção da capacidade pessoal e social e possibilitando a transformação de relações sociais de poder", ou não (BARQUERO, 2005, p. 76).

Objetivando contribuir para esta discussão, o presente artigo visa apresentar e discutir um quadro de construção de PGTA, no caso, o plano dos povos indígenas que habitam o alto e médio curso do rio Paru de Leste, norte do Pará.

2 PERCURSO METODOLÓGICO

2.1 OS POVOS INDÍGENAS DO RIO PARU DE LESTE

Os povos Wayana, Aparai, Tiriyó, Akuriyó, Txikiyana, entre outros, são falantes de línguas da família Karib e vivem imemorialmente na região da tríplice fronteira do Suriname, Guiana Francesa e do Brasil em comunhão pacífica estabelecida por intermédio de redes de relacionamento, intercâmbio comercial e do matrimônio interétnico, incluindo povos tupi (BARBOSA, 2004; GALLOIS; GRUPIONI, 2009; GRUPIONI; OLIVEIRA; LINKE, 2018; VELTHEM, 2003).

No Brasil, eles atualmente somam cerca de 1.100 pessoas de 220 núcleos familiares, distribuídos em 24 aldeias localizadas às margens do alto e médio curso do Rio Paru de Leste, no Pará (GRUPIONI; OLIVEIRA; LINKE, 2018).

Seu território concentra-se na porção oriental do "Complexo do Tumucumaque", ou "região do Paru de Leste", no extremo norte do Pará, sendo composto por duas terras contíguas: TI Parque do Tumucumaque e TI Rio Paru D'Este (Figura 1). Ambas as áreas foram homologadas mediante Decreto Presidencial s/nº, de 03 de novembro de 1997, e totalizam mais de 4,2 milhões de hectares contendo diferentes fitofisionomias amazônicas (GRUPIONI, 2010; VELTHEM, 2003; VELTHEM; LINKE, 2010, 2014a).

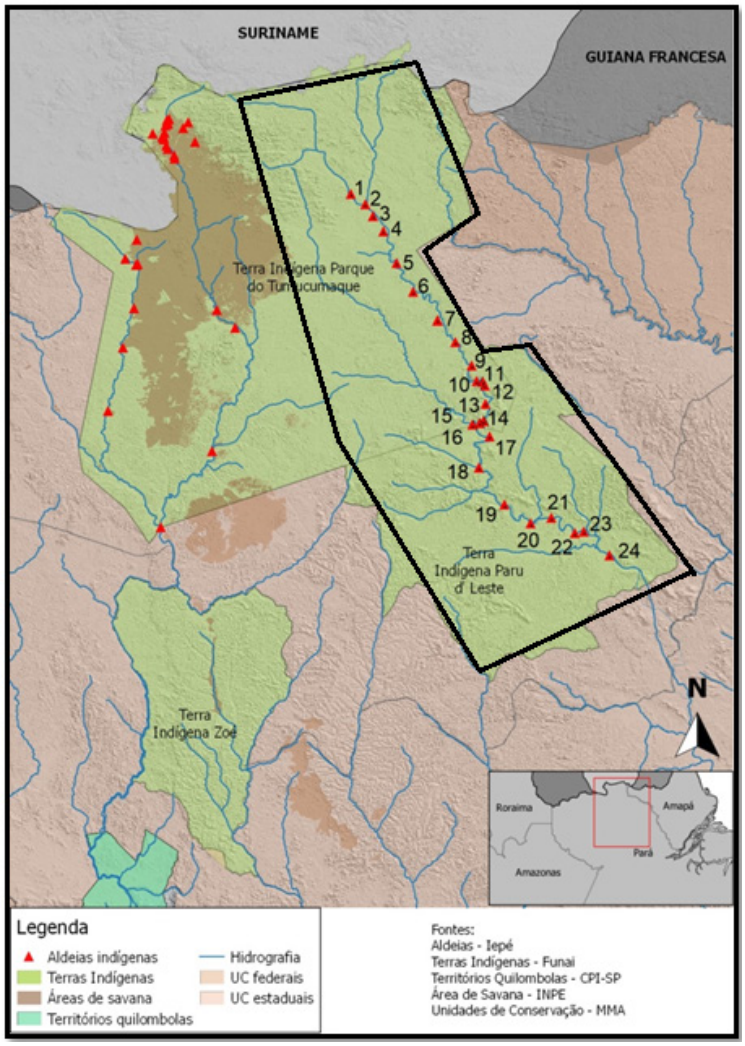

Figura 1 | Mapa das Terras Indígenas Parque do Tumucumaque e Rio Paru D'Este. Polígono em preto: calha do Rio Paru de Leste, a área de abrangência do PGTA do Paru de Leste.

Fonte: Fabrício Amorim, 2019.

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Quadro 1 | Lista das aldeias indígenas na calha do Rio Paru de Leste.

Aldeia (nº mapa)	*Nome*	*População estimada (2018)*
1	Pakupinan	16
2	Cachoeirinha	33
3	Matawaré	110
4	Taunumai	13
5	Jahelai	43
6	Manau	16
7	Tyryryman	14
8	Iliwa	11
9	Maxipurimo	33
10	Bona	288
11	Murei	21
12	Kurieukuru	21
13	Aramapuku	20
14	Arawaka	37
15	Tapauku	54
16	Sitale Kumnta	12
17	Kurupohpano	38
18	Xuixuimene	74
19	Jolokoman	20
20	Ananapiare	36
21	Kurumurihpano	37
22	Itapeky	25
23	Pururé	60
24	Parapara	46

Fonte: Dos autores, 2019.

Suas atividades produtivas baseiam-se em sistemas rotativos de roçados onde cultivam grande agrobiodiversidade com destaque para a mandioca (Manihot esculenta Crantz). A atividade de caça é concentrada no inverno (de janeiro a agosto), enquanto a pesca no verão (de agosto a janeiro), e a coleta e o extrativismo durante o ano todo (GRUPIONI; GALLOIS, 2009; GRUPIONI; OLIVEIRA; LINKE, 2018; LINKE; VELTHEM, 2017; VELTHEM; LINKE, 2010; 2014a).

Nos últimos 100 anos, esses povos passaram por uma série de intervenções externas que transfiguraram áreas territoriais e formas de assentamento do espaço físico (BARBOSA, 2004; GALLOIS, 1986; GRUPIONI, 2010; LAPOINTE, 1970; LINKE; VELTHEM, 2017; SCHOEPF, 1972; VELTHEM, 2003).

Em 1997, já bem depois da promulgação da Constituição Federal em 1988, as terras dos povos do Rio Paru de Leste foram regularizadas e contam com políticas públicas desenvolvidas nas comunidades por unidades da Secretaria Especial de Saúde Indígena (DSEI/Sesai), do Núcleo de Educação Indígena da Secretaria de Educação do Amapá (NEI/Seed-AP), e do acompanhamento local da Funai (Coordenação Regional do Amapá e Norte do Pará), todas localizadas em Macapá/AP (GALLOIS; GRUPIONNI, 2009; GRUPIONI; OLIVEIRA; LINKE, 2018; LINKE; VELTHEM, 2017).

Visando monitorar essas políticas, além de organizar a mobilização e representação dos povos indígenas da região, foi criada uma primeira organização indígena em 1996, a Associação dos Povos Indígenas do Tumucumaque (Apitu). Esta foi desmembrada anos mais tarde em duas associações: em 2009 a Associação dos Povos Indígenas Tiriyó, Katxuyana e Txikyana (Apitikatxi), para atender os povos concentrados na região ocidental do Complexo Tumucumaque e, em 2010, na Associação dos Povos Indígenas Wayana e Apalai (Apiwa), que, apesar do nome, representa toda a porção oriental, incluindo povos de outras etnias (GRUPIONI; OLIVEIRA; LINKE, 2018).

As lideranças indígenas são, tradicionalmente, homens adultos e anciãos, especialmente os responsáveis pela fundação de uma aldeia. Hoje, a condição de liderança é mais fluida, sendo observado um número crescente de lideranças mulheres e alguns jovens, notadamente os professores indígenas e Agentes de Saúde Indígena (AIS), todos com grande participação na Apiwa, nos fóruns e assembleias (GRUPIONI; OLIVEIRA; LINKE, 2018).

2.2 PESQUISA DOCUMENTAL E DE CAMPO

Os dados apresentados neste texto foram coletados durante 14 oficinas de construção e execução do PGTA da região do Rio Paru de Leste realizadas entre o período de 2014 a 2019, totalizando um esforço amostral superior a 100 dias. As informações foram obtidas a partir da observação participante, em conversas informais e em entrevistas semiestruturadas, seguindo orientações e métodos consagrados na literatura etnográfica (ALBUQUERQUE; LUCENA; CABALZAR, 2010; BALÉE, 1994; 2013; BEGOSSI et al., 2002; CAMPOS, 2002; CUNHA, 2010; POSEY, 1997a; VIERTLER, 2002).

A entrevista semiestruturada buscou versar sobre saberes e práticas sobre o meio ambiente, o histórico de ocupação territorial e levantamentos censitários; contando com espaços destinados às manifestações sobre problemáticas vivenciadas nas comunidades, além de ideias e sugestões de resoluções, muitas das quais foram integradas ao PGTA.

Em setembro de 2014 foram realizadas três oficinas coletivas com duração aproximada de uma semana cada. A primeira oficina ocorreu na aldeia Xuixuimene (TI Rio Paru D'Este), uma segunda na aldeia Mataware e uma terceira na aldeia Bona (ambas TI Parque do Tumucumaque). Na primeira oficina foram realizadas entrevistas semiestruturadas com oito lideranças das oito aldeias presentes na calha do médio curso do Rio Paru de Leste (interiorizadas na TI Rio Paru D'Este).

Na segunda oficina foram realizadas entrevistas com seis representantes das seis aldeias do alto curso do Rio Paru de Leste (TI Parque do Tumucumaque). Na terceira oficina, foram entrevistadas 10 lideranças das 10 aldeias do médio curso do rio, concluindo todas as 24 aldeias da região (das duas TIs). Alguns meses após essas oficinas, as 24 lideranças voltaram a se reunir na aldeia Bona para uma assembleia de discussão e validação de todo o processo.

Assim, de 2015 a 2019 passamos para a fase de execução das atividades previstas no PGTA. O restante das informações deste texto foi levantado durante sete módulos de formação de pesquisadores indígenas com duração aproximada de sete dias cada.

Esta pesquisa foi aprovada pelas lideranças indígenas em dois momentos: 1) na assembleia ordinária das lideranças do Rio Paru de Leste, promovida pela Apiwa, Funai e Instituto Iepé, ocorrida em novembro de 2014, e 2) na assembleia extraordinária ocorrida em fevereiro de 2019. Ambas possuem Ata.

3 HISTÓRICO DE CONSTRUÇÃO DO PLANO DE GESTÃO AMBIENTAL E TERRITORIAL

Na região do Paru de Leste muitas experiências de gestão territorial e ambiental foram realizadas antes mesmo da publicação da PNGATI, tais como manejos de recursos naturais, ações de valorização

cultural, atividades de proteção territorial, produção de material escolar diferenciado, articulações com áreas protegidas circunvizinhas, etc. (GRUPIONI; OLIVEIRA; LINKE, 2018; LINKE; VELTHEM, 2017; VELTHEM; LINKE, 2010; 2014b, 2014c).

Todas essas experiências acumularam-se nas vivências das aldeias, sendo periodicamente revisitadas nos encontros e assembleias subsequentes, e incluídas na discussão final da construção do PGTA. Tal histórico é importante para a compreensão sobre os caminhos trilhados e as opções feitas ao longo do tempo (ver Quadro 2 abaixo).

Quadro 2 | Quadro histórico das principais ações para a gestão ambiental e territorial do Paru de Leste.

Data	*Ações*	*Público participante*	*Resultados e inovações*
1997	Homologação das Terras Indígenas Parque do Tumucumaque e Rio Paru D'Este	Os povos das terras indígenas	Terras Indígenas homologadas e registradas em cartório e na SPU
1999	Projeto de proteção e reocupação territorial	Povos habitantes das duas TIs.	Abertas 14 novas aldeias na calha do Rio Paru de Leste
2005 a 2008	Oficinas de valorização cultural	Cinco oficinas de uma semana cada, com participação de todas as lideranças indígenas. Público total superior a 300 pessoas (homens, mulheres, adultos e crianças).	Início das discussões sobre patrimônio cultural material e imaterial. Discussão sobre necessidade do manejo de matérias-primas utilizadas nos objetos de uso tradicional. Publicações.
2007 a 2008	Oficinas de levantamento socioambiental.	Cinco oficinas e duas reuniões contando com a presença de lideranças indígenas de todas as aldeias.	Levantamento dos principais problemas socioambientais nas comunidades. Início das discussões em torno de gestão coletiva.
2008 a 2009	Levantamento experimental da situação da caça e pesca em aldeias antigas	Cinco oficinas nas aldeias Bona, Murei e Maxipurimo. Público-alvo: cerca de 300 pessoas	Inventário, levantamento e diagnóstico da atividade de caça e pesca na região. Início dos debates sobre gestão de territórios compartilhados de caça e pesca.
2009 a 2015	Formação de pesquisadores indígenas Wayana e Aparai	Catorze oficinas de uma semana cada para 15 jovens Wayana e Aparai (mulheres e homens) de oito diferentes aldeias.	Instrumentalização dos jovens em formas de documentação e pesquisa cultural sobre as formas de vida nas línguas nativas. Resultados são discutidos nas assembleias da Apiwa.
2009 a 2013	Formação do Conselho Consultivo do Mosaico de Áreas Protegidas do Amapá e Norte do Pará	Uma dezena de reuniões com lideranças de todas as aldeias das duas terras indígenas, junto a outros povos, líderes comunitários, agentes públicos de órgãos federais e estaduais (Funai, ICMBio/MMA, Sec. Est. Meio Amb. do Amapá, etc.).	Pensar a gestão ambiental e territorial para integrar a região para além dos limites das terras indígenas.
2010 a 2014	Experiência de manejo comunitário: arumã (Ischnosiphon spp.)	Quatro visitas técnicas em campo com duração de duas semanas cada, envolvendo mais de 30 Wayana e Aparai (homens, jovens e adultos) de três aldeias. Intercâmbio para aldeias Baniwa (Rio Negro, AM).	Mais de 10 módulos de manejo experimental em três aldeias. Publicação.
2012	Publicação do Decreto da PNGATI, Nº 7.747 de 05 de junho de 2012.	Todas as terras indígenas declaradas pela Funai	Instituição da PNGATI.
2014 a 2015	Diagnóstico Socioambiental	Realização de três oficinas regionais (ver metodologia)	Diagnóstico geral, incluindo informações das ações e atividades anteriores. Primeira versão do PGTA.
2016 a 2018	Projeto de execução do PGTA	Acordos e ações previstos no plano são executados envolvendo todas as aldeias.	O PGTA começa a ser executado.

Fonte: Autores, 2019.

O processo de construção do PGTA propriamente dito inicia-se em 2014 (ver metodologia). Nesse momento, houve acompanhamento próximo das lideranças, diretoria da Apiwa, técnicos da Funai e indigenistas do Instituto Iepé em todas as etapas (Figura 2). Em posse das informações coligidas e organizadas, em fins de 2014 foi realizada uma grande assembleia extraordinária na aldeia Bona, quando os resultados do diagnóstico foram apresentados, discutidos, retificados e validados por todos. Além dos problemas levantados, e em muitos pontos reiterados, foram apresentadas e discutidas possíveis estratégias e soluções, as quais muitas viraram acordos entre os participantes daquele fórum, onde respectivas participações foram distribuídas conforme as competências das instituições (Apiwa, Funai e Iepé), e dos membros das comunidades (lideranças, AIS e professores indígenas). Uma vez finalizada essa etapa, considerou-se pronta uma primeira edição do PGTA. Posteriormente, esses dados foram refinados e publicados em formato de livro (GRUPIONI; OLIVEIRA; LINKE, 2018).

Figura 2 | Oficina de diagnóstico socioambiental na aldeia Bona, 2014.

Fonte: Linke, 2014.

Por motivos históricos, geográficos e, principalmente, socioculturais, as lideranças indígenas do Complexo do Tumucumaque decidiram organizar o PGTA em dois componentes, seguindo a dicotomia presente nas organizações indígenas: i) porção ocidental (Apitikatxi); ii) porção oriental (Apiwa), sendo este representativo das 24 aldeias do Rio Paru de Leste: o "PGTA do Paru de Leste".

Apesar de haver muitos pontos em comum, não há uma preponderância ou sobreposição política entre os lados. Questões centrais, como a saúde, são tratadas conjuntamente em articulação. Para questões mais locais, como os manejos de recursos, há independência nas decisões celebradas e na execução das atividades.

4 O PGTA DO PARU DE LESTE E A PNGATI

O PGTA do Paru de Leste foi organizado pelas lideranças em seis eixos temáticos, tendo como inspiração planos percursores, muito exemplificados nas discussões, como o Plano de Vida dos Povos Indígenas do Oiapoque e o PGTA da Terra Indígena Kaxinawá e Ashaninka do Rio Breu (APIO, 2009; GAVAZZI, 2007). Os eixos buscam abarcar dimensões que extrapolam a gestão ambiental e territorial, a saber: 1) Proteção Territorial; 2) Governança e Empoderamento; 3) Manejo e uso sustentável de recursos naturais; 4) Cultura; 5) Educação escolar e 6) Saúde.

Seguindo orientações da Funai, o PGTA foi construído para ser cíclico, a fim de facilitar futuras revisões no transcorrer do processo, com os seguintes passos: 1) mobilização; 2) discussão dos problemas e acordos/possíveis soluções; 3) planejamento das atividades; 4) execução das atividades; 5) monitoramento e apreciação dos resultados, voltando ao ponto inicial (FUNAI, 2013).

Figura 3 | Reunião do PGTA no interior da casa comunal da aldeia Maxipurimo.

Fonte: Linke, 2018.

No Quadro 3 apresenta-se, em formato resumido, o PGTA a partir de seus eixos constitutivos, incluindo os objetivos, problemáticas e as principais estratégias ou soluções acordadas pelas lideranças indígenas. Para todos os eixos, os atores diretamente envolvidos são as comunidades, a associação Apiwa, a Funai, e o Instituto Iepé. Para maiores detalhes, ver a publicação do PGTA (GRUPIONI; OLIVEIRA; LINKE, 2018).

Quadro 3 | Resumo do PGTA do Rio Paru de Leste.

	Objetivos	*Problemática*	*Estratégias*
1) PROTEÇÃO TERRITORIAL	Garantir a integridade física das terras indígenas.	Limites distantes das aldeias: áreas de risco de invasores.	• Ocupar ostensivamente os limites com aldeias novas e bases de vigilância; • Ações de vigilância e monitoramento constantes, incluindo órgãos competentes; • Sistema de comunicação; • Regularizar pistas de pouso; • Destinar descarte apropriado ao lixo.
2) GOVERNANÇA E EMPODERAMENTO	Fortalecer as instâncias de decisão e deliberação do PGTA.	Qualificar a participação e o controle social das lideranças tradicionais e da associação representativa em face dos novos desafios.	• Qualificar e fortalecer as lideranças indígenas e a associação para o acompanhamento do PGTA e outras políticas indigenistas; • Construir plano local de consulta livre, prévia e informada; • Intercâmbios com outros povos; • Articular com áreas protegidas circunvizinhas.

	Objetivos	*Problemática*	*Estratégias*
3) MANEJO E USO SUSTENTÁVEL	Garantir estoques de recursos naturais para a sobrevivência e soberania da população	Perda de agrobiodiversidade nas roças e pátios. Crescente escassez de caça, pesca e algumas matérias-primas.	• Promover diálogos interculturais de manejos de recursos naturais; • Fortalecer o intercâmbio de mudas e sementes nativas; • Observar localmente as mudanças climáticas; • Zonear áreas "de poupança" livres de caça, pesca, coleta e agricultura; • Não trazer nem utilizar na TI pesticidas ou sementes geneticamente modificadas.
4) CULTURA	Garantir cultura forte e atuante, caminhando junto com elementos culturais externos.	Descontinuidade e desinteresse nos conhecimentos tradicionais e suas formas de repasse.	• Promover manifestações culturais; • Buscar meios para reconectar o repasse de conhecimentos intergeracional; • Produzir materiais culturais para circulação interna e externa às aldeias (livros, vídeos, etc.) • Formação de jovens; • Registro de patrimônio cultural junto ao Iphan.
5) EDUCAÇÃO	Garantir educação escolar diferenciada e de qualidade, que sirva para a vida dentro e fora das aldeias.	Ausência de programa político-pedagógico (PPP) para a região. Infraestrutura precária, poucos professores indígenas, profissionais não indígenas pouco qualificados e/ou desestimulados.	• Criação de PPP para a região com ampla participação indígena; • Criação de calendário escolar local; • Merenda com alimentos locais; • Produção de material diferenciado; • Melhorar a infraestrutura; • Formação de professores indígenas e não indígenas; • Qualificar o acompanhamento das lideranças.
6) SAÚDE	Garantir atendimento médico de qualidade e contextualizado, focado na prevenção.	Infraestrutura precária; poucos profissionais de saúde indígenas e não indígenas para a demanda; falta de medicamentos nas aldeias.	• Melhorar a infraestrutura; • Formação de Agentes Indígenas de Saúde (AIS); • Regularizar escalas dos profissionais de saúde; • Qualificar o acompanhamento das lideranças.

Fonte: Adaptado a partir de Grupioni, Oliveira e Linke, 2018.

5 GESTÃO TERRITORIAL E O ALCANCE SOCIOPOLÍTICO DA PNGATI NO PARU DE LESTE

O PGTA do Paru de Leste apresenta uma série de desafios interligados por várias questões de diferentes naturezas, como o acesso remoto à área, alta diversidade sociocultural da região, questões intergeracionais, consumo de produtos manufaturados e aldeamentos estabelecidos fora dos padrões tradicionais (GRUPIONI; OLIVEIRA; LINKE, 2018).

Cada PGTA carrega consigo os anseios e prioridades de cada povo, dentro de histórias e processos mobilizatórios ímpares (COMANDULLI; INGLÊS-DE-SOUZA; ALMEIDA, 2012). Isso, contudo, não impede que haja analogias e pontos de interseção. O PGTA do Parque Indígena do Xingu (PIX), no Mato Grosso,

por exemplo, aloca grande parte de seus esforços na proteção territorial das nascentes do Xingu que ficaram de fora dos limites e hoje drenam vastos pastos e sojais (ATIX; ISA, 2016).

Os limites territoriais também são abordados no PGTA do Paru de Leste, porém, de forma diferente, pois os contextos territoriais são outros. A estratégia funda-se no (re)conhecimento e ocupação dos pontos vulneráveis das terras indígenas, por meio de abertura de aldeias e bases, associada a expedições articuladas entre as comunidades e órgãos competentes, um sistema eficaz de comunicação, e regularização das pistas de pouso. Adicionalmente trata o descarte de lixo. Tais estratégias são interessantes, pois significam a incorporação dos limites cartográficos para dentro da lógica nativa (GUIMARÃES, 2014). Isso não deixa de ser uma forma de resistência política pela garantia de direitos, sendo o principal viverem em paz em sua terra.

Sobre a proteção territorial, o PGTA da Terra Indígena Wajãpi, no Amapá, prevê estratégias com o entorno, que é povoado por assentamentos rurais, além do fortalecimento da mobilidade tradicional wajãpi (APINA; AWATAC; IEPÉ, 2017). Contudo, são encontrados muitos paralelos entre os PGTAs Wajãpi e do Paru de Leste, por ambos pertencerem ao movimento indígena ligado historicamente a Macapá, local onde estão unidades estatais descentralizadas, e parceiros, como o Iepé, que atuam nas duas regiões (APINA; AWATAC; IEPÉ, 2017; GALLOIS; GRUPIONI, 2009; GRUPIONI; KAHN, 2013).

Assim, talvez o ponto central que liga ambos os PGTAs seja a busca constante pelo fortalecimento da governança interna, por meio da qualificação e legitimação de lideranças e das associações, envolvendo a construção de diferentes pontes políticas, como as que tratam da gestão para além dos limites territoriais, e a formação (APINA; AWATAC; IEPÉ, 2017; GRUPIONI; OLIVEIRA; LINKE, 2018).

Por isso, esse eixo é fundamental e transversal, já que na acepção freireana do empoderamento, é somente com participação qualificada, transpondo o histórico do poder pela alienação, que será possível a consecução desta e demais políticas públicas, como as previstas nos eixos de saúde e educação escolar (BARQUERO, 2012; FREIRE, 1987).

A formação citada também é carro-chefe de outros PGTAs, como os das TI Kaxinawa do Rio Humaitá, e da TI Mamoadate, ambas no Acre. Em tais planos vemos a figura do “agente agroflorestal indígena”, ator fundamental no diálogo intercultural, constando em todos os eixos (ALMEIDA; OCHOA; GAVAZZI, 2016; GAVAZZI; ROCHA, 2015). Igualmente ocorre no Paru de Leste, onde a formação é um instrumento de empoderamento e do diálogo de saberes e sistemas epistemológicos, internos e externos às comunidades, auxiliando e ligando todos os eixos (GRUPIONI; OLIVEIRA; LINKE, 2018; LINKE; VELTHEM, 2017).

O PGTA das TIs do noroeste do Rio Negro se concentra também no diálogo intercultural da pesquisa aliando conhecimentos e técnicas de fora com formas tradicionais do saber (FOIRN; ISA, 2017; 2018). Entre várias, podemos citar como exitosas as experiências de manejo da pesca, iniciadas anos atrás, nos afluentes Tiquié e Içana (CABALZAR, 2005; 2010).

Similarmente, o eixo de manejo e uso sustentável de recursos naturais foca os sistemas produtivos dos povos do Rio Paru de Leste, adotando medidas que mesclam formas tradicionais com adaptações de técnicas da extensão rural, dentro de um diálogo de saberes. Esse ponto também é observado no PGTA da TI Kaxinawá e Ashaninka do Rio Breu, no Acre, contando com ferramentas de etnozoneamento e regras de uso do meio ambiente (GAVAZZI, 2007).

Vemos, assim, que a PNGATI trouxe ao Rio Paru de Leste grande potencial mobilizatório ao permitir aos povos não somente o conhecimento das políticas indigenistas, como a possibilidade de pensar e organizar coletivamente o território, identidades e interfaces com o mundo exterior (GALLOIS, 2004; LITTLE, 2002).

Apesar de os dados apontarem que a construção do PGTA do Paru de Leste foi ancorada na ampla e histórica participação dos povos da região, cremos ser prematuro julgar o grau de empoderamento social

dado pelo desenvolvimento local da política. Fica claro, por outro lado, que os processos de criação do PGTA buscaram objetivamente naturalizar e internalizar preocupações com a vida em territórios fisicamente limitados, abrindo diferentes possibilidades. Entre os acertos, o processo possibilitou aos indígenas um pensamento crítico sobre o momento político atual, e a conscientização sobre ameaças aos seus direitos e estratégias de mobilização. Não à toa há um eixo específico para a governança e o empoderamento local. Esse olhar crítico, de autorreconhecimento, tomando posse do real, como dizia Freire, foi catalisado pela implementação local da PNGATI, podendo o PGTA ser compreendido como um corolário do processo iniciado em 1997, com a demarcação das terras indígenas (FREIRE, 1981; 1987).

Mas ao voltarmos aos autores que celebram a crítica freireana, Horochovski e Meirelles, por exemplo, afirmam que a vertente intransitiva do empoderamento granjeia visibilidade, influência e capacidade de ação e decisão às comunidades e organizações envolvidas (HOROCHOVSKI; MEIRELLES, 2007). Isso, contudo, segundo Barquero, demandaria um descolamento, uma emancipação da sociedade civil (no caso, os indígenas como um todo) do Estado, sendo, nesse caso hipotético, o PGTA um espaço de emancipação dos excluídos: os indígenas (BARQUERO, 2012). Como visto, a PNGATI tem em sua redação mecanismos que buscam travar diálogos mais simétricos, superando o paradigma tutelar. Seguindo a linha de alguns autores, essa é, sem dúvida, uma forma de empoderamento intransitiva, pois é possível concluir que com a PNGATI os povos indígenas do Brasil ganham influência e controle sobre suas vidas em seus territórios (INGLÊS-DE-SOUZA, 2012; WALLERSTEIN; BERSTEIN, 1994).

Por outro lado, não podemos nos furtar de lembrar que a PNGATI continua sendo uma política estatal, organizada no bojo de um arcabouço burocrático alheio às comunidades indígenas, constituindo um desafio também para o corpo técnico responsável (GUIMARÃES, 2014). Ademais, a PNGATI é voltada para terras indígenas ao menos declaradas, as quais, em última instância, permanecem sendo terras da União, como claramente pontuado no artigo 231 da Constituição Federal. Apesar da aplicação da PNGATI não ser uma imposição, acaba, na prática, o sendo, já que centraliza todas as ações de "gestão territorial e ambiental em terras indígenas" dadas na interface Estado X povos indígenas. Nesse ponto, é impossível não lembrar que as terras indígenas salvaguardam grandes extensões territoriais, sendo componentes fundamentais em estratégias para conservação ambiental no Brasil, em especial na Amazônia (BONANOMI et al. 2019; CRISOSTOMO et al., 2015; FERREIRA; VENTICINQUE; ALMEIDA, 2007; NOLTE et al. 2013; SANTILLI, 2005).

Em que pese as formas de vida tradicionais, apontadas como motrizes de tal conservação, é preciso voltar à questão inicial do "bom selvagem" rousseauniano, pois, devemos perguntar aos índios se depositar tanta responsabilidade não seria, como aponta Cunha, um grande mal-entendido, "[...] um caso de projeção ocidental de preocupações ecológicas sobre um bom selvagem construído ad hoc?" (CUNHA, 2009, p. 277).

Assim, ao limitar e enquadrar a zona de ação política, é possível concluir que a PNGATI igualmente pode representar uma forma transitiva de empoderamento organizacional dos povos indígenas, entre eles os do Rio Paru de Leste (BARQUERO, 2012).

6 CONSIDERAÇÕES FINAIS

A PNGATI é uma política muito recente no quadro histórico das relações entre o Estado nacional e os povos indígenas no Brasil. Ela se propõe a mudar paradigmas há muito arraigados, como a tutela encabeçando. Assim, dúvidas com relação aos efeitos e naturezas do desenvolvimento dessa política no seio das comunidades levarão algum tempo até serem totalmente compreendidos por todos os atores envolvidos, indígenas ou não. Por isso, como vimos, é possível encarar hoje a PNGATI de diferentes maneiras.

Na questão do empoderamento, é possível que a PNGATI alcance diferentes espectros a depender do contexto de sua implementação local. Os PGTAs representam diferentes formas de empoderamento local,

a depender de muitos fatores que extrapolam, por vezes, a dinâmica comunitária e as interfaces dadas com agentes e parceiros externos. O histórico do povo e do território em questão pesa muito na avaliação.

No caso do PGTA dos povos do Paru de Leste, os dados e registros apontam que a chegada da PNGATI suscitou um olhar crítico mais aguçado, uma reflexão geradora de mobilizações.

Seu PGTA, como vemos nos quadros, basicamente aponta caminhos para buscarem melhorias nas condições de vida nas aldeias, buscando criar pontes entre a atuação das lideranças indígenas, órgãos estatais e parceiros da sociedade civil. Para além, o PGTA objetiva o fortalecimento político interno e externo, premissas interiorizadas em um eixo com esse específico objetivo. Tal fim indica um caminho real para o empoderamento local por meio do fortalecimento da mobilização interna e externa e do controle social, instrumentalizando os indígenas para a execução da PNGATI e demais políticas públicas.

Evidentemente sempre há trabalho por fazer, e sendo essa uma política recente, em franca construção, ainda há muito espaço para o aperfeiçoamento. No PGTA observado, ainda há muitas questões pendentes, principalmente as que dizem respeito ao futuro funcionamento dos diferentes atores envolvidos no planejamento, na execução, no monitoramento e na avaliação das ações e acertos propostos. Ademais, é possível que outros problemas ainda não assinalados se interponham no decurso de execução do plano, sendo plausível que questões anteriormente prioritárias deixem de sê-las no transcorrer do processo.

Não podemos perder de mente que conceitos de "qualidade de vida" e "bem-estar" nas terras indígenas, praticamente premissas da PNGATI, são igualmente passíveis de transformações e ressignificações internas no fluir do tempo. E tais transformações cabem avaliações que, em última instância, pertencem somente aos indígenas interessados. De todo modo, mecanismos de monitoramento para o contínuo aperfeiçoamento do funcionamento do plano estão previstos no PGTA, seguindo orientações da Funai.

Finalizando, essas e outras questões que pretendem medir e aferir graus de apropriação precisam ser continuamente monitoradas e estudadas. Dado o alto grau de dinamismo e complexidade desse assunto, futuros estudos sobre os temas deste texto são muito bem-vindos. Esperamos que esse primeiro olhar sobre o PGTA do Paru de Leste colabore nesse processo.

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Mismatches between extended urbanization and everyday socioenvironmental conflicts in Santarém, Pará, Brazil

Descompassos entre a urbanização extensiva e os conflitos socioambientais cotidianos em Santarém, Pará, Brasil

Ana Cláudia Duarte Cardoso[a]

Kamila Diniz Oliveira[b]

Taynara do Vale Gomes Pinho[c]

[a]PhD em Arquitetura, professora associada IV da Universidade Federal do Pará, Belém, PA, Brasil
E-mail: acadoso@ufpa.br
[b]Mestranda do Programa de Pós-Graduação em Arquitetura e Urbanismo da Universidade Federal do Pará, Belém, PA, Brasil
E-mail: kamiladinizoliveira@gmail.com
[c]Doutoranda do Programa de Pós-graduação em Arquitetura e Urbanismo da Universidade Federal do Pará, Belém, PA, Brasil
E-mail: taynaragomes@gmail.com

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ABSTRACT

This article aims to investigate the reasons why the environmental debate has failed to flourish within contemporary urbanization in the Global South, by investigating the case of the newly created Metropolitan Region of Santarém (MRS), located in the Brazilian Amazon. This area has been occupied for thousands of years, and today is a region where natural resources have been overexploited. Urbanization has been extensive in Santarém and associated with institutional violence, in which old social hierarchies have been re-contrived and homogenizing spatial patterns have been imposed onto territories where the original occupation and spatial structures linked to the production of commodities coexist. It was observed that to understand the socio-environmental conflicts of the MRS, it is necessary to consider the connections between the Global North and South and between countryside and city, subsumed by a new urban that has stratified and encompassed the planet.

Keywords: Santarém. Global South urbanization. Sustainability. Extended Urbanization.

RESUMO

Este artigo tem por objetivo investigar razões para o não florescimento do debate ambiental na urbanização contemporânea do Sul Global, por meio de um estudo da recém-criada Região Metropolitana de Santarém, localizada na Amazônia brasileira, em área de ocupação milenar que hoje

é zona de superexploração de recursos naturais. Em Santarém, a urbanização é extensiva e associada à violência institucional, reedição de velhas hierarquias sociais e imposição de padrões espaciais homogeneizadores aos territórios onde ocupação original e estruturas espaciais ligadas à produção de commodities coexistem. Constatou-se que para compreender os conflitos socioambientais da RMS, há de se considerar conexões entre Norte e Sul global e entre campo e cidade, subsumidas por um novo urbano que estratifica e abrange o planeta.

Palavras-Chave: Santarém. Urbanização do Sul Global. Sustentabilidade. Urbano Extensivo.

1 INTRODUCTION

The Eurocentric concept of city-regions emerged after World War II. Since then, adaptation to Fordist and post-Fordist phases of capitalism have been taken as its catalyst, and over time has evolved into archipelagos of nodes that compete and cooperate across the planet (Scott, 2019). The city-oriented debate based in the Global North also highlights the emergence of new city typologies and local and world geographies, well adapted to new forms of labor, as being milestones in the transition towards a cognitive economy (Soja, 2000; Garreau, 1991).

This transition ties in with yet another paradigm shift, related to the environmental circumstances across the planet, which has created new geopolitics for cities and regions, described by While, Jonas and Gibs (2004) as an "urban sustainability fix", or the green element of the 1980s growth machine presented by Logan and Molotch (1987). In Europe, such a process has recomposed landscapes and ecologies, and promoted agreements amongst social groups and classes, and has been subdivided into several approaches, such as urban sustainability (SWANN; DESTALE, 2019), urban ecology (BARLES; BLANC, 2016), ecological urbanism (HAGGAN, 2015), urban political ecology (Heynen, Kaika and Swingedown, 2006), and even the idea of how food shapes our cities (STEEL, 2013).

Although such approaches present several differences, they nonetheless converge when it comes to the need for land-use controls, distributing access to natural resources, providing infrastructure and energy and a correspondence between the way of life and the territory. Besides, some have strongly acknowledged adaptation to climate change as being an important issue, thereby becoming aligned with the formal inclusion of cities and urbanization onto the agenda of adaptation to climate change by the Intergovernmental Panel on Climate Change (IPCC, 2014), including the understanding that hegemonic capitalism is placing human life and world biodiversity at risk (IPBES, 2019).

While levels of criticism have gradually increased in the Global North, an environmental and urbanization crisis has become established in the Global South, due to the intensification of urbanization (ALMANDOZ, 2015) and the overexploitation of natural resources (GUDYNAS, 2019). Generations of decolonial theorists have claimed that in the main, States in the Global South countries support political and economic structures that operate within the same dynamics of colonial systems (BALLESTRIN, 2013; MIGNOLO, 2017). They have enforced power and social hierarchies, and have sustained homogenization and hegemony through violence (either physical or institutional), together with a variety of manners with which to organize material life, social and spiritual values, and previous knowledge, to exploit both people and natural resources (BARROS, 2019).

Within such a context, this article explores the contradictions that exist between the forms of use and occupation of the territory within the recently created Metropolitan Region of Santarém (MRS) in the state of Pará[1]. Local communities have been forced to develop resistance strategies, based on their identities, historic inheritance and traditional[2] knowledge, to link human settlements and nature in a well-intentioned manner, as recommended in principle by current urban ecological concerns.

The new productive dynamics, although based outside the city, demonstrate a variant pattern of implosion and explosion, described by Lefebvre (1999 [1970]), through the verticalization of the city

centers (implosion) and the changes of use in the peri-urban areas, where housing schemes, tourist and real state enterprises have outbid the territory occupied by native peasant communities (explosion). This explosion has also formed nodes located in further areas of the municipalities where industrial extractive activities have been installed (agribusiness, mining).

Given this situation, we seek to discuss what would constitute the analogous narrative for the Global South of an "urban sustainability fix", considering the consequences of the current urbanization process and the urgent need to preserve biodiversity and roll back Amazonian environmental degradation, or why socioenvironmental concerns have not flourished in the Global South as they have in the Global North. The backdrop to this discussion is the re-contrivance of exploiting natural resources with multinational financing in Latin America, and the related major territorial transformations, characterized by short-sighted, environmental degradation and little absorption of labor, plus the constitution of hybrid peripheral edge areas in the suburbs, with shopping malls, real estate ventures and traditional peri-urban spaces (CARDOSO et al, 2018).

The presence of infrastructure associated both with logistics for commodity export, and the creation of new business and housing spaces over the floodplains, forest, and territory of peasant production, evokes the phenomena already described in the literature on contemporary urbanization, based on implosion and explosion (LEFEBVRE, 1999 [1970]), planetary urbanization (BRENNER, 2014), extensive urbanization (MONTE MOR, 1994), or the conception of the edge city continuum (GARREAU, 1991).

On the other hand, neglecting the connection between ancestry, reciprocity, identity and sovereignty regarding how to live and produce, and the preservation of nature, herein understood as natural resources (forest, floodplain, rivers), practiced by local communities, plus the violence with which political and economic power has erased their spatial manifestations. This has reinforced the need for postcolonial and decolonial theoretical perspectives, which place in check the perpetuation of strategies of domination by the Global North over the Global South, which, regrettably, strongly permeates academic discourse and public policies (ROY, 2016; BARROS, 2019).

2 RESEARCH DESIGN

This was a qualitative research, developed between 2015 and 2019, based on fieldwork carried out once a year. The first stage of fieldwork was exploratory, based on previous knowledge of the region and focused on identifying the relevant social agents and the existing socio-spatial dynamics. Once contacts were established within the social movements, and public and private sectors, the second stage of fieldwork was initiated to contact authorities and social leaders in their offices and communities and to observe local dynamics, to establish parallels between city and countryside. From this point, the documentary research was developed, gathering official documents, local newspaper articles, and academic literature, to contextualize legislative projects, either approved or under-appreciation, which had either aims or outcomes related to territorial restructuring.

The stages of assessing documents and of observation were complemented by interviews held with a) staff from the NGOs Fase Amazônia and Saúde Alegria and the Cooperative Coomflona, b) lecturers and technicians from UFOPa, and technicians in charge of the Municipal Environment Secretariat, Land Coordination of EMATER and the INCRA local office, c) representatives from the Male and Female Rural Workers Union (STTR), from the Santerém Diocese, and Real Estate Enterprises. We also called on the experience of participation in daily activities within the São Brás community in the Agro-extractivist Settlement Eixo Forte, to examine the community's production, housing, and sociability. The overlap of shapefiles, documents, and spatial observations gathered from all these sources, enabled the production of new cartographies to reveal the socio-environmental conflicts, which in turn were compared to the information available on websites that advertise real estate sector products. This research needs to be followed up by further quantitative research to measure the intensity of the processes and conflicts that have been identified.

3 THE SOCIAL FORMATION OF THE TERRITORY INSIDE THE METROPOLITAN REGION OF SANTARÉM (MRS)

The privileged location of Santarém, within an area rich in biodiversity and scenic beauty, and easily accessible from the viewpoint of fluvial logistics, would explain the occupation of this site for more than 7000 years by civilizations with urban characteristics, given their social organization and network links (ROOSEVELT, 2009; LOPES, 2017). Indeed, such an abundance motivated the Portuguese to appropriate these indigenous sites during the 17th century, by establishing the city of Santarém as an intermediary commercial warehouse between the Amazonian metropolises of Belém and Manaus, to potentialize the exploitation and export of exotic products from the floodplain and forest (CORRÊA, 1987).

The foundation of Portuguese colonial cities was instrumental in restructuring the Amazonian territory, and for fostering the Marquis of Pombal's policy of miscegenation between the Portuguese and Indigenous peoples, to produce a population called *cabocla*, which was able to combine indigenous knowledge on biodiversity with the commercial experience of the Portuguese (COSTA, 2019). It made the transition from a pattern of indigenous occupation to a myriad of localities and small settlements, inhabited by families of *Caboclos*, which although dispersed far from one another, were nonetheless connected through the network of rivers (COSTA, 2012).

For these families, the floodplain was a space of abundance, which enabled the practice of multiple activities throughout the year, such as fishing and petty production of agriculture, the transhumance of herds to higher firmer land, petty extractivism (of gathering from the forest) and trading at the city market (STOLL, 2014). *Caboclos* have always had a great familiarity with the river and the forest, despite the silence of official data regarding this fact and the stereotypical associations made by the urban elites concerning poverty and idleness (LOUREIRO, 2014).

Africans were also introduced into the region in the seventeenth century, thereby originating the *quilombola* communities, which began to appear on the farms inherited from former masters or in areas occupied by runaway slaves, who managed to adapt very well to the conditions of production across the region (CUEVAS, 2011). Because of the droughts in the Brazilian Northeast, another type of peasant migrated to the Amazon, the *Sertanejo*, who, in comparison with the *Caboclo* and the *quilombola*, was more daring and violent. However, throughout the decades they merged into the Amazonian *Caboclo* and assumed extractivism (petty extractivism) as their productive activity. Thus, an Amazonian peasantry was formed, which sometimes produced for the market (during the petty extractivism cycles), and sometimes for subsistence (LIMA, 1999).

During the rubber cycle (years 1850-1910), the productive structure of the forest products was prejudicial to this population, as it drained off the economic and social benefits towards the metropolis of Belém, and to the cities that were commercially stronger (VENTURA NETO, 2017), as in the case of the city of Santarém.

The stereotypical image of backwardness and poverty also came from the operations of the *aviamento*, a form of semi-slavery, which maintained the petty extractivist in continuous debt with the employers. The balance between the profit from rubber production and the debt with food, ammunition, and accommodation, offered to the worker by the *aviador* (the entrepreneur) always went against the worker. This circumstance, in addition to the culture of land occupation by adverse possession, placed this group of workers in a very unfavorable situation during the process of national integration (the 1950s-1970s), which presupposed the privatization of the land and financing profitable productive activities following a capitalist perspective (VENTURA NETO, 2017).

The capitalist exploitation of the forest was made feasible by a complete paradigm shift - abandoning the river as the main logistic structure, transforming land into a commodity, with the assumption that any work would take place within capitalist relations. At the turn of the twenty-first century, the region

within the bounds of the city of Santarém was being disputed by both agrarian and extractive activities, followed by tourism. All these activities were unable to generate the expected labor absorption levels, as a large contingent of the population remained outside the formal market (see Chart 1), living in the ancient *caboclo* system, characterized by Loureiro (2002) as being of the "river, backyard, family farm, forest", which for centuries, had been successful in building livelihoods and a popular economy. The dispersion of rural communities and villages intertwined the settlements and the space of food production, linking communities as nodes by rivers and trails.

Chart 1 | Official socioeconomic and demographic data and percentage of the territory occupied by the municipal seats (cities), in the MRS.

	Ratio between urban/ rural population	*% of the municipality occupied by the urban fabric of the city*	*Municipal economy data reported on the database of the IBGE (@cidades.br)*
SANTARÉM	Population: 302.900 **33.3% rural** 66.6% urban	0.43%	30000 formal jobs for 150.000 people of economically active age (15.7% of the employed population) Average monthly income 2.1 Minimum Wages[3]
BELTERRA	Population: 17.624 **38% rural** 54% urban	0.34%	1260 people employed (7.3% of the employed population) Income up to half a minimum wage: 52.1% of the population Average monthly income 1.9 MW
MOJUÍ DOS CAMPOS	Population: 15.982 (the rural/ urban proportion unavailable)	1.59%	103 people employed (0.7% of the employed population) Average monthly wage 2.1 MW
BRAZILIAN AVERAGE	Population: 209.3 million **15% rural** 85% urban	Not applicable	Average monthly income 2.2 MW

Source: IBGE (2010, 2018).

The high proportion of people of economically active age, kept outside the market or with remuneration of up to ½ a minimum wage, indicates that the substitution and denial strategies of traditional forms of work have not been successful in this context. In this respect, Figure 1 illustrates the distribution of communities in relation to drainage in the municipalities, indicating how much the local rivers were determinant in defining the location of human settlements, as well as a strong bond between people, river, floodplain and forest for their livelihood, which has existed until the present day.

The figure also outlines the urban fabric of the cities and presents the connecting highways and the extent to which the towns of Belterra and Mojuí dos Campos, municipalities dismembered from the municipality of Santarém, have become inserted into the area already converted over to soybean production, and which is cut by highways (federal and state) and contains the hydroelectric Curuá-Una, built by Eletronorte (a state-owned company) in the 1970s. Urban public policies approach the area within the urban fabrics and the nearby roads, disregarding the ancient pattern of settlements, and their dependence on the rivers and forest.

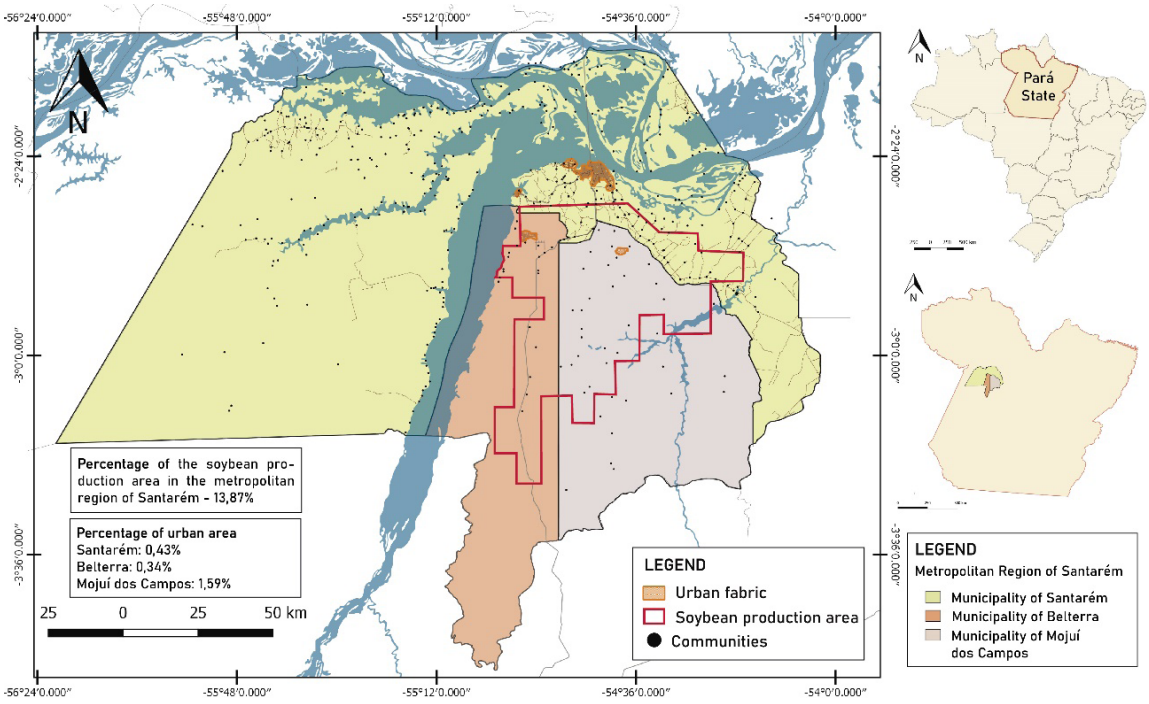

Figure 1 | Distribution of human settlements (communities) in the MRS.

Source: Rural Workers Union (STTR, 2016); IBGE (2010).

4 THE CONTEMPORARY EXTENSIVE URBAN REGIME IN SMR

Over recent decades the regional political and economic elite have established external links, and therefore have become capable of representing national and global capitalist interests, and of constituting power blocs and political and economic privileges based on official funding, on the valorization of rural and urban land that it already controlled, on the exploitation of timber, livestock and soybean production and, more recently, on the real estate market (VENTURA NETO, 2017).

In the case of Santarém, representatives of the elite have aimed to accelerate the conversion of land use and occupation from rural into urban, and consider that protecting the traditional way of life is an obstacle to the profitable structuring of the territory, despite its environmental resilience, thereby operating as new agents of colonization in the twenty-first century (OLIVEIRA, CARDOSO, 2016).

This has been made possible by power coalitions between the state and market, which may affect both cities or other parts of the municipalities since the frontiers remain open either for the exploitation of natural resources or for the accumulation of real estate. The introduction of new typologies (tower blocks in the city center, and land divisions on the outskirts) has created a new image, with a strong symbolic appeal. In practice, however, it has been restricted to axes or zones where the real estate market has followed national prices[4] (MELAZZO, 2013), thereby characterizing a phenomenon of extensive urbanization[5], still poorly understood at a local level.

There has also been an interchange of local agents from rural activities (e.g.: soybean production) to larger urban investments (e.g. real estate, logistics or mining projects) (MELO, 2015), promoting socio-environmental exclusion, which always occurs with selective modernizations (Santos, 2008), close either to human settlements (rural villages and cities) or to areas of investment in rural areas (mining fields).

In the municipality of Santarém, the implementation of logistics, the installation of soybean fields, and the expectation of deploying mining areas are related to the operating strategies of financial capital. Currently,

multinational corporations fund mining and grain production, and have been followed by other global players who have linked themselves to local capital to foster real estate production in and around the city.

This has, therefore, prepared the way for the tourism real estate sector to operate in the village of Alter do Chão and other areas of scenic beauty. The restructuring (and rural exodus) that these actions have promoted across the territory has created another market, exploited by national companies, such as the social housing program *Minha Casa, Minha Vida* (My House, My Life). This program produced the housing scheme called Residencial Salvação, on the outskirts of Santarém, which when occupied became the most populous district of the city, with 15000 poor residents, isolated and vulnerable to crime and violence (REIS; RODRIGUES, 2019).

In this aspect, modernizations are dialectically linked with land commodification. The new extractive and real estate activities claim rural and peri-urban areas originally occupied by peasant and traditional populations, while the inner-city spaces have imploded to enable the construction of apartment tower blocks, or vegetation has been suppressed by land-use change, thereby denying the presence of nature.

The metropolitan space has been structured by the explosion of new uses across the territory, and the implosion of Santarém's city center (by verticalization and the specialization of uses), but this dialectic movement is not perceived as part of the same capitalist strategy of homogenization and integration of this landscape to the market; in everyday practice, there is outstanding resentment (by the peasants) against the city. Locally, the city is viewed as a privileged symbol of the oppression of rural communities.

This feeling is interpreted by representatives from social movements through the statement "when the [agri-extractivist] settlement plants nothing, the city does not dine", complemented by the question: "why doesn't the city adequately repay the communities for what it receives?" (Interview, January 2019). Moving against the debate on how food shapes cities, the city promotes the oppression of its hinterland inhabitants.

However, across the whole municipality the uses that form the new extended urban fabric[6] contaminate rivers and soil, suppress vegetation, reduce biodiversity and cause water scarcity, factors that hinder the way of life of the population that lives outside the formal market, and that has always constituted a popular economy that respects the environmental cycles - based on a combination of animal breeding, small crops, petty extractivism (of gathering) and fishing, under the collective management of the land. This circumstance affects the livelihoods of groups that live either in- or outside the city, and that interact with other segments of the population through the open market (SÁ, COSTA, TAVARES, 2006), and that support the local gastronomy and tourism.

Federal public policies directed towards this metropolitan region tend to privilege the exogenous agenda, which in turn, is well received by local agents interested in linking the investments made in the city to the image of a classical metropolis, where there is a predominance of constructive density, individual property, a conventional provision of infrastructure and a strong emphasis on a pattern of consuming industrialized products. This agenda goes hand-in-hand with deforestation and the deterritorialization of the original population and goes against all international consensus, cited in the introduction of this article, such as the need to reduce CO2 emissions, to preserve biodiversity or for cities to adapt to climate change.

Stone (1989) stated that the implications of the game regarding urban sprawl and land use conversion - here understood as the production of an extended urban fabric, may be decoded from the answers to such questions as: Who decides? How do they decide? And how do the agents adapt themselves?

The power game to create the MRS has relied on the interests defined at several decisive moments. A relevant starting point would be the historical demand for the emancipation of the western region of the state of Pará from the territory of Pará. This was justified by the aim of strengthening the formal economy through the interlocution of the political class with the soybean producers, who already worked on the central plains of Brazil; the creation of the municipality of Belterra, dismembered from

Santarém in 1997; the emancipation of the municipality of Mojuí dos Campos, dismembered from Santarém in 2013; and by the granting of mining rights to multinational mining companies in the 2000s.

The proposal to create the MRS was presented by a local politician, a representative of the region, to the Chamber of Deputies in the State of Pará in 2010, taking advantage of the political alignments of the municipal, state and federal administrations, and agreements between several political representations based on the Western Region of the state of Pará (PL 1/2010, State law 79/2012).

The expectations of political and economic growth were coupled with the centralized management of federal resources. This required the adherence of states and municipalities to federal programs to obtain funding, devising a fairly conventional agenda of "development" for the new metropolitan region (a large city-region as it were), which was unable to consider its socio-biodiversity and local knowledge on how to manage long term natural cycles as a differential or a potential to alternative forms of development, not listed in Global North agendas.

This modernization was a decisive move in jeopardizing the achievements gained by social movements over the past decades. Thanks to their commitment to protecting biodiversity, they had mobilized federal organs linked to territorial management in search of institutional solutions, which could guarantee that they would remain on public lands (FOLHES, 2010, 2016). This resulted in the creation of intermediary typologies between the two extreme positions of the agrarian reform settlements, destined for migrant peasants, and the conservation units, devised by the National System of Conservation Units, which determined the eviction of all those living there.

Decades of negotiations resulted in a territorial mosaic in which important milestones, such as the Resex Tapajós-Arapiuns was created, in 19981, together with the Agro-extractivist Settlement Projects (PAE) Lago Grande, in 2005. Alongside this, countless *quilombola* communities were certified by the Palmares Foundation[2] thereby guaranteeing that traditional populations remained in the forest, floodplain and riverbank environments, including those living within the city or in the peri-urban areas.

Despite this obvious resistance, public policies directed towards the area have not created a convergence between its Amazonian profile and the generic metropolitan debate. Both the mosaic of protected areas in the municipalities and the traditional communities amalgamated as neighborhoods of the city of Santarém began to be seen as obstacles to the ongoing development project, understood mostly as economic growth. The decades of superpositioning these rationalities have generated a socio-spatial stratification that has inserted typical typologies of industrial societies into the city of Santarém - such as the port of the Cargill Company, built on an old beach in the city center, an official housing scheme, a shopping mall and informal occupations (in fact, the former fishermen's villages).

Moreover, the extended urban fabric that structures the metropolitan space of Santarém is now funded by financial capital involved in the production of all these typologies, and upon the expectations of exploiting bauxite, by an American mining company, which is claiming one-fifth of the area of PAE Lago Grande to open new operational sites, while maintaining 57% of this settlement for mineral prospecting surveys (field research, 2019).

Another 13.87% of the metropolitan area is already dedicated to soybean plantations. These activities instrumentalize the advancement of an urban ubiquity, governed by a distant logic that gradually outbids the historic spatial patterns, to the extent that it amalgamates peri-urban peasant communities located along the city's expansion axis, or *quilombola* communities, into ordinary city neighborhoods and peripheries (GOMES; CARDOSO, 2019).

This has consequently spoilt the fractal of the huge regional territorial mosaic that also existed in and around the city, and that has supported livelihoods, based on the management (without destruction) of the local biodiversity, which could be an indicator of resilience, the protection of biodiversity and socio-

environmental balance. This fading process was furthered by the stigmatization of the populations that depend on nature, and by the action of local media in associating economic growth to the (frustrated) implantation of industrial plants and to expanding the port area (which became a top priority).

However, these changes have not taken place without a reaction from local social movements, which have promoted 12 community workshops (5 urban and 7 rural), 3 public hearings and a municipal conference, to discuss and review the Santarém Master Plan (*Plano Diretor*)[7], in a popular process that terminated in December 2017, when their proposed document was delivered to the City Council (REIS, RODRIGUES, 2019). After one year of analysis the new master plan (Lei 189 \ 2018) was approved by the City Council, with a unanimous vote to alter the popular proposal, and for the production of a cartography that had not been previously discussed, such as the map of agricultural aptitude, which considered 41.57% of the territory of the municipality of Santarém fit for the cultivation of grains, an area unprotected by conservation units or related to floodplains.[8]

This map caused a great controversy between the progressive and conservative sectors, by overlapping the area suitable for monoculture with areas still covered by forest and agri-extractivist settlements, where dozens of communities and extractive villages would be subjected to the effects of deforestation and contamination of water, soil, and air if the monoculture area was enlarged.

This was an example of how the local agenda is ruled by external interests. Meanwhile, communities were unrecognized by the master plan as the inheritance of a wise Amazonian capacity to balance human settlements and nature – but rather, they remained invisible and unentitled to public transport, water supply, electricity, telephone, internet, and access to services and equipment. They lacked support for enhancing small-scale technological solutions (historically practiced) for their needs (e.g., small turbines used for hydroelectric production), accessible solutions for public transport, connecting villages to one another and to the city; for recognizing centralities and functional complementarities between the villages (via the distribution of public equipment such as schools and health clinics) and most of all, there was a clear dismissal of popular knowledge in public policies (PINHO, 2011; DAL'ASTA, AMARAL, MONTEIRO, 2017).

Although the economic elite expected advantages with a change of the productive platform (from petty extractivism to mineral extractivism and agribusiness[9]), the recent history of the Amazon indicates that more qualified positions in exporting activities were supplied by migrant labor, with no effective absorption of any local labor (LOUREIRO, 2002; CARMO et al, 2014). On the other hand, these activities have generated environmental degradation, land expropriation and a decline in the production conditions of the original population (CARDOSO, CÂNDIDO, MELO, 2018; GOMES, 2017).

This logic had already been devised in the municipal master plan for Santarém in 2006, which defined an area for urban expansion with a radius of 30 km from the center of the city of Santarém out to the former village of Mojuí dos Campos, assimilating several ancient communities scattered across the area, and designated *quilombola* areas for port expansion (PMS, 2006). The master plan approved in 2018, eliminated the expansion zone, defining only the urban perimeter and rural districts, but established a port area equivalent to the entire front of the city (the whole riverbank inserted in the urban perimeter), reaching the neighborhoods of the fishing and *quilombola* communities, which today constitute the close periphery to the city center.

The new law (Law 189/2018) not only expanded the area with the potential of receiving a cargo terminal, but it also triplicated[10] the volume of cargo possible in relation to the already installed Cargill terminal, which exports most of the pork for Dutch pork production. Prioritizing logistics compromises local levels of wellbeing (based on cultural identities and productive sovereignty) and practices that depend on access to the river, contrary to the aims proposed in post-industrial societies.

The federal instrument for land regularization, Law 13.465/17, eliminated agri-extractivist settlements situated on public lands, to provide access to land according to the market rules. The land was put up

for sale that was immobilized collectively for these populations, for a lower price than that practiced by the market, on a family-by-family basis (BENATTI, 2018), affecting, for instance, PAE Eixo-Forte, located between the city of Santarém and the touristic village of Alter do Chão (Figure 2). This strategy undermined collective organization and highlighted the difficulties of the families in affording to buy the land and, most of all, to maintain it, fostering PAE's replacement by deforestation and suburbanization.

Within the PAE communities, the housing area corresponds to just 10% of their production area, and there is a great need for uncontaminated water and soil (OLIVEIRA, CARDOSO, 2017). As land became a commodity and urban rationality advanced, public policies reduce the needs of the communities to housing and suppress the links between the conditions of production and reproduction. Communities based within the city, but along the riverbanks, are under huge pressure to become regularized and absorbed by the local real estate market. However, within the city area, Law 13.465/17 associated land regularization to the obligation of supplying infrastructure based on conventional infrastructure and not on ecological solutions already practiced by the natives, thanks to land availability. Defining targets according to market priorities presupposes the intensive use of land and a high dependence on building works, and prompts the transfer of duties (or the liberation of land) to the private sector (FISCHER, 2018). This trend will increase the urban fabric, reduce soil permeability and the city´s resilience to floods and the impacts of climate change.

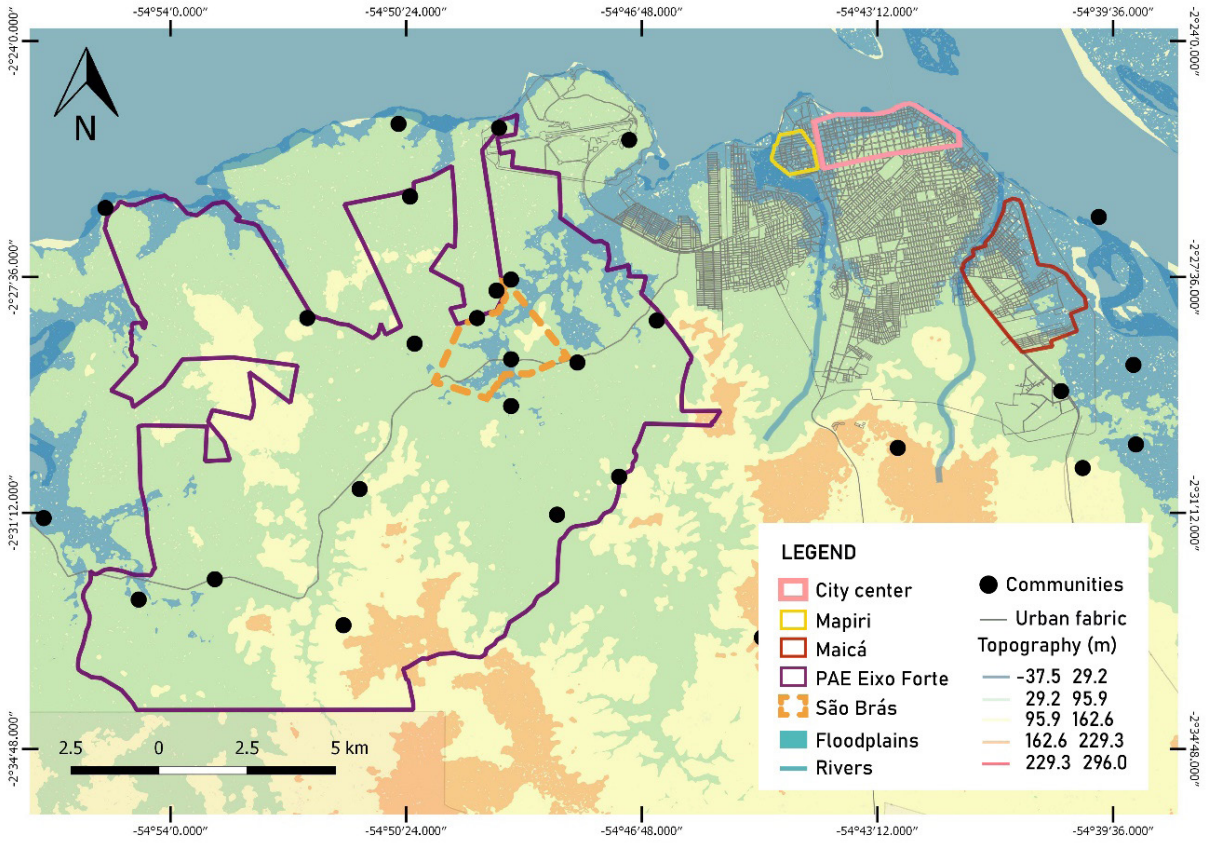

Figure 2 | Santarém's urban fabric, site (relief and floodplains) and outline of studied areas.

Source: Prepared by authors, based on the Union of Rural Workers (STTR, 2016) and cartographic bases of IBGE (2010).

The links between the expansion of agribusiness and mining and the master plan and the prospects of land regularization presuppose that the whole population would be economically incorporated into the new dynamics, despite the high degree of mechanization and automation of these activities, which are in the capital, technology and skilled labor-intensive. Expanding the power of these agents in the municipality signifies expelling

the population from small communities towards the city, where the conditions of housing, infrastructure, and income generation have become less compatible with the knowledge they possess to build their livelihood, despite their contribution to the local gastronomy, and with the alignment of the circumstances of their land occupation to the logic of landscape ecology (DARMSTADT, OLSON, FORMAN, 1996). Modernization creates the poorest social and environmental circumstances, due to economic domination.

5 CONCLUSIONS

This article provides evidence of the existing contradictions between the developmental discourse of public policies and the daily reality of the population in a newly created peripheral metropolitan region. Although it was created in the twenty-first century, there is a clear re-contrivance of the colonial metropolis in the manner by which the MRS was devised. Coalitions of political and economic power have reinforced predatory, short-sighted targets that have assumed land as a commodity, exploited nature and excluded social groups that were not fully integrated into the capitalist rationality, thereby denying the opportunity of development for a local socio-environmental consciousness based on deeply rooted experience and knowledge.

The resistance of local communities concerning this dominance has created hybrid circumstances, which demand that the links between urban and rural territories and practices need to be fully understood. The emerging extensive urbanization is biased towards fractions of capital that jeopardize natural resources both in and outside the city, albeit conducted by different but complementary activities. The simultaneous increase in socio-economic and environmental problems indicates that a "city-region" such as the MRS, cannot afford to copy either old Brazilian metropolitan regions or Global North metropolis strategies, particularly when the impact of economic dependency on large extractivism (including monocultures) is already known[11].

This case demonstrates that centuries of association between man and natural resources should be a reference for new, more organic urbanization patterns, more suited to tropical regions and their ancient cultures, and a starting point for a possible "Global South urbanization conception", able to carry the positive concerns that the Global North's "urban sustainability fix" aims to achieve.

However, this potential demands an ontological turn of public policies towards respecting diversity and the sovereignty of people, to the same extent as nations. It places the need to reduce the logic of private property in peripheral regions, and to acknowledge communitarian control of public land as an effective strategy for maintaining the environment and the quality of life of the original inhabitants, to protect life on the planet.

In such a context, to depict only the city space as a research object helps to reinforce the dependency of peripheral areas on global capitalism. The approach of cities blinds research to the importance of identity, autonomy, and culture, contained within a myriad of settlements that do not fit in with the time of profit. Emphasis on the ordinary city, without its dialectical counterparts – a fully inhabited rural region and an extensive urban area created by logistics, is instrumental in the advancement of post-industrial financial capital in areas where primitive accumulation is favored, such as the Amazon; a place where Northern formulas to produce green or eco-efficient ventures are easily distorted and used to deliver privileges to the elites.

From the case of Santarém, it is clear that the pattern of capitalist accumulation is moving from the former selective action on particular areas of interest – which was unable to dismantle small production created on top of a millennial history, towards a more comprehensive exploitative pattern. This assumes that any kind of land (either urban or rural) is a "commodity", as important as mineral ore or soybeans, and promotes environmental and social impacts of local and global relevance, considering the importance of tropical forests for the planet's climate.

Finally, the pro-growth agenda imposed on the MRS through official discourse and laws has a demonstrative effect for smaller municipalities (and cities) of peripheral regions and is the tip of the

iceberg of neoliberal coalitions of power that do not wish for legal obstacles to their goals, and that operate at national and international levels, to obtain advantages and to easily outbid local inhabitants.

At this point, Global North concerns on how cities can play a role in tackling the environmental crisis are very welcome to the Global South, to reinforce: a) efforts to protect use values rather than exchange values and to question accumulation and private property within tropical forests, b) to fight for solutions for sanitation, transport, and energy, that are suitable for the ways of living and producing, which have been very successful in protecting biodiversity and natural resources; and c) to make advances in providing full citizenship (in a Lefebvrian sense), consolidating and making truly differential spaces visible, where high levels of accumulation and consumption are not the rule, stating in a different manner, where the balance in the usage of social and natural resources is searched for.

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NOTES

1 | The State of Pará is the second largest state in Brazil, twice the size of continental France, and highly affected by the "Arc of deforestation" in the Amazon. Santarém is a regional pole, a municipal seat with an estimated population of 302.667in 2018 (https://cidades.ibge.gov.br/brasil/pa/santarem/panorama). The Metropolitan Region of Santarém was created in 2011, and is also made up of the municipalities of Belterra and Mojuí dos Campos. In Brazil, each municipality has its administrative seat (city) under the same name.

2 | The word traditional is used in the text in the sense of endogenous and being rooted within a positive perspective concerning environmental and social aspects.

3 | The Brazilian Minimum Wage was equivalent to U$233.2 in January 2020.

4 | Standard apartments at the Plaza de Vienna luxury building (166 m2, on 25 floors) are advertised for R$1.350.000,00, according to the advertisement available in https://pa.olx.com.br/regiao-de-santarem/imoveis/e-luxo-plaza-de-viena-100-decorado-e-mobiliado-576165472.

5 | Standard apartments with an area between 180 to 192 m2 are advertised from R$850.000, 00 (1 R = 4 US$), even in the village of Alter do Chão, due to overlooking the meeting of the waters of the Tapajós and Amazonas Rivers (see Announcements in http://www.coimbraimobiliaria.com.br). The extensive urbanization extends beyond the cities, in networks that penetrate virtually all the regional spaces, integrating them into the fabric of world networks, and structuring the capitalist production of space (MONTE-MÓR, 1994).

6 | The expression "extended urban fabric", does not designate the built-up cities, but all manifestations of the predominance of the city over the countryside. In this sense, a second residence, a highway, a supermarket in the countryside, accommodation supporting the mineral exploitation, mines, farms, silos, etc., are part of the urban fabric.

7 | *Planos Diretores* are enforced by the Federal City Statute, meant to be a law that delivers systemic guidelines for all municipal policies, with a minimum set of instruments to control the private appropriation of social production of the city. The City Statute is greatly concerned with the speculation of private land and offers no solution for areas where land is mostly public, such as the Brazilian Amazon.

8 | The map presents and its legend states that: the categories "good, regular or restricted agricultural aptitude for planted pasture" and "inadequate land for agricultural use, but indicated for conservation and environmental preservation or ecotourism", correspond mostly to the spaces subject to the floodplain; while the "agriculturally fit for farming with an emphasis on perennial crops, forest essences, pastures, and fruit trees" is not detectable, and all the remaining areas are described as "agriculturally fit for farming and intensive grain production", except for the Resex Arapiuns.

9 | The expression industrial extractivism assumes the meaning exposed by Gudynas (2016), and the reprimarization scenario of Latin America exposed by Goresntein and Ortiz (2018).

10 | This project may be viewed on the YouTube platform at www.youtube.com/watch?v=0TndxyASxIA.

11 | According to Gorenstein e Ortiz (2019:50-51), the impact is expressed through socio-environmental tensions and political conflicts due to water contamination and its effects on agriculture and tourism; the removal of peasant communities; the generation of jobs in the service and supply sectors that require qualification; the growth of inequality, unemployment, and informality; the growing influence of multinational corporations on local power structures.

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Economistic discourses of sustainability: determining moments and the question of alternatives

Discursos economicistas de la sostenibilidad: Los momentos determinantes y la pregunta por alternativas

Discursos economicistas de sustentabilidade: momentos determinantes e a busca por alternativas

Esther Meyer[a]

Ulli Vilsmaier[b]

[a]Leuphana University Lüneburg, Faculty of Sustainability, Lüneburg, Germany
E-mail: Esther.Meyer@leuphana.de

[b]Leuphana University Lüneburg, Institute of Philosophy and Sciences of Art and Center for Methods, Lüneburg, Germany
E-mail: Ulli.Vilsmaier@leuphana.de

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ARTICLE- VARIA

ABSTRACT

Despite the worldwide increase in discourses and politics around sustainability, the meanings of the concept vary significantly in different linguistic communities and cultures. This may undermine the multidimensionality and ethical dimension of the concept and jeopardize its political status. This article aims at highlighting discourse strands on sustainability from different linguistic communities in an intercultural orientation, and how they are theoretically shaped. It comprises a revision of existing and our own discourse analyses. The results show hegemonic discourses of economistic conceptualizations, as well as alternatives, which vary between communities and languages. We would like this article to contribute to an exchange and a profound discussion between the linguistic discourses, as well as to a methodological reflection on discourse analysis from an intercultural perspective. We conclude that critical transdisciplinary research, either as a science of sustainability or as transformative research, breaks with hegemonic orders, and thus, complements understandings of (un)sustainable ways of life.

Keywords: Sustainability sciences. Transdisciplinary. Discourse analysis. Hegemonic discourses. Intercultural.

RESUMEN

A pesar del aumento mundial de discursos y políticas sobre sostenibilidad, los significados del concepto varían en diferentes comunidades lingüísticas. Esto puede debilitar la multidimensionalidad y la dimensión

ética del concepto y poner en peligro la política. El artículo tiene como objetivo destacar los hilos teoréticos del discurso sobre la sostenibilidad y la sustentabilidad de diferentes comunidades lingüísticas en una orientación intercultural. Presenta una revisión meta-analítica de trabajos analíticos del discurso y un propio análisis. Los resultados muestran discursos hegemónicos de conceptualizaciones economicistas, así como alternativas. Aspiramos a contribuir a un intercambio y una discusión en profundidad entre los discursos lingüísticos y a la reflexión metódica de la investigación analítica-discursiva desde una perspectiva intercultural. Concluimos que la investigación transdisciplinaria fortalece, ya sea como ciencia de la sustentabilidad o como investigación transformadora, la fractura de los órdenes hegemónicos y, por lo tanto, complementa la comprensión de formas de vida (no) sustentables.

Palabras-Clave: Ciencia de la sustentabilidad. Transdisciplina. Análisis del Discurso. Discursos hegemónicos. Intercultural.

RESUMO

A disseminação mundial da sustentabilidade aumentou de forma significativa nos discursos e na política desde a resolução da ONU Objetivos de Desenvolvimento Sustentável de 2015. No entanto, o significado do conceito varia em diferentes comunidades e culturas lingüísticas. O presente artigo apresenta uma revisão analítica-discursiva dos conceitos de sustentabilidade em uma perspectiva intercultural. Os resultados mostram discursos hegemônicos de conceitualizações economicistas, bem como alternativas, que se constituem em diferentes comunidades lingüísticas. O artigo pretende fomentar uma troca e uma discussão profunda entre os grupos lingüísticos, bem como uma reflexão metodológica sobre a análise do discurso a partir de uma perspectiva intercultural.

Palavras-Chave: Ciências da Sustentabilidade. Transdisciplinar. Análise de discurso. Discursos hegemônicos. Intercultural.

1 INTRODUCTION

Since the resolution of the "Sustainable Development Goals" by the United Nations (UN) in 2015, the dissemination of the concept of sustainability has increased significantly in discourses and policies worldwide. It could seem that the concept has permeated science and the general public and that, with this, a further step has been taken towards the normative principle. And apparently, that is happening in different linguistic communities. At the same time, it is necessary to investigate the meaning of the concpet more in depth: What does sustainable mean? And in which contexts does it acquire different meanings? How have the different discourses been constituted, in reaction to the universal, national, and economic principles of sustainable development, as declared by the UN, with respect to different sociocultural, economic, and political historical situations in the different world-regions?

We develop concepts and theories about sustainability and sustainability sciences from a review of discourse analyses. The assumption is that discursive dynamics affect the work related to sustainability in politics, economics, and even sustainability sciences. The question is whether this leads to the reproduction of certain arguments for, as well as cultures of, unsustainability. Inquiries into marginalizing dynamics—as, for example, in the discourse on growth—must also be a component of scientific work on sustainability, to recognize the constitutive causes of unsustainability.

Based on a meta-analytic review of discursive-analytic work, this article provides insights into strands of sustainability discourses, especially an overview of the strands and assumptions that need to be pursued in more depth.

The article is structured as follows: Section 2 presents the method of the analysis. The following chapters continue with considerations of contextual dependency on discourses (3) and an approach

towards the concepts of sustainability, sustainable development and sustainability sciences, in order to formulate working definitions for these terms (4). Then, the different (historic) moments of sustainability and sustainable development are specified that have been constitutive for the different discourse strands (5). Using concepts and terms that clarify the different ways of understanding sustainability (6), some of their discourse limitations are outlined (7). Thus, Section 8 presents the implications that this has for sustainability sciences and discusses the potential of transdisciplinarity. Finally, conclusions are outlined (9).

2 METHODOLOGY

Critical discourse analysis pays special attention to the ways in which dominant theories emerge that, through their discourses, (re)produce power relations (CLARKE, 2012). This article departs from discursive-analytical work carried out in German and English and presents discussion threads that were the results of these analyses. Part of the results was also published in German.[1]

Starting from the review of publications on the sustainability discourse,[2] we highlight limitations and strands that the authors draw as discursively dominant. Here, a previous own discourse study (MEYER, 2014) of German texts that were published in the period between 2003 and 2013, and containing the term "social sustainability" in their titles without referring to a specific object, constitutes our starting point. Our work experiences related to sustainability is also incorporated.

The emphasis is on the (re)formulation of hypotheses regarding the constitution of sustainability by social, and especially economic, discourses. We attempt to locate marginalized discourses on sustainability, sustainable development, and sustainability sciences. According to a differentiated definition of eco-linguistics, we are looking for ethical and multidimensional sustainability strands, also—and especially—beyond discourses on certain explicit terms (ALEXANDER and STIBBE, 2014). Starting from German and English discourses, we approach the Latin American discourse landscape from a European perspective.

This research is part of the project CCP—"Complexity or Control? Paradigms for Sustainable Development"[3]—which aims at the systematic analysis of perceptions of critical and transdisciplinary research in sustainability, and its conceptual and methodological configuration.

3 CONTEXTUAL DEPENDENCE OF THE DISCOURSE

Each thought and knowledge production is located and tied to conditions (HARAWAY, 1988) and therefore no one can exempt themselves from their own positionality (QIN 2016). Particularly in the case of investigating discourses and their historical and cultural dependences, this fact should guide the analyses themselves. Both the nationalized situation and the environmental, sociocultural, political, economic and sustainable are part of the analytical challenge. Therefore, we have approached the analyses of Latin American discourse from a European point of view.

In Spanish - unlike the German analogue to English, where the word *Nachhaltigkeit* exists - the discourses on sustainability have been constituted in different ways, as *sostenibilidad* and *sustentabilidad*. The same applies to *desarrollo sostenible* and *desarrollo sustentable* (*nachhaltige Entwicklung [GER]* or sustainable development [EN]).

Vanhulst has published in English (VANHULST and ZACCAI, 2016) and Spanish (VANHULST and HEVIA, 2016) a quantitative network and bibliometrics analysis and mapping (discourse analysis) on the modes of appropriation of the sustainable development discourse in Latin America in the last 40 years. The authors maintain that sustainable development has taught the effects of critical and radical counter-

hegemonic discourses regarding (post-)Eurocentrism and modernity, represented by scientists such as Escobar (1995), and by the two concepts - *sostenible* and *sustentable*:

> If sostenible in the hegemonic model refers to the economic, sustentable must be considered as the guarantee of all forms of life and of all the ways in which that life is culturally expressed. (ALBÁN and ROSERO, 2016, p. 38; own translation).

In the Latin American discourse on sustainable development, "the Brundtland report 'Our common future' (CMMAD, 1987) and the Meadows report 'The limits of growth' (MEADOWS et al. 1972) were the most central references" (VANHULST and ZACCAI, 2016, p. 75). In turn, Vanhulst et al. express a specific appropriation of the political principle in Latin America, calling it "Latin American environmental thought" (ibid., p. 208; own translation). The universal principle of sustainable development is questioned by the struggle for cultural autonomy of marginalized indigenous groups as a modern techno-economic development principle originating in a reductionist rationality (VANHULST and ZACCAI 2016).

Concepts of sustainable development, found, among others, in the Brundtland Report, connect with sustainable development a "set of tools for the efficient management of the environment" (ibid., p. 73). According to Santiago (2009), this understanding results from hegemonic economic rationality, inconsistent with complex ecology. Therefore, it is economics that stands out as the central discipline in the results of the bibliometric analysis by VANHULST and HEVIA (2016).

4 SUSTAINABILITY, SUSTAINABLE DEVELOPMENT, AND SUSTAINABILITY SCIENCES: DEFINITIONS, HISTORY, AND DETERMINING MOMENTS

As a concept, sustainability focuses on current and future living conditions. Accordingly, sustainability sciences has been described as an "arena" that "is governed by normative ideas on sustainable development, which are used as a framework for scientific analysis" (MICHELSEN and ADOMßENT 2014, p. 42; own translation).

In the German language, as in Spanish, the concept of sustainable development has its origin in the translation of the term sustainable development, which was introduced in the Brundtland Report. The report presents the result of "the commission convened by the UN, called the 'World Commission on Environment and Development,' under the command of Norwegian President Gro Harlem Brundtland based in Norway" (KLIPPEL and OTTO 2008, p. 56; own translation). Essentially, the Brundtland Report expresses the normative requirement for economic, social and ecological development worldwide, which is justified by the possibility of equal opportunities – intergenerational - for future generations. In turn, this development should be structured in such a way as to allow access, in equal intragenerational terms, to natural resources by all human beings of the current generation (HAUFF, 1987; DINGLER, 2003). Inter- and intragenerational equity are defined depending on the political values of the day (GRUNWALD, 2011).

Due to it's normative orientation towards sustainability, sustainability science, also contributes to the development of an alternative mode of research, better known as Mode 2 (MICHELSEN and ADOMßENT, 2014). This concept of research emerged in the scientific literature in 1994 with the book by Gibbons et al. *The New Production of Knowledge* (1994). Mode 2 research is characterized by contextuality, heterogeneity, reflexivity, and transdisciplinarity and thus, a research approach that acknowledgeds the normative nature of any kind of knowledge production. The science of sustainability (SPANGENBERG, 2011) implies transdisciplinary research, which aims to unite critique on objectivity and scientific progress (KLEIN, 2014) with the aim of moving towards sustainability or - and that is left open - towards sustainable development.

5 DISCURSIVE STRANDS ON SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT: ECONOMISTIC HEGEMONY

The findings of various discourse analyses have confirmed that both sustainability and sustainable development are influenced by other more general and dominant social discourses. In this way, the tension between neoclassical economics and other alternative economic theories cuts across these notions. With this, the object of scientific studies in sustainability, at least in German and English, is built on the tension between the concepts of strong sustainability and weak sustainability. Strong sustainability corresponds to the term of *sustentable*, and weak sustainability to the term of *sostenible* (ALBÁN and ROSERO 2016).

Unlike weak sustainability, in the concept of strong sustainability (ZIEGLER and OTT 2011; OTT and DÖRING 2004) nature is understood as the ecological basis of life and thus, not considered substitutable. Within these limits of strong sustainability, all human effort, in particular the mode of economic activity, has to be achieved. Likewise, the concepts of weak and strong sustainability are found in the sustainability guidelines of efficiency, consistency, sufficiency, and subsistency. Positioning sustainability or sustainable development in this tension has normative and political implications. These may have effects in terms of the social changes that are produced by responses to sustainability. The discursive analyses have indicated the existence of a hegemonic discourse of sustainable development.

The characteristics of this discourse are based on the capitalist theory of well-being, the neoclassical theory, including its methodical application in economics for the purpose of increasing economic growth (SZE, 2018). In turn, it is linked to weak sustainability, under the assumption that, in principle, the different pillars or dimensions of sustainability are integrated (DINGLER, 2003; TREMMEL, 2003; STEURER, 2002). Although the integration of ecological, economic and social objectives is called for, nevertheless, the relations that the social and ecological dimensions have to the economistic discourse are unacknowledged, in such a way that these are only admitted under the premise of fostering economic growth.

"The hegemonic discourse of sustainable development is found in the discursive tradition of [...] modernity" (DINGLER, 2003, p. 484; own translation). However, its development could have led to a crisis that would eventually threaten the conditions that make life possible for human beings of the current generation and those of the future ("hypothesis of the unsustainability of modernity", ibid., p. 493; own translation). This conditionality of sustainable development as a specific concept of modernity, together with the marks it leaves on economies, were the starting point for our analyses. The discursive origin in English of this idea can be traced back to an ecological modernization by Hajer (1995). In German, the critique by Eblinghaus and Stickler (1996) is a relevant discoursive event: "Sustainability and power, towards a critique of sustainable development."[4] The critique is still found in current literature (ROSE and CACHELIN 2018).

The research project "Sustainable development between performance and symbolism" (for its German acronym, "NEDS"[5]) analyzes the Brundtland Report from the perspective of an economic construction of ecological reality. In its analysis of the report, the research project presents seven hypotheses with which the ideas of unsustainability and modernity are differentiated. These hypotheses argue that "economic logic links the expectations of the natural and technical sciences with legal and administrative regulations to contribute essentially to a discursive version of sustainability as a problem of administrative management" (HÖHLER and LUKS, 2004; own translation). The authors of the NEDS project conceive sustainable development along a shift in the conceptualization of nature and ecology. It is directed towards the idea of an economically and administratively controllable environment.

Our analysis on German-language publications on social sustainability investigates the hegemonic imposition of discourse, as well as its current dynamics in the face of discourses, the perception of problems, and alternative solutions (MEYER, 2014). As a result, 5 of the 11 texts which we have analyzed deal with the marginalized perception of problems related to sustainability. They

recommend the creation of economic forms that go beyond operationalizing the capitalist growth economy. These are alternatives that are grounded in theories of sufficiency, post-growth, subsistence, or regionalization and that include changing conceptualizations and forms of "work" within the framework of social ecology.

The results are confirmed by a recent study of Acosta and Brand (2018). These concepts debate, from the perspective of liberal moral philosophy, the substantive and normative content of social sustainability and establish the foundations for theories, norms of action, demands, and political options. It remains open how alternative perspectives to neoclassical economic theory are treated within scientific texts on the conceptual approach to social sustainability. This could be linked to the search for theories of social sustainability, that is, to the development of issues within sustainability research, and simultaneously contribute to plurality of theories that bring down the hegemonic discursive order.

In another analysis, Santiago (2009) contrasts two discourses on sustainability that are in dispute. The first of them is built on a culture of commodification:

> Sutainability, under the vision of corporations, has economic rationality as its central point (Leff 1998). That is, it is the old and well-known developmental strategy transformed into a liberal development discourse (Crush 1998; Escobar 1995; Esteva 1999; Rist 1999; Sachs 1999) by the Brundtland Commission (WCED 1987), now *only in green*. (SANTIAGO, 2009, p. 359; own translation)

The second discourse of an alternative nature, focuses on the social conditions of production by human beings, based on the social and local implications that are the consequence of the extraction of resources worldwide. The perspectives and discursive strands that emerge from this alternative - which mostly come from Latin America, Africa, and Asia - can be described with the following concepts, demands, and values: culture; historical perspective; diversity; pluralism; local knowledge, movements, participation, and control; strategies for a non-capitalist future; autonomy; sufficiency; resistance to privatization; design; complexity; and horizontal networks built on trust, reciprocity, and cooperation as ethical coordinates (ibid.).

Additional analyses of the discourse have focused on the political interpretations of sustainability or sustainable development, particularly on the political discourses that lead to neoliberal policies. A critical analysis published in 2014 investigated the discursive strands of sustainable development in the British government's public policy documents between 1990 and 2000, and concluded that:

> In this way, the political discourses of neo-liberalism, Thatcherism and New Labour are reflected in the discourse of sustainable development, and sustainable development is presented from within the paradigm of neo-liberalism and neoclassical economics. (KAMBITES, 2014, p. 344 ff.)

It is important and interesting to point out how neoliberalism develops based on an ideal of administration and regulation that is part of what is contemplated in the Brundtland Report:

> It should be noted that the strong orientation of the report towards observation, measurement and, consequently, towards administrative strategies and solutions, in fact do not fit in with the program of a 'neoliberal' policy, which are usually attributed to the Brundtland Report and its subsequent interpretations of sustainability. In contrast, the Commission's administrative approach is rather oriented towards the debates of the 1970s, which were strongly influenced by a significant reliance on socially coordinated regulation and planning. (HÖHLER and LUKS, 2004, p. 52; own translation)

It turns out that for a further investigation into the tensions between neoliberalism and regulation, in relation to the discourses of sustainability and sustainable development, it would be of added value to approach the material, the institutional configurations and their practices from within the framework of an analysis of dispositives (BÜHRMANN and SCHNEIDER 2008). This is in order to associate conceptual definitions and theoretical perspectives with political and political-environmental implications.

6 JUSTICE IMPLICATIONS: DEVELOPMENT = GROWTH

Modern Eurocentric and dominant sustainable strategies cause effects of exclusion and displacement in the way of understanding nature from a theoretical perspective of equity and are equally influenced by them. The Brundtland Report, as a defining moment in the development of the sustainable development discourse, as well as its subsequent interpretations, could also have contributed to this.

Through the hegemonic strategy that seeks to obtain economic growth for all states, both inter- and intragenerational forms of equity should be configured. In principle, the indicator of these is the state welfare, expressed in quantitative terms. The goal of sustainable development would be for all countries to achieve sustainable growth values that are as high as possible (HÖHLER and LUKS 2004). In turn, the determination of sustainable development as the main idea is tied to the theories of development that seek the expansion of Western values (ibid.). Through environmental regulation, control and administration, these values should be developed intergenerationally in a sustainable way and transmitted to other regions of the world where they can be deployed (VANHULST and HEVIA, 2016; ALBÁN and ROSERO, 2016).

Some discourse analyses draw a prioritization of generational equity in sustainable development and a marginalization of its intragenerational dimension (DINGLER, 2003). This doesn't impliy an expansion, as established politically and normatively, but a "discursive displacement towards economic-environmental approaches" (ibid.; own translation). The hegemonic economic discourse is accompanied by a prioritization of intergenerational equity, which replaces the discourses on "social justice within Germany" (TREMMEL, 2003, p. 30; own translation) and a critical discourse on growth. In economics, intragenerational equity is treated as a balance in the market where resource allocation is perfect. The hegemonic discourse then leads to an exclusion "of other perceptions about problems and their solutions" (ibid.) and an ethically unacceptable marginalization of human rights (MEYER, 2020, forthcoming).

It seems that in the political sphere the adoption of sustainable development has been transformed into an appropriation of this concept through the free play of powers, in which science acts as a wild card at the cost of ethical and theoretical considerations (SCHULTZ et al., 2008; STIEFERLE, 2007). Also, causal sensitivity is marginalized:

> Global crisis is not a technical problem, nor even an economic problem. It is, fundamentally, a cultural and political problem, where we need new epistemological and ethical tools. (AYESTARAN 2011, p. 213)

Additionally, the sustainability sciences explicitly formulate a pluralistic claim. If the strategies for sustainable development of economistic discourses prevail, these claims would not be done justice. In this sense, it would be impossible under a "dominant culture of unsustainability [...] to capture models of dependency" (KAGAN, 2012, p. 11; own translation). This leads to the circular self-strengthening of unsustainable situations (Figure 1).

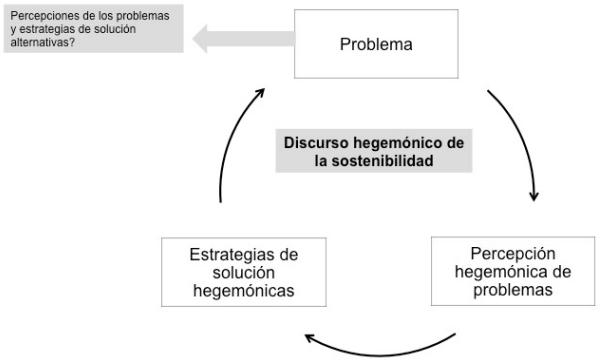

Figure 1 | Hegemonic cycle

Source: Own representation

7 IN SEARCH OF ALTERNATIVES - MARGINALIZED DISCOURSES

According to what has been presented, different poles can be distinguished around the discourses on sustainability and sustainable development, the hegemonic power that shapes them, and the concepts that emerge from the articles reviewed. In a first reading, it is striking that the Mexican analysis of Santiago (2009) tends to name alternative discourses in the most differentiated way. In contrast, German studies focus on inquiries into the hegemonic discourse of unsustainability, as a specifically modern pole (HÖHLER and LUKS 2004; DINGLER, 2003) to point out the need for alternative theories that imply a change in economy. Also, they seek to unveil and name these theories (MEYER, 2014).

Thus, the question arises as to how and where these alternatives can be sought within a sustainable frame of reference. On the one hand, special attention must be paid to the development of other dominances, as is done through neoliberal policies. On the other hand, however, also alternative sustainability concepts, cannot leave modern thought patterns[6] or, due to political-normative reasons, do not want to. Thought in terms of "inside-outside of modernity" remains equally imprisoned by the modern logic of thought.

Höhler and Luks highlight the difficulty of searching for solutions and sustainable alternatives, which are both critical (or where possible ethically sustainable) and verifiable:

> If these modern concepts are definitely doomed in relation to the goals of sustainability, it cannot be indicated in a contingent world. (HÖHLER and LUKS 2004, p. 63; own translation)

In the analysis of discourses on change[7] of, and alternatives (ibid.) to the hegemonic discourse, insights can also be generated through the analysis of practices, situations (CLARKE, 2012), and cases (VILSMAIER et al. 2015).

In what follows, we will outline the potential of transdisciplinary sustainability research, to contribute to a critical and differentiated discourse that generates alternative strategies. This form of research explicitly embraces differences, considering heterogeneous perspectives and cultural self-determinations (VILSMAIER et al., 2017; ENGBERS 2020), and is oriented towards cooperation and mutual learning, thereby trying to counter marginalization and satisfy the ethical demands of sustainability.[8]

8 IMPLICATIONS FOR SUSTAINABILITY SCIENCES AND RESEARCH

To a certain extent, Mode 2 research layed the theoretical ground for transdisciplinary research within its "own theoretical structure, investigative methods and practices" (HUNECKE, 2006, p. 42; own translation) and new criteria for evaluating scientific qualities (HUNECKE, 2006; GIBBONS, et al. 1994).

> Discussion on Mode 2 has provided an important contribution in drawing attention to transdisciplinary research. (VILSMAIER and LANG 2014, p. 94; own translation)

Transdisciplinary sustainability research addresses so-called sustainability challenges as problems of today's world and demands to interact with this world. The research mode intends to generate knowledge oriented to transformation towards sustainability. In transdisciplinary research, scientists investigate societal problems - and their solutions - in a joint process with individuals or groups (political, economic, civil society) not involved in academic fields (ibid.). In critical transdisciplinarity, all participants are considered as researchers and jointly contribute - with different knowledges and in different roles - to the research process (VILSMAIER et al. 2017).

This type of process seeks to generate different forms of knowledge (PROCLIM, 1997; VILSMAIER and LANG 2014):

I. System knowledge: knowledge (and experiences) of researchers about socially relevant problems and phenomena in the research process. In this way, the generation of knowledge is conceived as a process of seeking understanding, recognition, identification, analysis, and questioning.

II. Target knowledge: normativity, understood in the form of assessments (sometimes unconscious), paradigms and political convictions, targeted at making them explicit. This implies working with differences, conducting transparent public discussions, and not leaving the orientation to an academic elite based on their own values (ZIEGLER and OTT 2011).

III. Transformative knowledge: this type of knowledge must guarantee that the different targets proposed (for example, requests and recommendations) are achieved. In relation to publications, this means getting involved beyond the orthodox academic media.

Especially in the case of target knowledge, it is possible to observe that in transdisciplinary sustainability research, the dominant discourses can prevent a complex understanding of problems. When the dominant social paradigms generate evidence and determine opinions, orientations and understanding of the problems, as well as everything that is worth saying, they contradict the elements of transdisciplinarity, based on differentiations and complementarities.

At the same time, this form of research creates a space to make visible and actively address the problematic of dominant discourses on sustainability and sustainable development that challenge the young field of sustainability sciences as a science of sustainability (SPANGENBERG, 2011). In this regard, transdisciplinary research is a promising approach, since it explicitly and critically faces these challenges. Because of its pluralistic, heterogeneous and reflective structure, the principles of this type of research hold the potential to make the sustainability discourse visible, expressible, and actionable.

Consequently, transdisciplinary research also produces situations that are beyond current hegemonic structures. For this, its adoption is not only necessary for research practices, but also for the elaboration of theoretical, epistemological, and methodological foundations. Such foundations would position transdisciplinary research in sustainability as a complementary mode of research to disciplinary and interdisciplinary forms.

Additionally, it would be placed as a research practice in-between science-driven research and other forms of knowledge production, and between the institution of science and other societal institutions. This occurs because transdisciplinary research does not only aim at epistemic objectives, but it carries within itself an interventionist claim directed at societal transformation for the implementation of a sustainable ethic.

By positioning critical transdisciplinary sustainability research in the space between different societal institutions and highlighting its search for political and meditative ways of producing understandings and practices, a place can be created where epistemic and transformative goals can be intertwined (VILSMAIER et al. 2017). In this way, research results can take into account certain scientific quality criteria and at the same time gain social and cultural robustness (GIBBONS, 1999; NOWOTNY, 2000; VILSMAIER et al., 2015). This can be achived on two levels: (i) the plurality of knowledges and understandings find recognition and significance; and (ii) the different objectives of sustainability are addressed as a field of tension that can be approached from a perspective of sustainability ethics.

In line with the work of Bhabha (2004), critical transdisciplinary sustainability research can be understood as a field in which "existing structures, power relations and dependencies can be suspended - at least

for a situational episode - when discrepancies are articulated and thereby made tangible" (VILSMAIER et al., 2017, p. 174). Transdisciplinary research spaces seek to overcome established societal structures, while cooperative research spaces are created between members of different societal domains (ibid.).

These seek to overcome power relations in knowledge production by giving rise to contributions of different knowledge cultures. Thus, sustainable transformations could be achieved and the unidirectionality in the transfer of knowledge and decision-making structures could be replaced by structures oriented towards mutual knowledge production and learning (VILSMAIER et al., 2015). However, thereby disparities are not equated. Instead, differences in the qualities and the scope of knowledge, roles in societal structures, and positions based on interests and ideologies open spaces for the foundation of critical transdisciplinary research in sustainability.

9 CONCLUSIONS AND FUTURE PERSPECTIVES

With our discourse-analytical work we outlined the interconnectivity between the concepts of both sustainability and sustainable development in the dominant discourses, as well as what this implies for sustainability sciences and research. A panorama on selected linguistic communities has been opened. It serves as a start that calls for responses due to the principal limitations given the authors own situatedness. We recognize that as authors we are positioned in a specific, cultural, historical, and linguistic situation, and therefore limited; our mother tongue is German, and we speak English and Spanish, but not Portuguese. Likewise, other limitations of our contribution are based on the methodology. Thus, the discourse-analytical schools are not differentiated in the meta-analysis, and the selection of the investigated search terms include, and at the same time exclude, specific discourse strands.

This conceptual and reconfigurative work resumes approaches for alternatives, together with a general call for the strengthening of theoretic plurality in economics and sustainability sciences. Likewise, the ontological, epistemological and ethical foundations of sustainability should be reconsidered for the further development of alternative theories on transformations in forms of human coexistence. These alternatives take into account both the substantive and normative claims of sustainability (which could be, for example, the fulfillment of human rights and the conservation of nature as a foundation for life) as well as the procedural and differentiable understandings on regulations. Corresponding philosophical approaches can already be found and will be further elaborated (MEYER, 2020, forthcoming).

A critical transdisciplinary sustainability research contributes to the generation of target knowledge, by addressing ethical and cultural aspects. In this way, and as a complement to system and transformative knowledge, the understandings produced by this knowledge represent transformative moments, which are based on ethical argumentation and mutual learning. With this, a critical transdisciplinary research strengthens the fracture of hegemonic orders and thus complements understandings on (un)sustainable ways of life - either as a science of sustainability (SPANGENBERG 2011) or as transformative research (WBGU, 2011).

The intellectual challenge is to research collaboratively and interculturally, and learn from each other about the discursive and counter-hegemonic dynamics of sustainability. Doing this between different spaces and cultures, and between different sociocultural, economic and political historical situations on different continents (ibid.), supports autonomous projects based on cultural difference (VILSMAIER et al., 2017). How do we problematize, for example, global modernity?

The understanding of the discursive formations in academic systems in different world regions and their historical contingencies facilitates the visualization of the differences and the gears between discourses. Contrary to a single historical critical deconstruction of its own European position, we consider understandings of other discursive dynamics and other narratives as the conditions for the possibility of change, motion, and reconfiguration.

> Science of the emergent paradigm also claims to be a translator. That is to say, it encourages the emigration of concepts and theories developed locally to other cognitive spheres and their utilization outside their original context. It is knowledge about the conditions of possibility […] of human action projected into the world from local time-spaces (DE SOUSA SANTOS, 1992, p. 38).

The development of normative goals, as effectively attempted in the case of the Sustainable Development Goals in 2015, must address and represent the different cultural, political, economic, and historical situations, and in particular the concepts of nature, of human beings, communities, appropriation practices, and forms of belonging.

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NOTES

1 | Ökonomistische Diskurse der Nachhaltigkeit: Bestimmende Momente und die Frage nach Alternativen. En: Pfister, T.: Nachhaltigkeitswissenschaften und die Suche nach neuen Wissensregimen. Metropolis.

2 | The following were used as search terms: (Sustainability* AND discourse). Discourse methodologies, as well as different orientations on the discursive analysis of publications are not discussed here.

3 | *CCP – Complexity or Control? Paradigms for Sustainable Development.*

4 | *"Nachhaltigkeit und Macht. Zur Kritik von Sustainable Development."*

5 | *NEDS – "Nachhaltige Entwicklungs zwischen Durchsatz und Symbolik."*

6 | For example, among the objectives of left-wing sustainability are structural changes within modern societies—and their categories of thought—which are assigned "to the ability to link alternatives to current dominance of capital markets" (SCHACHTSCHNEIDER 2007, p. 137; own translation; HÖHLER and LUKS 2004).

7 | "Thus, the belief in perpetual growth, linear growth […], which meet under the labels of 'process' and 'change,' belongs to various perspectives," (KAGAN 2012, p. 38; own translation) such as "the phenomenon of economic growth […] understood as a synonym of progress and change" (STEURER 2002, p. 114; own translation).

8 | In the present work we are not concerned with the normative and prescriptive definition of sustainability ethics. Underlying this is the premise of the recognition of its existence.

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Discursos economicistas de la sostenibilidad: Los momentos determinantes y la pregunta por alternativas

Economistic discourses of sustainability: determining moments and the question of alternatives

Discursos economicistas de sustentabilidade: momentos determinantes e a busca por alternativas

Esther Meyer[a]

Ulli Vilsmaier[b]

[a]*Leuphana University Luneburg, Faculty of Sustainability Luneburg, Germany*
E-mail: Esther.Meyer@leuphana.de

[b]*Leuphana University Luneburg, Institute of Philosophy and Sciences of Art and Center for Methods, Luneburg, Germany*
E-mail: Ulli.Vilsmaier@leuphana.de

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ARTICLE- VARIA

RESUMEN

A pesar del aumento mundial de discursos y políticas sobre sostenibilidad, los significados del concepto varían en diferentes comunidades lingüísticas. Esto puede debilitar la multidimensionalidad y la dimensión ética del concepto y poner en peligro la política. El artículo tiene como objetivo destacar los hilos teoréticos del discurso sobre la sostenibilidad y la sustentabilidad de diferentes comunidades lingüísticas en una orientación intercultural. Presenta una revisión meta-analítica de trabajos analíticos del discurso y un propio análisis. Los resultados muestran discursos hegemónicos de conceptualizaciones economicistas, así como alternativas. Aspiramos a contribuir a un intercambio y una discusión en profundidad entre los discursos lingüísticos y a la reflexión metódica de la investigación analítica-discursiva desde una perspectiva intercultural. Concluimos que la investigación transdisciplinaria fortalece, ya sea como ciencia de la sustentabilidad o como investigación transformadora, la fractura de los órdenes hegemónicos y, por lo tanto, complementa la comprensión de formas de vida (no) sustentables.

Palabras-Clave: Ciencia de la sustentabilidad. Transdisciplina. Análisis del Discurso. Discursos hegemónicos. Intercultural.

ABSTRACT

Despite the worldwide increase of discourses and politics on sustainability, the meanings of the concept vary significantly in different linguistic communities and cultures. This may undermine the multidimensionality

and ethical dimension of the concept and jeopardize according politics. The article aims at highlighting discourse strands on sustainability of different linguistic communities in an intercultural orientation, and how they are theoretically shaped. It comprises a revision of existing and own discourse analysis. The results show hegemonic discourses of economistic conceptualizations, as well as alternatives, which vary between communities and languages. The article wants to contribute to an exchange and a profound discussion between the linguistic discourses, as well as to a methodological reflection on discourse analysis from an intercultural perspective. We conclude that critical transdisciplinary research strengthens, either as a science of sustainability or as transformative research, the fracture of hegemonic orders and thus complements understandings of (un)-sustainable ways of life.

Keywords: Sustainability sciences. Transdisciplinary. Discourse analysis. Hegemonic discourses. Intercultural.

RESUMO

A disseminação mundial da sustentabilidade aumentou de forma significativa nos discursos e na política desde a resolução da ONU Objetivos de Desenvolvimento Sustentável de 2015. No entanto, o significado do conceito varia em diferentes comunidades e culturas lingüísticas. O presente artigo apresenta uma revisão analítica-discursiva dos conceitos de sustentabilidade em uma perspectiva intercultural. Os resultados mostram discursos hegemônicos de conceitualizações economicistas, bem como alternativas, que se constituem em diferentes comunidades lingüísticas. O artigo pretende fomentar uma troca e uma discussão profunda entre os grupos lingüísticos, bem como uma reflexão metodológica sobre a análise do discurso a partir de uma perspectiva intercultural.

Palavras-Chave: Ciências da Sustentabilidade. Transdisciplinar. Análise de discurso. Discursos hegemônicos. Intercultural.

1 INTRODUCCIÓN

Desde la resolución de los 'Objetivos de Desarrollo Sostenible' por la ONU en 2015, la diseminación de lo sustentable y lo sostenible ha aumentado significadamente en discursos y políticas a nivel mundial. Podría parecer que los conceptos han llegados al alcance de la ciencia y del público general y que, con ello, se ha dado un paso más en dirección hacia los principios normativos. Y aparentemente, eso se está dando en diferentes comunidades lingüísticas. Al mismo tiempo es necesario indagar en el contenido de los significados de tal afirmación: ¿Qué significa lo sustentable y qué, lo sostenible? ¿Y en qué contextos adquieren diferentes significados? ¿Cómo se han constituidos los diferentes discursos en reacción al principio económico nacional universal del *sustainable development* como declarado por la ONU con respecto a diferentes contextos históricos socioculturales, económicos y políticos en los distintos continentes?

Desarrollamos los conceptos y las teorías sobre lo sustentable y lo sostenible y la conceptualización de la ciencia de la sustentabilidad desde una revisión de análisis del discurso. El supuesto es que las dinámicas discursivas inciden en el trabajo relacionado con lo sustentable y lo sostenible en política, economía e incluso en la ciencia de la sustentabilidad. La pregunta es si eso conduce a la reproducción de determinados argumentos así como de culturas de la in-sustentabilidad. La indagación acerca de dinámicas represivas –como, por ejemplo, en el discurso sobre el crecimiento– debe también ser un componente del trabajo científico en sustentabilidad para reconocer las causas constitutivas de la in-sustentabilidad.

En este artículo proporcionamos, con ayuda de una revisión meta-analítica del trabajo discursivo-analítico, un estudio sobre los hallazgos del discurso de la sustentabilidad. Brindamos una visión general sobre los hilos y hipótesis a las que es necesario hacer un seguimiento exhaustivo.

Hemos estructurado el artículo de la forma siguiente: En sección 2 presentamos el método del análisis. Seguimos con consideraciones de la dependencia contextual de discursos (3) y un acercamiento hacia

los conceptos de sustentabilidad, desarrollo sostenible y ciencia de la sustentabilidad, con el fin de formular definiciones determinantes (4). Después, precisamos los diferentes momentos en los cuales la sustentabilidad y el desarrollo sostenible se han sido detonantes de las tensiones discursivas (5). Mediante conceptos y términos que aclaran las diferentes maneras de comprender a la sustentabilidad, (6) esbozamos algunas de sus limitaciones discursivas (7). Así, en la sección (8) presentamos las implicaciones que ello tiene para la ciencia de la sustentabilidad y discutimos el potencial de la transdisciplinariedad. Finalmente, se esbozan algunas conclusiones (9).

2 METODOLOGÍA

El análisis crítico del discurso presta especial atención a los modos en que van surgiendo teorías dominantes que, a través de sus discursos, (re)producen relaciones de poder (CLARKE, 2012). El artículo se refiere al trabajo discursivo-analítico realizado en países de habla alemana e inglesa. Identificamos hilos de discusión que fueron el resultado del trabajo de análisis del discurso. Pretendemos contribuir a un intercambio a través de las comunidades lingüísticas (nacionales). Una parte de los resultados también fuera publicada en alemán[1].

Partiendo de la revisión de publicaciones sobre el discurso de la sustentabilidad[2], ponemos en evidencia las limitaciones y líneas que los/as autores/as extraen como discursivamente dominantes. Un estudio propio anterior (MEYER, 2014), a través del análisis discursivo de textos alemanes sobre sustentabilidad social en el período comprendido entre los años 2003-2013, constituye nuestro punto de partida. Además incorporamos nuestras experiencias laborales en este campo científico.

Por lo tanto, nuestro énfasis en este trabajo consiste en la (re)formulación de hipótesis con respecto a la constitución de la sustentabilidad por discursos sociales y sobre todo economicistas.

Esta investigación forma parte del Proyecto *CCP* –'¿Complejidad o control? Paradigmas para el desarrollo sostenible'[3]– que se dirige al análisis sistemático de las percepciones sobre la investigación crítica y transdisciplinaria en sustentabilidad, su configuración conceptual y metodológica. Intentamos de localizar los discursos suprimidos sobre sustentabilidad, desarrollo sostenible y ciencia de la sustentabilidad. De acuerdo con una definición diferenciada de eco-lingüística, estamos buscando hallazgos éticos y multidimensionales de sustentabilidad, también y especialmente, más allá del discurso en ciertos términos explícitos (ALEXANDER y STIBBE, 2014).

3 DEPENDENCIA CONTEXTUAL DEL DISCURSO

Cada pensamiento y producción de conocimiento está situado y atado a circunstancias (HARAWAY, 1988) y por lo tanto nadie se puede eximir de su propia posicionalidad (QIN 2016). Particularmente en el caso de investigar discursos con respecto a la dependencia histórica y cultural este hecho debe guiar las propias practicas. Tanto la situación nacionalizada como la situación medioambiental, sociocultural, política, económica y las prácticas sustentables forman parte del desafío analítico.

Por lo tanto, nos hemos aproximado a los análisis del discurso de América Latina desde un punto de vista Europeo. En un primer paso, resumimos los resultados de nuestra exploración. A continuación, presentamos los resultados, que se han publicado y explorado en los países de habla alemana e inglesa para formular más preguntas que contribuyan al debate académico.

En español - a diferencia del alemán análogo al inglés, donde existe la palabra *Nachhaltigkeit* - los discursos sobre *sustainability* han sido constituidos de distintas formas, como *sostenibilidad* y *sustentabilidad*. Lo mismo se aplica al desarrollo sostenible y sustentable (*nachhaltige Entwicklung* o *sustainable development*).

Vanhulst ha publicado en inglés (VANHULST y ZACCAI, 2016) y español (VANHULST y HEVIA, 2016) un análisis y mapeo cuantitativo (análisis de redes, bibliometría) y cualitativo (análisis de discurso) sobre los modos de apropiación del discurso de *sustainable development* en América Latina en los últimos 40 años. Los autores sostienen que *sustainable development* ha enseñado los efectos de los discursos críticos y contra hegemónicas radicales con respecto al (post-)eurocentrismo y la modernidad, representados por científicos como Escobar (1995), y por los dos conceptos –lo sostenible y lo sustentable:

> Si lo sostenible en el modelo hegemónico hace referencia a lo económico, lo sustentable debe ser considerado como la garantía de todas las formas de vida y de todas las formas en que esa vida se expresa culturalmente" (ALBÁN y ROSERO, 2016, p. 38).

En el discurso latinoamericano del desarrollo sostenible "el informe Brundtland 'Nuestro futuro común' (CMMAD, 1987) y Meadows 'Los límites del crecimiento' (MEADOWS et al. 1972) se imponen como las referencias más centrales" (VANHULST y HEVIA, 2016, p. 184). A su vez, Vanhulst et al. expresan una apropiación específica del principio político en América Latina llamándolo "pensamiento ambiental latinoamericano" (ibíd., p. 208). El principio universal del *sustainable development* es cuestionado por la lucha por la autonomía cultural de los grupos indígenas marginalizados como principio desarrollista tecno-económico moderno con origen en una racionalidad reduccionista (VANHULST y ZACCAI 2016).

Concepciones de *sustainable development*, que se encuentran, entre otro, en el 'Informe Brundtland', conectan con el desarrollo sostenible un "set de instrumentos para una gestión eficiente del medio ambiente" (ibíd., p. 73; traducción propia). Este entendimiento resulta de una racionalidad económica hegemónica, no coherente con la ecología compleja (SANTIAGO 2009). Por lo cual es la economía la que destaca como la disciplina central en los resultados del análisis bibliométrico (VANHULST y HEVIA 2016).

4 SUSTENTABILIDAD, DESARROLLO SOSTENIBLE Y CIENCIA DE LA SUSTENTABILIDAD: DEFINICIONES, HISTORIA Y MOMENTOS DETERMINANTES

Como concepto, la sustentabilidad se enfoca en las condiciones de vida actuales y futuras. La ciencia de la sustentabilidad se ha descrito como una 'arena' que "se rige por las ideas normativas sobre el desarrollo sostenible, las cuales son utilizadas como marco para el análisis científico" (MICHELSEN y ADOMßENT 2014, p. 42; traducción propia).

En la lengua alemana, al igual que en el español, el concepto de desarrollo sostenible tiene su origen en la traducción del término *sustainable development*, el cual apareció con ocasión del 'Informe Brundtland'. El informe presenta el resultado de "la comisión convocada por la ONU, denominada 'Comisión Mundial sobre el Medio Ambiente y Desarrollo', bajo el mando de la Presidenta noruega Gro Harlem Brundtland con sede en Noruega" (KLIPPEL y OTTO 2008, p. 56, traducción propia). Esencialmente, el 'Informe Brundtland' expresa el requerimiento normativo de un desarrollo económico, social y ecológico a nivel mundial, que se encuentra justificado en la posibilidad de la igualdad de oportunidades –intergeneracional– para las generaciones futuras. A su vez, este desarrollo debe estar estructurado de forma tal que posibilite el acceso en condiciones intrageneracional igualitarias a los recursos naturales por parte de todos los seres humanos de la generación actual (HAUFF, 1987; DINGLER, 2003). La equidad inter- e intrageneracional se ven definidas dependiendo de los valores políticos de turno (GRUNWALD, 2011).

Por su parte, la ciencia de la sustentabilidad, cuyo contenido se enfoca hacia la sustentabilidad entendida a partir de su orientación normativa, contribuye también al desarrollo de un modo alternativo de investigación, mejor conocido como Modo 2 (MICHELSEN y ADOMßENT, 2014). Este concepto de investigación surgió en la literatura científica en el año 1994 con el libro de Gibbons et al. '*The New Production of Knowledge*' (1994) y se caracteriza por contextualidad, heterogeneidad, reflexividad y transdisciplinariedad. La ciencia de la sustentabilidad (SPANGENBERG, 2011) implica la

investigación transdisciplinaria en sustentabilidad, la cual pretende unir la crítica a la objetividad y a los avances científicos (KLEIN, 2014) con el objetivo de encaminarse hacia la sustentabilidad o –y eso se deja abierto– al desarrollo sostenible.

5 HILOS DISCURSIVOS SOBRE SUSTENTABILIDAD Y DESARROLLO SOSTENIBLE: HEGEMONÍA ECONOMICISTA

Los hallazgos de diversos análisis del discurso han confirmado que tanto la sustentabilidad, como el desarrollo sostenible, se ven influidos por otros discursos sociales más generales y dominantes. De esta forma, la tensión entre la economía neoclásica y otras teorías económicas alternativas atraviesa dichas nociones. Con ello, el objeto de los estudios científicos en sustentabilidad, al menos en alemán e inglés, se construye sobre la tensión entre los conceptos de *strong sustainability* y *weak sustainability*. *Strong sustainability* corresponde al término de lo sustentable, y *weak sustainability* al término de lo sostenible (ALBÁN y ROSERO 2016).

A diferencia de la *weak sustainability*, en el concepto de *strong sustainability* (ZIEGLER y OTT 2011; OTT y DÖRING 2004) la naturaleza, entendida como la base ecológica de la vida, no se considera sustituible. Dentro de los límites de una *strong sustainability*, todo esfuerzo humano, el modo de actividad económica, tiene que suceder. Asimismo, se utilizan en las directrices de eficiencia, consistencia, suficiencia y subsistencia. El posicionamiento de la sustentabilidad o del desarrollo sostenible en el marco de esta tensión tiene implicaciones normativas y políticas. Éstas pueden tener efectos de cara a los cambios sociales que producen las respuestas a la sustentabilidad. Los hallazgos del análisis discursivo han señalado la existencia de un discurso hegemónico acerca del desarrollo sostenible.

Las características de este discurso se fundamentan en la teoría capitalista del crecimiento, esto es la teoría capitalista del bienestar, la teoría neoclásica del crecimiento, incluyendo su aplicación metódica en la economía y su finalidad de aumentar el crecimiento económico (SZE, 2018). A su vez, se vincula con *weak sustainability*, bajo la presunción de que, en principio, los diferentes pilares o dimensiones de la sustentabilidad están integrados (DINGLER, 2003; TREMMEL, 2003; STEURER, 2002). Si bien se apela a la integración de los objetivos ecológicos, económicos y sociales, no obstante, se desconocen las relaciones y la trascendencia que la dimensión social y ecológica tiene en el discurso economicista, de modo tal que éstas sólo son admitidas en el discurso bajo el fomento económico.

"El discurso hegemónico del desarrollo sostenible se encuentra en la tradición discursiva de […] la modernidad" (DINGLER, 2003, p. 484; traducción propia). No obstante, el desarrollo de este podría haber llevado a una crisis que eventualmente amenazaría las bases que posibilitan la vida de los seres humanos de la actual generación y de las futuras ("Hipótesis de la in-sustentabilidad de la modernidad", ibíd., p. 493; traducción propia). Esta fundamentación del desarrollo sostenible como un concepto específico de la modernidad, junto con las marcas que deja en las economías, fueron el punto de partida de análisis. El origen discursivo en inglés de esta idea puede considerarse a partir de la denominación de una *modernización ecológica* realizada por Hajer (1995). En alemán también es relevante la crítica realizada por Eblinghaus y Stickler (1996) en su articulo: 'Sustentabilidad y poder, hacia una crítica del desarrollo sostenible'[4]. Esta critica todavía se encuentra en la literatura actual (ROSE y CACHELIN 2018).

El proyecto de investigación 'Desarrollo sostenible entre rendimiento y simbolismo' (por sus siglas en alemán '*NEDS*'[5]) analiza el 'Informe Brundtland' desde la perspectiva de una construcción económica de la realidad ecológica. A través del análisis del informe, el proyecto de investigación presenta siete hipótesis con las cuales se diferencian las ideas de in-sustentabilidad y modernidad. Estas hipótesis argumentan que la "lógica económica enlaza las expectativas de las ciencias naturales y técnicas con las regulaciones jurídicas y administrativas para contribuir esencialmente a una versión discursiva de la sustentabilidad como un problema de gestión administrativa" (HÖHLER y LUKS, 2004; traducción propia). Los/as autores/as del proyecto '*NEDS*' conciben al desarrollo sostenible mediante un

desplazamiento de los saberes y comprensiones sobre la naturaleza y la ecología, el cual se dirige hacia la idea de un medio ambiente controlable económica- y administrativamente.

Nuestro análisis sondeó las publicaciones en lengua alemana publicadas entre 2003-2013 y cuyos títulos contuvieran el término 'sustentabilidad social'. Igualmente, dichas publicaciones no debían hacer referencia a un objeto en concreto. Aquí también indagamos la imposición hegemónica del discurso, así como sus dinámicas actuales de cara a los discursos, la percepción de los problemas y las soluciones alternativas (MEYER, 2014). Como resultado, 5 de los 11 textos analizados tratan la percepción marginalizada de problemas relacionados con la sustentabilidad. Estos recomiendan la creación de formas económicas que vayan más allá de operacionalizar la economía del crecimiento capitalista. Se trata de alternativas que existen en las teorías de la suficiencia, el post-crecimiento, la subsistencia o la regionalización y que incluyen formas cambiantes de 'trabajo' en el marco del concepto de ecología social. Los resultados están actualmente confirmados por Acosta y Brand (2018).

Estos conceptos debaten, desde la perspectiva de la filosofía moral liberal, el contenido sustancial y normativo de la sustentabilidad social y establecen los fundamentos para las teorías, normas de acción, demandas y opciones políticas. Resta aún por constatar cómo se tratan las perspectivas alternativas a la teoría económica neoclásica al interior de los textos científicos sobre la aproximación conceptual a la sustentabilidad social. Ello podría vincularse con la búsqueda de teorías de la sustentabilidad social, es decir, al desarrollo de cuestiones en el interior de la investigación en sustentabilidad y simultáneamente contribuir con el pluralismo en las teorías que derriben el orden discursivo hegemónico.

En otro análisis, Santiago contrasta dos discursos sobre la sustentabilidad que se encuentran en disputa. El primero de ellos se construye sobre una cultura de la mercantilización:

> la sustentabilidad, bajo la visión de las corporaciones, tiene como punto central la racionalidad económica (leff 1998). es decir, es la vieja y conocida estrategia desarrollista transformada en discurso liberal del desarrollo (crush 1998; escobar 1995; esteva 1999; rist 1999; sachs 1999) por la comisión brundtland (wced 1987), ahora *maquillada de verde*" (SANTIAGO, 2009, p. 359).

El segundo discurso, de corte alternativo, se centra en las condiciones sociales de producción de los seres humanos, partiendo de las implicaciones sociales y locales que son consecuencia de la extracción de recursos a nivel mundial. Las perspectivas y líneas discursivas que se desprenden de esta alternativa - que en su mayoría provienen de Latinoamerica, Africa e Asia - pueden describirse con los siguientes conceptos, demandas y valores: cultura; perspectiva histórica; diversidad; pluralismo; conocimiento, movimientos, participación y control local; estrategias para un futuro no-capitalista; autonomía; suficiencia; resistencia a la privatización; diseño; complejidad; redes horizontales construidas sobre la confianza, la reciprocidad y la cooperación como coordenadas éticas (ibíd.).

Análisis adicionales del discurso se han enfocado en las interpretaciones políticas de la sustentabilidad o el desarrollo sostenible, particularmente en los discursos políticos que desembocan en políticas neoliberales. Así, un análisis crítico publicado en el año 2014 indagó sobre los hilos discursivos del desarrollo sostenible en los documentos de política pública del gobierno británico entre 1990 y 2000, y concluyó que:

> De esta forma, los discursos políticos del neoliberalismo, thatcherismo y del nuevo laborismo [*New Labour*] se ven reflejados en el discurso del desarrollo sostenible y este es presentado desde el interior del paradigma neoliberal y de la economía neoclásica" (KAMBITES, 2014, p. 344 y ss.; traducción propia).

Suplementariamente, Chile sería un caso rico de la comprensión para explorar por su historia política y económica con respecto al neoliberalismo. Resulta importante e interesante señalar cómo el neoliberalismo se desarrolla en función de un ideal de administración y de regulación que se inscribe dentro de lo contemplado en el 'Informe Brundtland':

> Debe resaltarse que la fuerte orientación del informe hacia la observación, medición y, en consecuencia, hacia las estrategias y soluciones administrativas, de hecho no encajan con la programática de una política 'neoliberal', que usualmente son atribuidas al Informe Brundtland y a sus interpretaciones subsecuentes de la sostenibilidad. Por el contrario, el enfoque administrativo de la Comisión se orienta más bien a los debates de los años 70, que se encontraban fuertemente influenciados por una confianza importante en la regulación y la planeación socialmente coordinadas. (HÖHLER y LUKS, 2004, p. 52; traducción propia).

Resulta que para una investigación adicional de las tensiones entre neoliberalismo y regulación, en relación a los discursos de sustentabilidad y del desarrollo sostenible, sería recomendable añadir las configuraciones materiales e institucionales y sus prácticas en el marco de un análisis de los dispositivos (BÜHRMANN y SCHNEIDER 2008) en los diferentes planos de análisis discursivo. Esto con el fin de asociar las definiciones conceptuales y las perspectivas teóricas con las implicaciones políticas y político-ambientales.

6 IMPLICACIONES EN EL PRINCIPIO DE EQUIDAD: DESARROLLO = CRECIMIENTO

Las modernas eurocéntricas y dominantes estrategias sostenibles tienen efectos de exclusión y desplazamiento en la forma de entender la naturaleza desde una perspectiva teórica de la equidad e igualmente se ven influenciadas por estos. El 'Informe Brundtland', como momento determinante en el desarrollo del discurso sobre desarrollo sostenible, así como sus interpretaciones subsiguientes, podrían también haber contribuido a ello.

A través de la estrategia hegemónica que busca obtener un crecimiento económico posible para todos los estados, deberían configurarse distintas formas de equidad, tanto inter- como intrageneracional. En principio, se entiende que el indicador de éstas es el bienestar estatal expresado en términos cuantitativos. En otras palabras, el objetivo del desarrollo sostenible consistiría en que todos los países alcancen valores de crecimiento sostenible, tan elevados como sea posible (HÖHLER y LUKS 2004).

A su vez, la determinación del desarrollo sostenible como idea principal está atada a las teorías del desarrollo que pretenden la expansión de los valores occidentales (ibíd.). Por medio de la regulación, el control y la administración del medio ambiente deberían, intergeneracionalmente, desarrollarse estos valores de forma sostenible y ser transmitidos a otras regiones del mundo en donde puedan desplegarse (VANHULST y HEVIA, 2016; ALBÁN y ROSERO, 2016).

Algunos análisis del discurso plantean la hipótesis sobre una priorización de la equidad generacional del desarrollo sostenible y una marginalización de su dimensión intrageneracional (DINGLER, 2003). Esto implica, no una ampliación, como se estableció política y normativamente, sino un "desplazamiento discursivo hacia enfoques económico-ambientales." (ibíd.). El discurso hegemónico economicista va acompañado de una priorización de la equidad intergeneracional, el cual reemplaza los discursos sobre "una justicia social al interior de Alemania" (TREMMEL, 2003, p. 30; traducción propia) y el crecimiento. En la economía se trata a la equidad intrageneracional como un equilibrio en el mercado cuya asignación de recursos sea perfecta.

El discurso hegemónico lleva entonces a una exclusión "de otras percepciones sobre los problemas y sus soluciones" (ibíd.) y a una marginación éticamente inaceptable de los derechos humanos (MEYER, 2020, venidero).

Pareciera ser que en el ámbito político la adopción del concepto de desarrollo sostenible se ha transformado en una apropiación de este concepto a través del juego libre de poderes, en el que la ciencia funge como un comodín a costa de consideraciones éticas y teóricas (SCHULTZ et al., 2008; STIEFERLE, 2007) así como de una sensibilidad causal:

> La crisis global no es un problema técnico, ni siquiera económico. Es, fundamentalmente, un problema cultural y político, para el cual requerimos nuevas herramientas epistemológicas y éticas (AYESTARAN 2011, p. 213; traducción propia).

Adicionalmente, la ciencia de la sustentabilidad formula explícitamente una reivindicación pluralista. Si las estrategias del desarrollo sostenible de los discursos economicistas se imponen, no se les haría justicia a dichas reivindicaciones. En ese sentido resultaría imposible bajo una "cultura dominante de la in-sustentabilidad […] captar modelos de dependencia" (KAGAN, 2012, p. 11; traducción propia). Esto lleva a un auto-fortalecimiento circular de las situaciones in-sustentables (Figura 1).

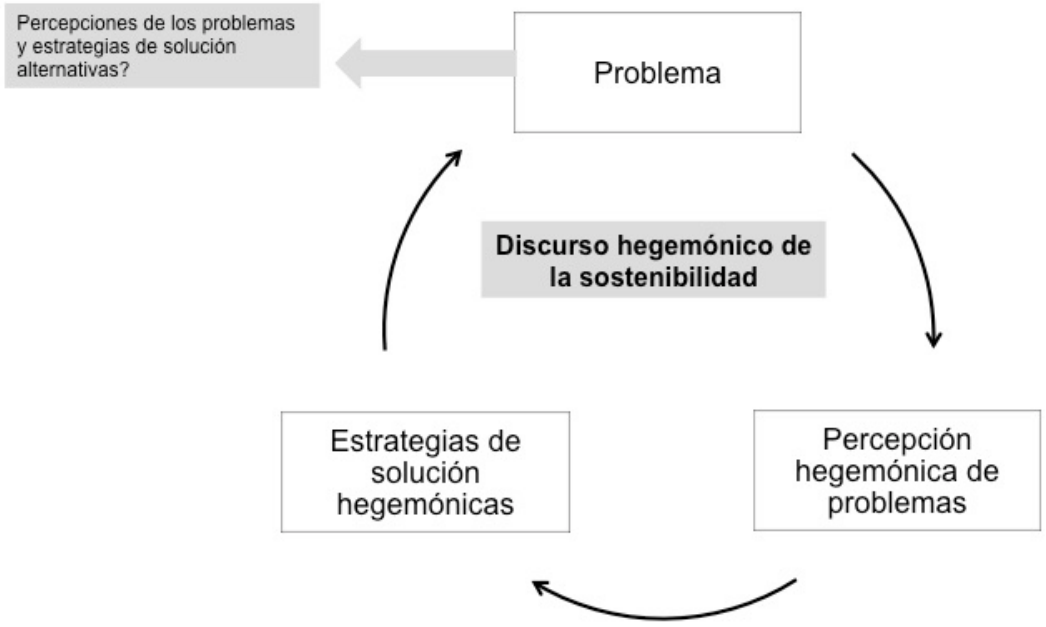

Figura 1 | Ciclo hegemónico.

Fuente: Elaboración propia.

7 INDAGACIÓN POR ALTERNATIVAS - DISCURSOS MARGINALIZADOS

De acuerdo con lo presentado, pueden distinguirse diferentes polos en torno al discurso sobre la sustentabilidad y el desarrollo sostenible, las tensiones hegemónicas que se sitúan dentro de estos y los conceptos que surgen a partir de los artículos reseñados. En una primera lectura, es llamativo que el análisis mexicano (SANTIAGO, 2009) tiende a denominar los discursos alternativos de la forma más diferenciada. Los estudios alemanes se centran en la indagación sobre el discurso hegemónico de la in-sustentabilidad, como un polo específicamente moderno (HÖHLER y LUKS 2004; DINGLER, 2003) para señalar la necesidad de teorías alternativas que impliquen un cambio en las formas económicas. Asimismo, buscan develar y nombrar estas teorías (MEYER, 2014). Así, surge la pregunta por el cómo y el dónde se pueden buscar estas alternativas en el interior de un marco de referencia sustentable.

De esta manera, debe prestarse atención tanto a la creación de otros dominios y cómo estos surgen desde las políticas neoliberales, como a los conceptos alternativos de la sustentabilidad, para que estos no puedan ni quieran apartarse del paradigma de la modernidad[6] de forma político-normativa. El pensamiento en términos de 'adentro-afuera de la modernidad' permanece igualmente preso de la lógica moderna de pensamiento.

Höhler y Luks resaltan la dificultad de la búsqueda por soluciones 'correctas' y alternativas sustentables, que sean a la vez críticas (o en lo posible sean éticamente sustentables) y comprobables:

> Si estos conceptos modernos están definitivamente condenados en relación con los objetivos de lo sustentable, no puede indicarse en un mundo contingente (HÖHLER y LUKS 2004, p. 63; traducción propia).

Con el análisis de los discursos sobre cambio[7] y alternativas (ibíd.) pueden conseguirse adicionalmente avances en el conocimiento a través del análisis de prácticas, situaciones (CLARKE, 2012) y casos (VILSMAIER et al. 2015).

En lo que sigue, vamos a esbozar el potencial de la investigación transdisciplinaria en sustentabilidad, para contribuir a un discurso crítico y diferenciado, que genere estrategias alternativas. Esta forma de investigación acoge explícitamente las diferencias, considerando perspectivas heterogéneas y auto-determinaciones culturales (VILSMAIER et al., 2017; ENGBERS venidero), está orientada hacia la cooperación y el aprendizaje mutuo, intentando con ello contrarrestar la marginalización y satisfacer las exigencias éticas de la sustentabilidad.[8]

8 IMPLICACIONES PARA LA CIENCIA E INVESTIGACIÓN EN SUSTENTABILIDAD

En cierta medida, el modo 2 de investigación incorpora la investigación transdisciplinaria con su "propia estructura teórica, métodos y prácticas investigativas" (HUNNECKE, 2006, p. 42; traducción propia) y nuevos criterios de evaluación de cualidades científicas (HUNNECKE, 2006; GIBBONS, et al. 1994).

> El Modo 2 de discusión ha provisto una contribución importante, la cual consiste en llamar la atención sobre la investigación transdisciplinaria" (VILSMAIER y LANG 2014, p. 94; traducción propia).

La investigación transdisciplinaria de la sustentabilidad aborda los llamados desafíos sustentables (*sustainability challenges*) como problemas del mundo actual y reivindica la demanda de interactuar con este mundo. El modo de investigación tiene el fin de poder generar un conocimiento orientado a la transformación hacia la sustentabilidad. En el modo de investigación transdisciplinaria, los/as científicos/as académicos/as investigan problemas sociales - y sus soluciones - con ayuda de métodos científicos en un proceso conjunto con individuos o grupos (políticos, económicos, de la sociedad civil) no involucrados en los ámbitos académicos (ibíd.). Todos los participantes de este proceso figuran como investigadores y participan conjuntamente en el proceso de investigación transdisciplinaria de la sustentabilidad.

En este tipo de procesos se busca generar diferentes formas de conocimiento (PROCLIM, 1997; VILSMAIER y LANG 2014):

I. Conocimiento sistémico: se trata del suministro de conocimientos (y experiencias) de los/as investigadores/as acerca de problemas y fenómenos socialmente relevantes en el proceso de investigación. De esta forma, se concibe la génesis del conocimiento como un proceso de búsqueda del entendimiento, reconocimiento, identificación, análisis y cuestionamiento.

II. Conocimiento meta: se entiende la normatividad en forma de valoraciones (en ocasiones inconscientes), los paradigmas y las convicciones políticas con el fin de hacerlos explícitos. Esto implica un trabajo diferenciado, la realización de discusiones públicas y transparentes y el no dejar a cargo de una élite académica las orientaciones basadas en sus propios valores (ZIEGLER y OTT 2015).

III. Conocimiento transformativo: este tipo de conocimiento debe garantizar que se alcancen los diferentes objetivos propuestos (por ejemplo peticiones y recomendaciones). En relación con las publicaciones, ello significa involucrarse más allá de los medios académicos ortodoxos.

Especialmente con el conocimiento meta es posible observar que en la investigación transdisciplinaria en sustentabilidad, los discursos dominantes pueden impedir una comprensión compleja de los problemas. En el momento en el que los paradigmas sociales dominantes generan evidencias y determinan opiniones, orientaciones y comprensión de los problemas, así como todo lo que es digno de ser dicho, se contradicen los elementos de una transdisciplina basada en las diferenciaciones y complementariedades.

Al mismo tiempo esta forma de investigación abre un espacio para hacer visible la problemática de la acción que ejercen los discursos dominantes. Tanto los efectos de supresión como los desplazamientos en los discursos sobre sustentabilidad y el desarrollo sostenible, retan al joven campo de la ciencia de la sustentabilidad como ciencia de la sustentabilidad (SPANGENBERG, 2011) a abordar activamente estos mecanismos. Un enfoque prometedor en este aspecto es la investigación transdisciplinaria dado que ésta se enfrenta crítica y explícitamente a estos desafíos.

A causa de su estructura pluralista, heterárquica y reflexiva, los principios de este tipo de investigación encierran el potencial de hacer visible, expresable y procesable al discurso de la sustentabilidad. En consecuencia, la investigación transdisciplinaria produce igualmente situaciones que se encuentran más allá de las estructuras hegemónicas actuales. Para ello, no es solo necesaria su adopción en la praxis de la investigación, sino también la elaboración de fundamentos teóricos, epistemológicos y metodológicos. Tales fundamentos posicionarían a la investigación transdisciplinaria en sustentabilidad como un modo de investigación complementario a las formas disciplinarias e interdisciplinarias.

Adicionalmente, se situaría como práctica de investigación en el umbral entre la investigación académica y la producción cotidiana de conocimiento y entre la institución de la ciencia y otras instituciones sociales. Esto ocurre porque la investigación transdisciplinaria no atiende únicamente a objetivos epistémicos, como es propio de la ciencia, sino que lleva en sí misma una reivindicación intervencionista dirigida a la transformación social para la implementación de una ética sustentable.

Con el posicionamiento de la investigación crítica en sustentabilidad en el espacio entre diferentes instituciones sociales y su búsqueda de formas poli-lógicas y meditativas de producir entendimientos y prácticas, puede crearse un lugar en el que los objetivos epistémicos y transformativos puedan ser tratados entrecruzadamente. De esta forma, los resultados de la investigación toman en cuenta los criterios científicos de calidad y a la vez ganan una fuerza social y cultural (GIBBONS, 1999; NOWOTNY, 2000; VILSMAIER et al., 2015) en dos niveles: (i) la pluralidad de conocimientos y entendimientos encuentran reconocimiento y significación; (ii) los diferentes objetivos de la sustentabilidad son abordados como un campo de tensión que puede ser adaptado desde una perspectiva de la ética de la sustentabilidad.

En línea con el trabajo de Bhabha (2004), una investigación transdisciplinaria y crítica en sustentabilidad puede comprenderse como un campo en el que las "estructuras, relaciones de poder y dependencias existentes se cancelan, al menos temporalmente, cuando las diferencias cognoscibles se articulan y con ello se vuelven tangibles" (VILSMAIER et al., 2017; traducción propia). Los espacios transdisciplinarios recurren y pretenden superar, las estructuras sociales establecidas, en tanto se crean espacios de investigación cooperativos entre los miembros de diferentes dominios sociales (ibid.). Estos buscan sobreponerse a las relaciones de poder en la producción del conocimiento al darles lugar a participantes de diferentes saberes culturales. Así, se podrían lograr transformaciones sustentables y reemplazar la unidireccionalidad en la transferencia del conocimiento y las estructuras decisorias por estructuras orientadas hacia conocimientos y aprendizaje mutuos (VILSMAIER et al., 2015). Con ello no se equiparan las disparidades, sino que las diferencias en la calidad y en el alcance de los conocimientos, los roles en las estructuras sociales y las posiciones basadas en los intereses e ideologías se entienden como conceptos que abren espacios para la fundamentación de una investigación transdisciplinaria crítica en sustentabilidad.

9 CONCLUSIONES Y PERSPECTIVAS A FUTURO

Mediante nuestro trabajo de análisis discursivo hemos perfilado la interconectividad entre los conceptos tanto de sustentabilidad como del desarrollo sostenible en los contextos discursivos dominantes, así como lo que ello implica para la ciencia e investigación en sustentabilidad. Hemos abierto un panorama sobre algunas diferentes comunidades lingüísticas.

Lo consideramos un inicio que, en su estado incompleto, requiere una respuesta. Reconocemos que como autoras estamos posicionadas en una situación histórica-cultural e lingüística especifica, y por lo tanto, limitada. Nuestro idioma materno es el alemán, hablamos el inglés y el español, pero no el portugués. Al igual, otras limitaciones de nuestra contribución están basadas en la metodología. Entonces, las escuelas de discurso analítico no se diferenciaron en el meta-análisis, y la selección de los conceptos investigados incluyen, y a la vez excluyen, hilos de discursos.

Este trabajo conceptual y reconfigurativo reanudará los planteamientos por alternativas, junto con un llamado general para el fortalecimiento del pluralismo en las teorías de las ciencias económicas y de sustentabilidad. Asimismo, deberían reconsiderarse los fundamentos ontológicos, epistemológicos y éticos de la sustentabilidad para un desarrollo posterior de teorías alternativas sobre las transformaciones en las formas de convivencia humana. Estas alternativas toman en consideración tanto las reivindicaciones sustanciales y normativas de la sustentabilidad (que podrían ser, por ejemplo, el cumplimiento de los derechos humanos y la conservación de la naturaleza como fundamento para la vida) como los entendimientos procesales y diferenciables sobre la normatividad. Así también se pueden encontrar y elaborar enfoques filosóficos correspondientes (MEYER, 2020, venidero).

Los planteamientos sobre la investigación en sustentabilidad, en lo que se refiere a las formas de conocimiento transdisciplinario descritas anteriormente, contribuyen a la generación de un conocimiento meta, al abordar aspectos éticos y culturales. De esta forma, y como complemento al conocimiento sistémico y al transformador, los entendimientos producidos por estos conocimientos representan momentos transformativos, que se basan en una argumentación ética, a través de la cooperación y el aprendizaje mutuo. Con ello, la investigación transdisciplinaria crítica fortalece, bien sea como ciencia de la sustentabilidad (SPANGENBERG 2011) o como investigación transformadora (WBGU, 2011), la fractura de los órdenes hegemónicos y complementa así los entendimientos sobre las formas de vida (in)sustentables.

El desafío intelectual es investigar de forma colaborativa e intercultural, y aprender unos de otros sobre la dinámica discursiva y contra-hegemónica de *sustainability*, entre distintos espacios y culturas, entre diferentes contextos históricos socioculturales, económicos y políticos en los distintos continentes (ibíd.) para apoyar proyectos autónomos basados en la diferencia cultural (VILSMAIER et al., 2017). ¿Cómo problematizamos, por ejemplo, *global modernity*?

La comprensión de las formaciones discursivas en distintas regiones culturales y políticas, académicas y sus contingencias históricas facilita la visualización de las diferencias y los engranajes entre discursos. Contrariamente a una sola deconstrucción crítica histórica de su propia posición europea, consideramos comprensiones de otras dinámicas discursivas, otras narrativas como las condiciones para la posibilidad del cambio, la moción y la reconfiguración.

> (...) science of the emergent paradigm also claims to be a translator. That is to say, it encourages the emigration of concepts and theories developed locally to other cognitive spheres and their utilization outside their original context. It is knowledge about the conditions of possibility […] of human action projected into the world from local time-spaces (SOUSA SANTOS, 1992, p. 38).

El desarrollo de metas normativas, como intentaba con efecto en el caso de los 'Objetivos de Desarrollo Sostenible' en el año 2015, debe atender y representar los diferentes contextos culturales, políticos,

económicos, históricos y en particular las concepciones de la naturaleza, de seres humanos, de comunidades, las prácticas de apropiación y las formas de la pertenencia.

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NOTAS

1 | Ökonomistische Diskurse der Nachhaltigkeit: Bestimmende Momente und die Frage nach Alternativen. En: Pfister, T.: Nachhaltigkeitswissenschaften und die Suche nach neuen Wissensregimen. Metropolis.

2 | Como término de búsqueda se usaron los siguientes: (Sustainability* AND discourse). Las metodologías del discurso, así como las diferentes orientaciones sobre el análisis discursivo de las publicaciones no son tratadas aquí.

3 | CCP – Complexity or Control? Paradigms for sustainable development.

4 | 'Nachhaltigkeit und Macht. Zur Kritik von Sustainable Development'

5 | NEDS – 'Nachhaltige Entwicklungs zwischen Durchsatz und Symbolik'.

6 | Por ejemplo, entre los objetivos de la sustentabilidad de izquierda, se encuentran los cambios estructurales al interior de las sociedades modernas –y sus categorías de pensamiento–, los cuales se asignan "a la capacidad de enlace de las alternativas al predominio actual de los mercados de capitales" (SCHACHTSCHNEIDER 2007, p. 137; traducción de las autoras; HÖHLER y LUKS 2004).

7 | "Así, pertenece a varias perspectivas la creencia en el crecimiento perpetuo, el avance lineal […], las cuales se reúnen bajo las etiquetas de 'proceso' y 'cambio'" (KAGAN 2012, p. 38; traducción propia), tal y como "el fenómeno del crecimiento económico […] entendido como sinónimo de progreso y cambio" (STEURER 2002, p. 114; traducción propia).

8 | En el presente trabajo no nos ocupamos de la definición normativa y prescriptiva de la ética de la sustentabilidad. A este subyace la premisa del reconocimiento de su existencia.

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Globalization and consumption: a case study of cool roofs as a socio-environmental alternative

Globalização e consumo: um estudo dos telhados brancos como alternativa socioambiental

Anderson Luiz Godinho Belem[a]

Bruno de Borowski[b]

Mairon Melo Machado[c]

[a]Instituto Federal de Ciência e Tecnologia Farroupilha, São Borja, RS, Brasil
End. Eletrônico: andebelem@gmail.com

[b]Instituto Federal de Ciência e Tecnologia Farroupilha, São Borja, RS, Brasil
End. Eletrônico: brb2@outlook.com

[c]Instituto Federal de Ciência e Tecnologia Farroupilha, São Borja, RS, Brasil
End. Eletrônico: mairon.machado@iffarroupilha.edu.br

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ABSTRACT

Globalization and consumer society are discussed in their environmental biases and with a transition between global and local scale. From experimental research, the effect of white roofs for temperature reduction in internal buildings at São Borja-RS is investigated. Practical experimentation makes use of habitats, with asbestos cement tiles. Graphs and statistical analysis were used in the study. It was verified that, in days of sun predominance, the habitations with white tile had 2 °C of temperature less than the gray tile, being this smaller in cases of cloudy or rainy weather. It has been estimated that, as a consequence of the lower temperature under ideal conditions, a white tile will result in a reduction about 4.4 kWh/year/m² in electric consumption with air conditioner, which translates into approximately R$ 2.00/year/m² (energy values at São Borja). Despite the appreciable reduction in average temperature, the financial return will be in the long term.

Keywords: Domestic Economy. Sustainability. White Roof. Consumer Society.

RESUMO

A globalização e a sociedade de consumo são discutidas em seus vieses ambientais sob uma transição escalar do global para o local. Enquanto o efeito dos telhados brancos para redução de temperatura interna em edifícios de São Borja-RS trata da parte prática. A experimentação prática faz uso de habitáculos, com telhas de fibrocimento. Gráficos e análise estatística foram empregados no estudo. Verificou-se que, em dias de predomínio de sol, os habitáculos com telha

branca apresentavam 2°C de temperatura a menos em relação a da telha cinza, sendo essa diferença menor em casos de tempo nublado ou chuvoso. Calculou-se que, por consequência da menor temperatura, sob condições ideais, uma telha branca irá resultar em uma redução de cerca de 4,4 kWh/ano/m² em consumo elétrico com condicionador de ar, o que se traduz em economia de aproximadamente R$ 2,00/ano/m² (valores da energia em São Borja). Apesar da redução apreciável na temperatura média, o retorno financeiro é em longo prazo.

Palavras-Chave: Economia Doméstica. Sustentabilidade. Telhados Brancos. Sociedade de Consumo.

1 INTRODUCTION

With growing energetic demand, coming from the expansion of development based on production and consumption that adapts and globalizes from mercantile capitalism, intensified after the recent technological revolutions, the degradation of natural capital occurs at an accelerated pace (MILLER and SPOOLMAN, 2013) Among the environmental problems generated, Goldstein (2009) exposes the increase of greenhouse gases emission (GGE), which brings as its main consequence the global warming.

With the advent of industrial revolutions and the consequent shift in the development of societies, cities are gradually becoming the *locus* of human. Changes in the territorial organization with the development of national states and the legitimacy of private property as a pillar of the current social organization led to an intensification in urbanization. However, only when technology reaches the countryside (Green Revolution) does the urban area start to concentrate populations, also in less developed countries.

Since the Cities and Biodiversity Outlook (2012), even considering the best scenarios, the urban areas will reach, until 2030, from two to five times more than now. It implies in a series of environmental consequences, as exacerbated consumption of water resources and agricultural land, a considerable loss of biodiversity and ecosystem services, add to consolidating climate change from local to global scales. In the same document, it exposes that the tendency to increase urban areas occurs preferably in less developed countries.

In this context, local scales of analysis present a list of problems related to the climate, which the thermal inversion, urban canyons, acid rains, heat islands, among others.

It is a fact that the highest concentration of humans occurs in intertropical and temperate northern thermal zones. The first one is remarkably hot and the second, with intense summers and winters in most of its climates, favors the use of appliances with the function of conditioning the air in restricted environments. It is worth mentioning that such equipment requires large amounts of electrical energy for its operation, and that the production of electrical energy directly involves the degradation of natural capital, as well as many times, the elimination of important environmental services to a greater or lesser degree.

One of the alternatives to avoid excess health, on the summers, at the edifications, and then avoid the indiscriminate use of home appliances and electrical energy to cool those places, are the cool roofs (white or green). White roofs painted by clear colors avoid the health excess. The green roofs are denominated since it is a vegetal cover, avoiding the sun exposition of buildings.

This study will discuss the relation between the city, the consumption society, and the environmental consequences of this process at different scales. The main goal will be featured in an experimental study to evaluate the technician of the cool roofs for buildings considering the geographic conditions of São Borja-RS.

2 FROM CONSUMER SOCIETY TO UNSUSTAINABILITY OF URBAN ENVIRONMENT

The more recent facet of capitalism is the use of information in real-time. Since it's become, practically hegemonic, the real-time information taken on civil meaning and turn itself a triumph of the biggest corporations per consumer goods' industry and financial market. Therefore, globalization earns velocity and intensity. Santos (2011) claims the process is perverse, and there is an urgent need for changes in the logic of globalization, keeping the characteristics of communities without enforcing a socioeconomic and sociocultural homogenization.

In the productive context, Ortigoza (2009) explains that with the informational capitalism, the main productive activities are organized with a global way taking use of a geographic network, also global, of production, competition and consumption and this structure reaches local networks homogenizing them at. Santos (2005) says that networks own character of materialism and action, being the mean by which pass the production, the good's movement, and the information. To Santos, this is how the universal is transposed to local scales.

As a product, geographic space will be consumed. It happens, as says Ortigoza (2009), by global pressure which creates public management organized to attack the capital, passing by cities homogenization to the detriment of the real population's necessity. It is worth noting that in this production-consumption logic, in the informational capitalism, the governments are seeing as articulators among owners of the mode of production and the consumers. Meanwhile, the small communities are ultimately materialized the production process at its landscapes. This process is the meaning characteristic of the actual international's division of labor, deterritorialization and national's states weakening at the neoliberal's logic.

These socio-spatial dialectics are directly linked with a consumption necessity that emerges, then, for the system's maintenance. The social relations are calculated by the capacity to obtain products, the 'get' overwhelm the affective moments of life. Inside of this logic, the consumption will be the greatest manager of global society, turn to object even the proletarians and their way of life, also. Lefebvre (1991), explains that this is the consumption society, society of ephemeral, of planned obsolescence, of the constant necessity of 'get'. In this context cities are consumption's spaces and the urban way of life is the cities substance.

The relation with the environment is evident in this context. Cortez (2009) expounds that the environmental crisis is also social, and this modus operandi is environmentally unsustainable, socially unjust, and morally indefensible. This affirmation resolves around of the environmental system fail to supply the increasing demand created by this same production-consumption itself, of environmental crisis who destroys the ecosystems regenerator's capacity, and concentration of wealth. The concentration which recently grew in developing countries is back to growth into developed countries (UNITED NATIONS, 2020).

Although, when the perception of the trigger process of the environmental crisis is emphasized, new points of view are proposed. The international conferences that occur time by time, for decades, for countries to discuss improvements about the global environment, show how these questions become political and economic. Examples of it were the confronting proposes of zero-development (zero-growth) and third countries' propose of developing by any costs, nowadays the discussion about and how it would work a "Green Economy", and, which level of global warming will be accepted.

What is observed, as a result, as illustrated by Cortez (2009), is the responsibility's transfer in environmental terms: Governments and Markets are allied, into a perverse logic, put the responsibility on consumers. At the same time, they must adapt to new technologies, new products, increasing consumption, creating new markets and don't abandon the lasts.

As from these ideas, new concepts are created, as "responsible consumption", "conscious consumption", "ethics and cooperative commerce", "green consumption" or, still, "sustainable consumption".

For Toni et al. (2010) "conscious consumption" would be an environmental and socially responsible lifestyle. Cortez (2009) explains, ethics and supportive commerce relate to the whole productive chain, from primary producer to consumer, but don't argue explicitly about environmental issues. However, that one becomes fundamental when ethics will involve each life aspect on Earth.

Responsible consumption dealing with costumers and your rights, and, must claim to understand the whole production process: origin, prices, value's distribution, earns of the producers and traders, etc.

A different designation, adopted by the market, is "green consumption", according to Consumers International manual's (2005). Its objective is to provide for consumers the choice of power for products that, in its production chain, do not cause environmental problems. The critical to "green consumption" occur when just a few brands can distribute their products to customer markets, constraining the consumer's choices to few possibilities. Furthermore, the green costumer just pays attention to the tech aspect and usually consumes expanses products, so, the biggest part of the population can't be a green costumer. Another concept tries to put together both perspectives: Sustainable consumption. Although, regardless of the term used, Cortez affirms:

> Most of the people in industrialized countries continue on a rising consumption route and many others, in developing countries, stay stuck in poverty. To promote a new role to consumption, any vision will need to include answers to four key issues: If global consumers class will have a better quality of life caused by their growth level of consumption; If societies may have the consumption with a balanced way, especially harming the natural environment with consumption; if societies can reshape consumer options for genuine choice; and if societies can prioritize or meet the basic needs of all (CORTEZ, 2009, p.59).

Considering cities as consumption spaces and dwelling place of humans, it is observed that despite the rhetoric, increasingly focused on sustainability. In countries less developed this is a distant reality. Davis (2006), in his review work, concludes that this is a Planet of Slums. In a chapter called "Slum Ecology", he puts in evidence the socioenvironmental result of exclusion and marginalization process, the union of inhumanity condition of life allied with extreme insalubrity, as well possible predictable natural disasters. Thus, despite the fast city's growth, the population's wellbeing, which depends on environmental quality, does not keep pace.

The Cities and Biodiversity Outlook (2012) shows that rates of urbanization, in South American countries, are bigger than, for example, European developed countries. This process was intensified by military governments, who, from the sixties to eighties, foster, in the region, economic politics based on green revolution in the agricultural sector, without making an agricultural land reform promoting conflicts in the fields and disorganized urban expansion.

"Green Revolution" was a group of technologies proposed, in the sixties, by developed countries (mainly the US) as a solution for the problem between population growth and food production. Novaes (2012) explains the main consequences of this process: changes at land's primitive accumulation cycles that to establish violence, stole and land fraud as a process (Murder of leaders, indigenous land's invasion, public's conservation units, manual and intellectual expropriation of the traditional population, forced migration); private land's expansion connected to multinational companies, implementation of technology and machinery, transgenic seeds and pesticides that just a few companies own patents.

This millennium for the first time in history occurred an inversion between rural and urban areas, on a global scale (United Nations, 2019). Nowadays, more than 50% of the world's population lives in urban areas, and the prediction for 2050 is 70% and a third part in slums. A large part of this urbanization process is related to the green revolution, but, once sold by developed countries, through the United Nations (UN), as a solution for world hunger, helped a fast and large-scale rural exodus in developing countries (NETTO, 2013).

Therefore, by more theoretical-conceptual instruments, technological tools or even in uncounted politics, the environment is thought of as a secondary meaning compared to the attention paid to economic development. After almost 20 years, words of Santos still demand attention, may the results of all the process suggest an intensification of urbanization, labor's expropriation by rural exodus and inequality expansion in the cities (DAVIS, 2006) and reification of the environmental issue who becomes a product (CORTEZ, 2009) more and more meager in urban landscapes, even being inherent for earth's life.

3 CONTEXTUALIZING THE WHITE ROOFS

Using a scale appropriated, the previous discussion should be tuned specifically to the urban space. The attempts to establish an order in this intense human-nature relationship go through planning. Monteiro comments that:

> By encompassing the natural foundations that outlined the first elements of a space that added the entire social product of work, mirroring a culture, the city encompasses political action (moral and ethical), aesthetic mediation, reconciling the functional use with the beautiful, in a highly accumulated congregation of conflicting interests, requires the validity of a social pact, governed by a legal order that ensures adequacy and equity to what is produced by the technique. (MONTEIRO, 2008, p.80).

In practice, there are many difficulties to overcome an economic view of space that materializes in hostile relations towards nature, especially in the urban environment. However, paying attention to environmental issues, it is a fact that human beings need environmental quality: clean air, clean water, agricultural land, among others, and became developed. (NUCCI, 2008).

Considering the weather, Lombardo (2009) explains that the relation between global and local scale is extremely complex and does not occur in a simple model. Moreover, the influence of city temperatures is irrelevant to the global size, once the build surfaces are only 1% of the terrestrial surface. However, concerning the launch of GHGs, the current consumer society is extremely relevant:

> Due to the increase in energy expenditure (for domestic use, transportation, for industrial purposes, among many others, dictated by a constant need to reduce distances and raise the standard of living (KANN, 2006), cities are the most important sources GHG emissions, contributing about 85% to the total emissions of CO2, CFCs and tropospheric O3 (OKE, 1997). The high density of pollutants in the urban plume affects the chemistry of the atmosphere and the climate on a large scale (CRUTZEN, 2004). According to some authors, the increase in convection, as a result of warming over urban areas, may contribute to the transport of water and pollutants to the medium and high troposphere, with potential consequences at regional and global levels (CRUTZEN, 2004; SHERWOOD, 2002) (LOMBARDO, 2009, p.116).

She continues and explains that in a general way, there is troubles associated with changes at radioactive balance, alteration near atmosphere circulation, an increase of atmospheric pollution, convective precipitation, and formation of urban heat islands (UHI), all of these created by environment degradation which anthropic origin.

Talking about the UHIs phenomena, Costanzo et al. (2016) attribute to the high population density additional warming, which would characterize the phenomenon. Amorim et al. (2009) explain that the main definition of UHIs is the differences in land use that exist between areas with building density, the concentration of materials with great energy potential for emissivity and reflectance, as well as urban activities that release heat in the surrounding atmosphere, and also areas with characteristics opposite to these (rural or peri-urban). This effect, coupled with the fact that there are regions on Earth

that, at least during certain periods, are naturally hot and humid, boost the demand for equipment that alleviates the sensation of heat, such as fans and air conditioners. Such equipment, despite making an isolated environment more comfortable, contributes to the launch of GHGs through energy consumption and, sometimes, the equipment itself.

For example, an air conditioning of 12.000 BTU/h will do, besides transfer almost 3,5kJ of energy per second (heat pull out of ambient – approximately 3,5 kW) from ambient to another, to dissipate energy with a power of approximately 1 kW, mainly because of the electric consumption of the equipment, as related by Ananthanarayanan (2013) and Tipler and Mosca (2012).

Cortez (2009) comments that there was, in Brazil, energetical loss higher than 50% in terms of refrigeration of commercial buildings, its uses would not be rationalized, and adequate equipment was not used. It was only in 2018 that the maintenance of air-cooling equipment becomes mandatory for public and private service environments, according to the Law 13.589/18.

Lombardo (2009) explains that among the motivations to UHI existence are: heat emission of anthropic origin; different materials with the capacity to accumulate thermal energy during the day and release it at night; changing the roughness of urban sites; reduction of evapotranspiration due to the lack of free building spaces with the presence of vegetation; changes in the radioactive balance due to the construction materials and the colors used on the surfaces.

Considering the UHI effects on the human being is important to stand out the thermal comfort of the species. The subject matter is a little bit controversial because cultural aspects imply in variations of the ideal temperatures. However, some measurements can be introduced, as in Figure 1, to analyze relative humidity and temperature.

The planning, in this way, suggests active solutions in the face of the urban climate and the creation of a system of free spaces, afforestation, green areas, and exposure of water slides. These solutions can generate improvements in thermal comfort, stabilization of surfaces, better air quality, and decrease of the sound pollution, among others.

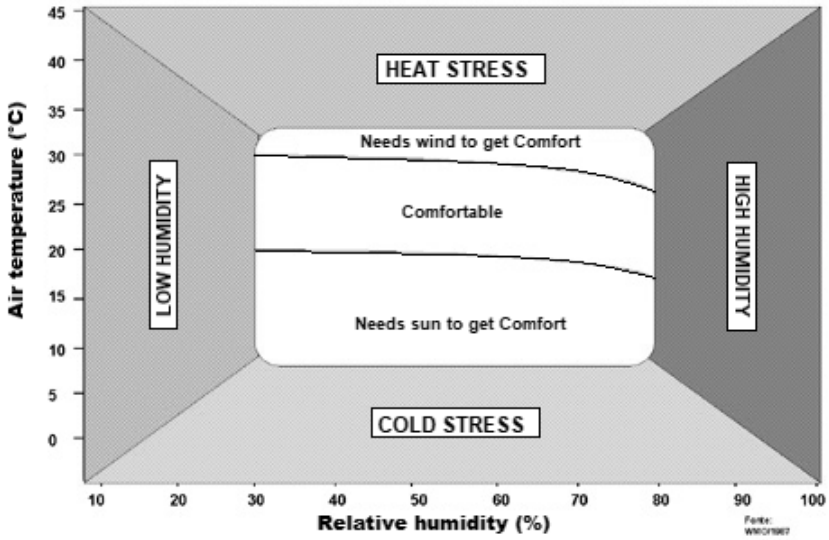

Figure 1 | Human thermal comfort.

Source: Portal do Instituto Nacional de Meteorologia, 2020.

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At building the residences, when solar radiation reaches the roof surface, some of the energy is reflected, and all the remains are absorbed (SABER *et al.*, 2012). The absorbed part results in an increase in the temperature at room surface, and consequently, an increase in the residence temperature. Because of it, under unfavorable conditions, the sunlight absorbed increases the cooling costs in buildings and houses with air conditioning, worsens thermal comfort and mortality during heatwaves, according to Sproul et al. (2014). Therefore, the development of alternative systems to minimize these effects is beneficial for society and the environment.

One of the existing alternative systems is the photovoltaic panels. The use of these panels on the roofs maximizes the use of solar energy by absorbing it and converting it into electrical energy. However, Beise (2004) explains that due to its still relatively high cost, this kind of alternative medium has little use, except for higher social classes. Other alternatives, suggested by Saber (2012) and by Sproul (2014), are painting the roofs with light colors, a proposal called the white roof and the cultivation of plants on the roofs and slabs called green-roof.

A partially or entirely covered roof by some vegetation is called “green” (SPROUL *et al.*, 2014). This characteristic gives to the green roofs the capacity, according to Smith e Roebber (2011), to cool the room – via an effect called cooled by evaporation – provision of habitat for biological life, improvement of air quality through the filtration of pollutants, some thermal insulation, among others.

About the white roofs, Ramos (2017) explain it via the application of reflection property of light colors, resulting in lower thermal absorption. The principle that justifies white tiles use, which goal is to soften the temperature in an inner room in comparison to the external place, occurs by the fact of the cover of a build, during the day, is under constant sunlight. Therefore, the luminosity will be converted into thermal energy, warming the inner room, an unwanted effect at hot weather (TESTA e KRARTI, 2017). To Levinson and Akbari (2010), in those situations, to reduce the thermal gain of the roof, advantages occur in reducing electrical consumption, since the use of electronic equipment designed for this purpose will not be the same (fewer hours of use during the day).

The white roof is explained by a physics phenomenon that light colors reflect more sunlight, going to lower energetic and thermal gains. Generally, roofs are painted with some white paint or acquired with this color, being used mainly in hot weather, due to the “heat” reduction. Because of its simplicity and easy application, the white roofs are strongly considered as an alternative to the thermal comfort and less use of air conditioning (LEVINSON E AKBARI, 2010).

The temperature is a measurable property of a system that expresses the kinetical energy inner it, that is, the molecular agitation. The Law Zero of Thermodynamics states that two or more bodies with the same temperature are in thermal balance (HALLIDAY *et al.*, 2009). This thermal balance is the natural state in which bodies not isolated tend to stay. For multiple bodies in different temperatures, the thermal balance will occur with energy flow among them, by either conduction, convection or thermal radiation.

The heat transfer by conduction, considering any cabin, will occur between the external air and the tiles of the build, and to minimize the heat inner the room, the thermal conductivity of the materials must be as small as possible. The color of the roof does not affect this property, so is not relevant to treat the white roof, but very important to apply regarding thermal insulation and heat reduction.

Siegel (2001) explains that all substances with a temperature higher than 0K lose energy via electromagnetic waves. This phenomenon is called thermal radiation. The radiation emitted by substances has any frequency levels, being the most common those located between infrared and visible light.

In the context of white roofs, it is important to know about thermal radiation and emissivity to recognize that the painting of a roof may or not have a significant effect, depending on the material on which it is applied, but it does not directly depend on the color of the paint.

Regarding wave phenomena, both reflection and absorption are relevant to white roofs. Once the roof is white, that is, it has all the colors of the visible spectrum reflected from itself, it will be absorbing only a part of the energy involved, avoiding the unnecessary entry of thermal energy into the room. White roofs can be improved, according to Xue et al. (2015), if they have a white coating based on a styrene acrylate copolymer, which can cover the entire visible spectrum and a large area of the near-infrared.

The city of São Borja, as most of the cities from the Rio Grande do Sul, is classified, according to Instituto Brasileiro de Geografia e Estatística (IBGE, 2018), as mild super humid mesothermal climate, that is, with average temperatures between 10 °C a 15 °C and without drought periods. Once the ambient temperature on the summer exceeds 40°C, higher than the tolerance range for human thermal comfort, the use of air conditioners and fans to soften the "feeling of heat" becomes a frequent action and constitutes a favorable location for the use of sustainable roofs.

4 METHODOLOGY PROCEDURES

The research makes a theoretical revision about the globalization process nowadays and discusses themes of consumption, planning, and environment urban troubles. It shows alternatives for heat reduction at builds.

The experiment consists of monitoring and register, by automatic thermometers, the inner temperature of two wood cabins with fiber cement roof tiles, one painted in white and another painted in gray, searching to verify and quantify the temperature difference in the environment as a function of roof tile color.

4.1 FIRST STEPS

Using three digital thermometers *data logger*, contact kind, with inner memory to save the data, of *Instrutherm*® enterprise, HT-810 model. Some tests performed to calibrate it, verify if the units are showing the same temperature, being in same the conditions. In a few days, the thermometers were disposed side by side, recording the temperatures. The difference between them was minimum (lower than 0.1 °C).

Two identical cabins were made, built of pinewood and with the following dimensions: Lenght - 1m; width – 1m (1m² of the area); 0.7m of height (Figure 1), organizing the cabins by following the proportion of a middle-class house in the region.

Figure 2 | Image of cabins with gray and white roofs.

Source: Author, 2017.

A tile roof of fiber cement with a thickness of 6mm and 2m length x 1m width, cut in two equal pieces of 1m² each, to stay without clearance above the cabins.

4.2 EXPERIMENTAL SETUP 1: CHECKING OUT AIR TEMPERATURES

All the preliminaries tests, as well as some definitive experiments, measured the inner (air) temperature inside the cabin. In these cases, the thermometers installed to measure the inner temperature were placed in the center of the box facing north, at a height of approximately 40 cm above the base of the box. To avoid direct heating due to the wooden walls, small Styrofoam plates placed between the thermometers and the walls, totaling around 2cm thick.

4.3 EXPERIMENTAL SETUP 2: CHECKING OUT TEMPERATURES WITH WATER

After the analysis of data obtained only with air experiment, it was found that temperatures varied very sharply, fluctuating very quickly compared to what was expected for an indoor residential location. To improve these results, it was decided to use water in the experiment, to create thermal inertia inside the houses.

The experiment with water consists of two 18L cans with 10 kg (and 15kg in another experiment) of water. The thermometers were disposed on the water surface, the cans at the cabin center, with the same distance between can and walls. The water allowed to make basic evaluations of energy.

5 RESULTS

Four experimental tests were done with the thermometers in the cabins, each one in different periods and weather conditions. Each experiment has changed some specific aspects, as the change of the place of room thermometer and measurement of water temperature. The data were collected by a *data-logger* thermometer, which registered it at a rate of one per minute, in all cases.

5.1 SIMPLE TEST WITHOUT WATER 01: AUGUST 2017

The room thermometer was in a place far from the cabins, fixed in a wall with shadow permanently, in a covered area. (Figure 3). Note that the line of air temperature in the white roof gives lower temperatures than the gray roofline, while the room temperature line is a basic reference.

It is possible to see that there are time intervals in which all thermometers were registering similar temperatures. It occurs at night and when the weather was cloudy or raining, situations in which solar light intensity is weaker or null.

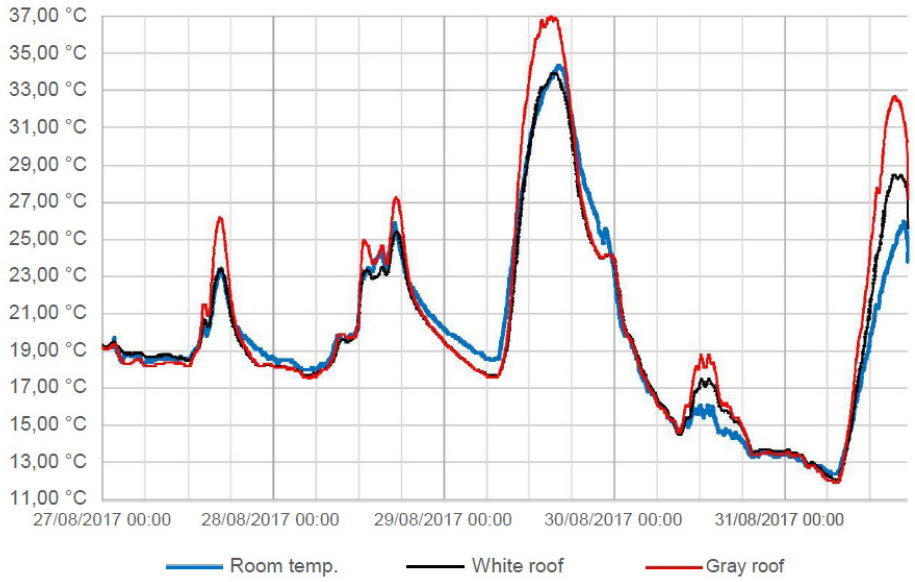
A general arithmetic average of all temperature values was performed between 00:00h of 27th until 17:00 on 31 August. This generally represents a reduction of 0.57 ° C due to the color of the roof.

It considers the night period, where it is not expected any difference because of the roof colors. Making an arithmetic average of the same temperatures considering the only solar light period, we obtain different results, shown in Table 1.

The results of table 1 suggest that the temperature difference during the day is almost always greater than 0.57 ° C. Assuming that only the 29th and 31st of August had full sun, the average daytime temperature reduction was 2.59 ° C, while on a cloudy or rainy day (27, 28 and 30) there was a reduction of approximately 0.65 °C.

With maximum temperature relations, August 29 provided high temperatures. The maximum room temperature reached 34.2°C, while maximum inner temperatures of cabins were 33,9°C (white roof) and 37°C (gray roof), a difference more than 3°C.

Graphic 1 | Results obtained with first experimental test.



Source: Author, 2017.

Table 1 | Arithmetical temperature average of first experimental test, in sunny periods.

Days and intervals	*Test 01 – Average of registered temperatures*			
	Room	*White Tile (TW)*	*Gray Tile (TG)*	*ΔT (TW – TG)*
27/08 – 08HS TO 18 HS	19.96°C	20.07°C	20.61°C	0.51°C
28/08 – 08HS TO 18 HS	22.25°C	21.94°C	22.74°C	0.80°C
29/08 – 08HS TO 18 HS	29.65°C	28.99°C	31.50°C	2.51°C
30/08 – 08HS TO 18 HS	15.09°C	15.95°C	16.55°C	0.60°C
31/08 – 08HS TO 18 HS	20.15°C	22.06°C	24.74°C	2.68°C

Source: Author, 2017.

5.2 SIMPLE TEST WITHOUT WATER 02: SEPTEMBER 2017

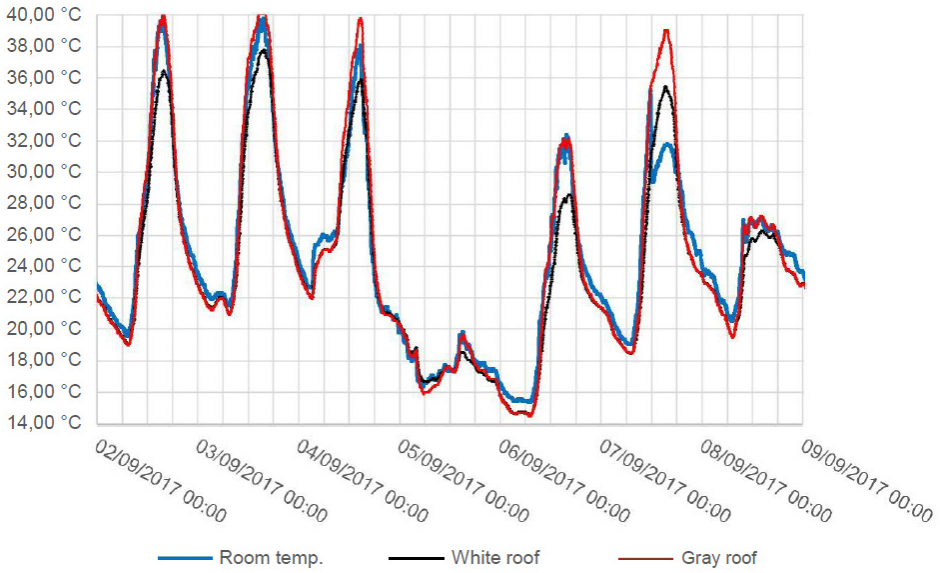
Between the first and nine days of September, another experimental test was made. Now, the unique difference was the local of room temperature thermometer, which is fixed to the outside of the south face of the house with the white tile, separated from the wood itself by two 10mm plates.

The data between the Day 2 until 00:00hs of the ninth day (complete data), gives similar results as the test before, a reduction of 3° in the daytime (Figure 4).

Making the arithmetical average of the periods with some incidence of sunlight, as made before, the data shown in Table 2 are obtained, which points to an average temperature reduction about 2.20 °C, at best, and below 1.00 °C in unfavorable situations (with low solar radiation).

Although the results considering only the air temperature be partially consistent with each other, it is not possible to verify, intuitively, the economic viability with those data alone. Besides, the inner temperatures of the cabins varied very quickly during the day, becoming like the ambient temperature in a short time, a fact that was not expected for a full-scale house, whose internal temperature oscillates more slowly.

Graphic 2 | Data obtained with the second experimental test.



Source: Author, 2017.

5.3 TEST WITH WATER: SEPTEMBER 2017

Since the fast variation of inner temperature verified in the previous tests, search to introduce elements that increase the capacity and thermal inertia inner the cabins. We choose to use water because its specific heat *c* is higher than other materials (4.18J/g * K) (BAUER et al., 2013).

The test made between the 19th and 21st days of September and the data is in Table 2. It is possible to see that the inner temperature oscillation is more smooth to those lines of room temperature, even with an all sunny day (Figure 5).

Table 2 | Average temperature at day periods of the second experimental test.

Days and intervals	*Test 02 – Average of registered temperatures*			
	Room	*White Tile (TW)*	*Gray Tile (TG)*	*ΔT (TW – TG)*
02/09 – 08HS TO 19 HS	31.94°C	30.16°C	32.19°C	2.03°C
03/09 – 08HS TO 19 HS	33.91°C	32.58°C	34.60°C	2.01°C
04/09 – 08HS TO 19HS	30.33°C	30.18°C	32.04°C	1.86°C
05/09 – 08HS TO 19HS	18.00°C	17.67°C	17.86°C	0.19°C
06/09 – 08HS TO 19HS	26.30°C	23.89°C	26.29°C	2.40°C
07/09 – 08HS TO 19HS	29.60°C	29.98°C	32.65°C	2.67°C
08/09 – 08HS TO 19HS	25.92°C	24.95°C	25.78°C	0.83°C

Source: Author, 2017.

From the data, it is possible to do the temperature average (table 3), with similar results that before, with a difference about 2°C at medium temperature (during the day) because of the white color of the roof.

Table 3 | Temperatures average at day periods with first water tests.

Days and intervals	*Test 03 – Average of registered temperatures*			
	Room	*White Tile (TW)*	*Gray Tile (TG)*	*ΔT1 (TW – TG)*
19/09 – 08HS TO 19 HS	32.18°C	25.11°C	27.32°C	2.20°C
20/09 - 08HS TO 19 HS	36.42°C	28.73°C	30.77°C	2.04°C
21/09 – 08HS TO 17H15MIN	35.10°C	28.27°C	29.99°C	1.72°C

Source: Author, 2017.

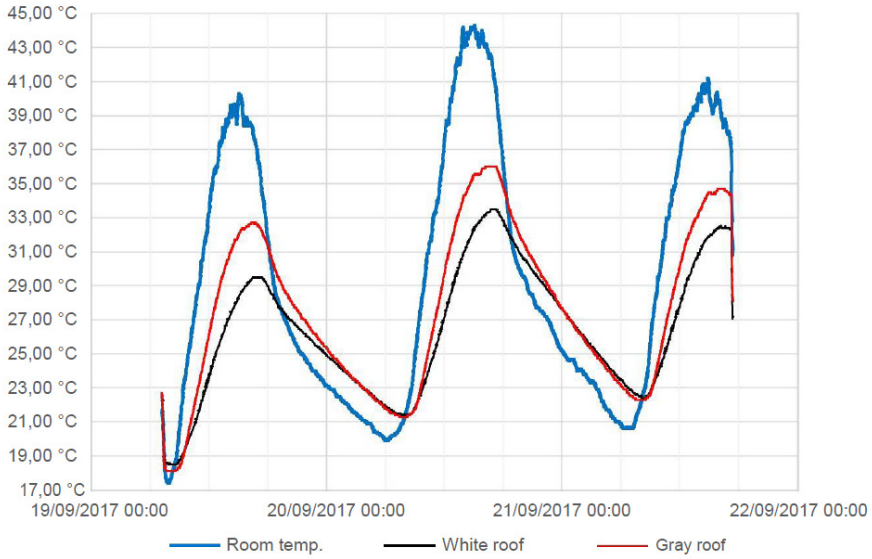
In terms of lower and higher temperatures to each date, our values are been presented in table 4. It enables, together with the difference between these values (ΔT2) of water temperature inner the cabin, the potential value of financial saving.

The temperature variation (ΔT2), water mass (m) (despise evaporation loss) and the specific heat of water (*c*), is possible to evaluate the quantity of thermal energy (Q) absorbed by white and grey roofs, considering the equation $Q=mc\Delta T2$ (HALLIDAY et al., 2009b).

With this information, it is possible to convert the caloric value (kJ) in energy, at kWh unity, and, since the energy charge by kWh is R$ 0,452/kWh (São Borja data), is easy to evaluate the financial save considering the roof painted, in comparison a one air conditioning (Table 5).

From the results of table 5, an electric energy saving prospect was calculated based on the experiment which shows, for sunny days, savings of less than half a penny per day for each square meter of cooled painted area (since the miniature houses had an area of 1 m²) roof).

Graphic 3 | Graphic representation of data obtained with water tests.



Source: Author, 2017.

Table 4 | Values of high and low temperatures to the water in cabins with white and gray tiles.

Date	*Low Temperature*		*High Temperature*		*ΔT2 Difference*	
	White Tile	*Gray Tile*	*White Tile*	*Gray Tile*	*White Tile*	*Gray Tile*
19/09	18.6°C	18.1°C	29.5°C	32.7°C	10.9°C	14.6°C
20/09	21.4°C	21.3°C	33.5°C	36.0°C	12.1°C	14.7°C
21/09	22.5°C	22.3°C	32.4°C	33.6°C	9.9°C	11.3°C

Source: Author, 2017.

Table 5 | Results of the economy considering the first data with the experimental water test.

Date	*Tile*	*ΔT2 (°C)*	*Q (kJ)*	*ΔQ (kJ)*	*ΔQ (kWh)*	*Economy (R$ /day m²)*
19/09	White	10.90	456.27	154.89	0.043025	0.006482433
	Gray	14.60	611.16			
20/09	White	12.10	506.51	108.83	0.030230	0.004554653
	Gray	14.70	615.34			
21/09	White	9.90	414.41	58.61	0.016280	0.002452853
	Gray	11.30	473.02			
AVERAGE				**107.44**	**0.029845**	**0.004496646**

Source: Author, 2017.

Extrapolating this value to a year of 365 sunny days, there would still be savings of only R$ 1.64 per cooled m², assuming that the environment is cooled by air conditioning throughout the morning and afternoon. Even in these best cases, a 50m² environment would save R$ 82.06 in one year with cooling costs.

The values found for savings with annual cooling costs per m², in the American context, between white tile and black tile vary between US $ 0.1 to US $ 4.0, with an average value of US $ 0.40 for the cases studied, according to Sproul et al. (2014).

Despite the similarity in the order of magnitude of the financial values found in this work and among those cited in the American research, it is not appropriate to compare these values only via monetary conversion, since many variables in the research were different from each other. In any case, financial savings figures of the mentioned dimension are low and imply a slow return on the initial investment.

In energy terms only, using the average value of *ΔQ* present in table 5 and dividing it by 3, under the conditions mentioned, a white painted roof could have the ability to reduce energy gains (in electricity) in something around 3.63 kWh/year for each m² painted and cooled.

Dividing the energy values Q of the white roof by the energy values Q of the gray roof, it is possible to find that there will be an average reduction of 18% in the absorbed heat. If taking into account the efficiency of an air conditioner (dividing the value by 3), it reveals that there will be a 6% reduction in cooling costs.

Of course, how much energy will be discarded will depend a lot on the season and the climatic situation. Nevertheless, the results obtained are lower in comparison to those presented by Synnefa et al. (2007In thi), which identify in their simulation an energy-saving between 9 to 49 kWh / m² / year for different locations.

5.4 TEST WITH WATER 02: OCTOBER 2017

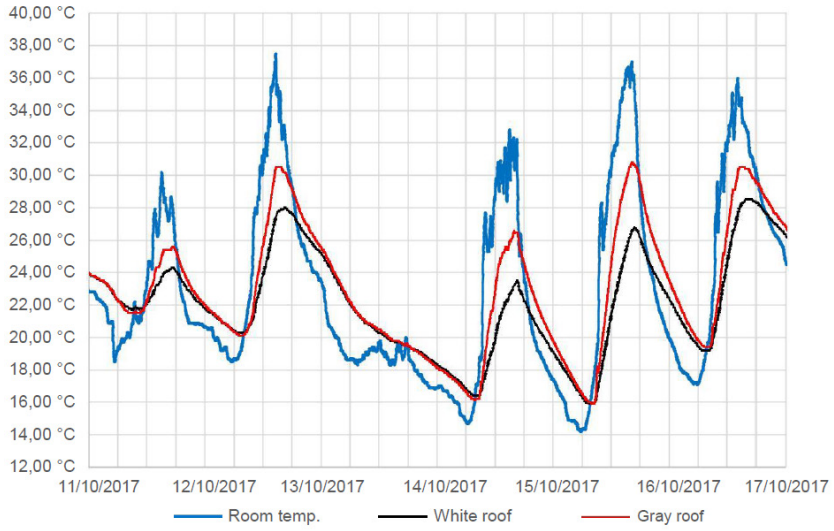
The last experimental test occurs between the 11th and 29th day of October 2017. The same methodology that before was used, since the only variation between the experiments was the water quantity, which now is 15 kg. With a long period of experimentation, the graphic representation will be divided into three graphics, to best visualization (graphics 5, 6 and 7). The vertical axis (each day) is the midnight hour of the day, for all graphics.

An analysis of the graphs shows a huge variation of weather during the whole period of experimentation, with several days whose graphics of room temperature is quite unstable, during the daytime, indicating clouds, rain, or significate winds. The main variability is useful since the real situation is that it will not necessarily be sunny all day.

Applying the same treatment used before to obtain the average temperatures, it is in table 6, which in general gives a medium difference about 1.54°C, a lower number than found previously, but understandable since the high number of days with constant sun.

To evaluate the financial saving, we use the same procedure, with the difference value of the maximum and minimum temperature (ΔT_2) being featured directly. The times for temperature measurement were from 08hs to 16h30min, respectively. The data are in table 7.

Graphic 4 | Graphic representation of temperatures at second water test (October 11st to 17st).



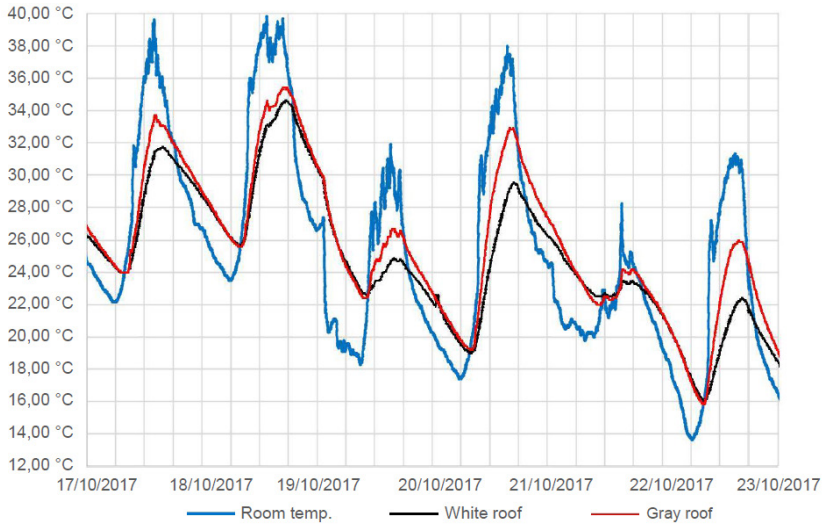
Source: Author, 2017.

In this case, despite the smallest difference between the average temperature cited before, the data of table 7 point daily savings of approximately 0,63 cents by m²of white area and cooled (air conditioning) by day, totalizing R$ 2.30/m²/year saved. In the same way, in energy terms, the predictions are about 5.09 kWh/m²/year saved.

Regarding the percentages, there is a prospect of savings around 9% with air conditioning costs, since the white painted tile will absorb almost 27% less thermal energy than the gray tile.

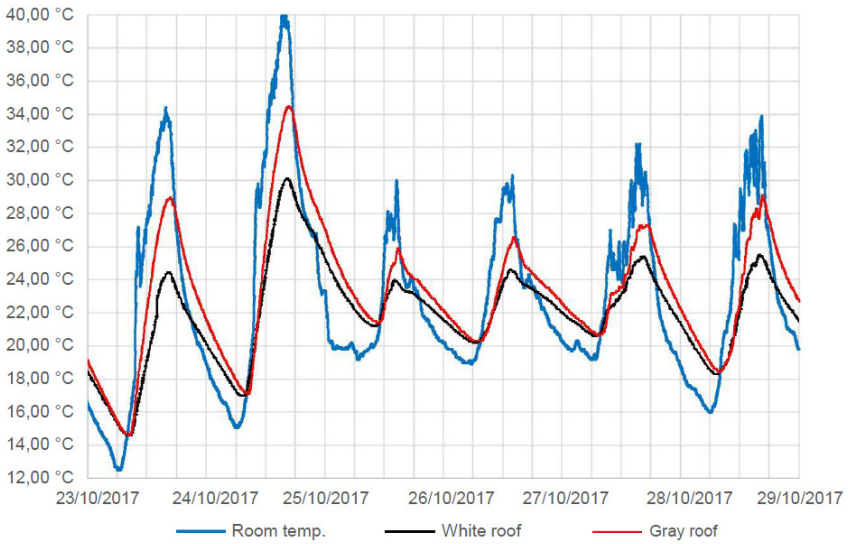
In general, using the results of all experiments, there was an average temperature reduction of approximately 2°C for sunny days and values below 0.5°C for situations in which the weather is not favorable, generating potential savings of nearly R$ 2.00 / year per square meter painted and cooled, which would also translate into 4.40 kWh / year / m² in electricity.

Graphic 5 | Graphic representation of temperatures at second water test (October 17st to 23st).



Source: Author, 2017.

Graphic 6 | Graphic representation of temeratures at second water test (October 23st to 29st).



Source: Author, 2017.

Table 6 | Temperature average during the day for the second test with water.

Days and intervals	*Test 04 – Average of registered temperatures*			
	Room	*White Tile (TW)*	*Gray Tile (TG)*	*ΔT1 (TW – TG)*
11/10 – 08HS TO 19 HS	22.70°C	22.91°C	23.51°C	0.60°C
12/10 – 08HS TO 19 HS	29.87°C	24.98°C	26.63°C	1.65°C
13/10 – 08HS TO 19HS	19.02°C	20.13°C	20.21°C	0.08°C
14/10 – 08HS TO 19HS	26.72°C	20.60°C	22.94°C	2.34°C
15/10 – 08HS TO 19HS	29.80°C	22.46°C	25.46°C	3.00°C
16/10 – 08HS TO 19HS	30.19°C	25.35°C	26.95°C	1.60°C
17/10 – 08HS TO 19HS	33.35°C	29.11°C	30.40°C	1.29°C

Days and intervals	Test 04 – Average of registered temperatures			
	Room	White Tile (TW)	Gray Tile (TG)	ΔT1 (TW – TG)
18/10 – 08HS TO 19HS	36.11°C	31.58°C	32.46°C	0.88°C
19/10 – 08HS TO 19HS	25.88°C	23.80°C	24.82°C	1.02°C
20/10 – 08HS TO 19HS	31.58°C	25.39°C	28.11°C	2.72°C
21/10 – 08HS TO 19HS	22.61°C	22.90°C	22.94°C	0.04°C
22/10 – 08HS TO 19HS	26.06°C	19.79°C	22.41°C	2.62°C
23/10 – 08HS TO 19HS	27.28°C	20.47°C	23.54°C	3.07°C
24/10 – 08HS TO 19HS	31.86°C	25.49°C	27.86°C	2.37°C
25/10 – 08HS TO 19HS	23.77°C	22.65°C	23.46°C	0.81°C
26/10 – 08HS TO 19HS	25.79°C	23.22°C	24.16°C	0.94°C
27/10 – 08HS TO 19HS	26.58°C	23.69°C	24.74°C	1.05°C
28/10 – 08HS TO 19HS	27.05°C	22.74°C	24.44°C	1.70°C
AVERAGE	**27.57°C**	**23.74°C**	**25.28°C**	**1.54°C**

Source: Author, 2017.

Table 7 | Results of the economy considering the second data with the experimental water test.

Date	Tile	ΔT2 (°C)	Q (kJ)	ΔQ (kJ)	ΔQ (kWh)	Economy (R$ /day m²)
11/10	White Gray	2.20 3.80	138.14 238.60	100.46	0.027907	0.004205
12/10	White Gray	7.70 10.00	483.48 672.90	144.42	0.040116	0.006044
13/10	Not applied. No temperature increase was registered during the afternoon					
14/10	White Gray	7.10 10.30	445.81 646.74	200.93	0.055813	0.008409
15/10	White Gray	10.80 14.80	678.13 929.29	251.16	0.069767	0.010512
16/10	White Gray	9.30 11.00	583.95 690.69	106.74	0.029651	0.004467
17/10	White Gray	7.50 8.80	470.93 552.55	81.86	0.022674	0.003416
18/10	White Gray	8.60 9.60	539.99 602.78	62.79	0.017442	0.002628
19/10	White Gray	1.30 3.20	81.63 200.93	119.30	0.033139	0.004993
20/10	White Gray	10.30 13.60	646.74 853.94	207.21	0.057558	0.008672
21/10	White Gray	0.30 1.10	18.84 69.07	50.23	0.013953	0.002102
22/10	White Gray	6.10 9.90	383.02 621.62	238.60	0.066278	0.009986

Date	*Tile*	*ΔT2 (°C)*	*Q (kJ)*	*ΔQ (kJ)*	*ΔQ (kWh)*	*Economy (R$ /day m²)*
23/10	White	9.80	615.34	276.28	0.076743	0.011563
	Gray	14.20	891.62			
24/10	White	13.10	822.55	257.44	0.071511	0.010744
	Gray	17.20	1079.99			
25/10	White	1.80	113.02	43.95	0.012209	0.001840
	Gray	2.50	156.98			
26/10	White	3.20	200.93	75.35	0.020930	0.003153
	Gray	4.40	276.28			
27/10	White	4.50	282.56	125.58	0.034883	0.005256
	Gray	6.60	408.14			
28/10	White	6.90	433.25	219.77	0.061046	0.009198
	Gray	10.40	653.02			
AVERAGE				**150.70**	**0.041860**	**0.006307**

Source: Author, 2017.

6 DISCUSSING THE PRACTICAL RESULTS

The differences in the roof colors bring a considerable impact at the cabin temperature, with a medium reduction of 2 °C for sunny days. A reduction like it is noticeable, but implies low electricity savings, resulting in a slow return on the investment.

The roof paint installed with white color must not be the main goal to search for electricity saving, but a reduction of internal temperature and better thermal and energetic efficiency of the build. Another justification to use this method in the potential effect to reduces the UHI phenomena in the city, if adopted at large scale, even with inconclusive studies about that effect at the world scale.

By the way, the research agrees with those of theoretical references, since that the temperature reduction implies lower consumption of air conditioners, generates less consumption of electricity and, consequently, less dependence on energy/technology to maintain the thermal comfort of residents.

7 FINAL CONSIDERATIONS

From a model of homogenizing globalization, ruled by the consumption and reification of the space, preferably at urban space, where founds the world population, it was found that environment questions are not incorporated in the guiding policies.

The materialization of this process occurs globally from different scales. For example, the global warming at the world scale, and floods, landslides or climatic troubles as heat urban island frequently reflect social inequalities.

Considering these troubles in the development of the consumer society, it is showed that measures to change such processes may start at local scales. In this context, cool roofs emerge as a viable alternative, because, in addition to the physical aspect related to the climate, it can be leveraged with public policies.

Furthermore, by the technical featured, this work can serve as a contribution to scientific research and can be refined at many aspects, as tests with different cover material, kinds of paints, colors and cabin size.

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Globalização e consumo: um estudo dos telhados brancos como alternativa socioambiental

Globalization and consumption: a case study of cool roofs as a socio-environmental alternative

Anderson Luiz Godinho Belem[a]

Bruno de Borowski[b]

Mairon Melo Machado[c]

[a]*Instituto Federal de Ciência e Tecnologia Farroupilha, São Borja, RS, Brasil*
End. Eletrônico: andebelem@gmail.com

[b]*Instituto Federal de Ciência e Tecnologia Farroupilha, São Borja, RS, Brasil*
End. Eletrônico: brb2@outlook.com

[c]*Instituto Federal de Ciência e Tecnologia Farroupilha, São Borja, RS, Brasil*
End. Eletrônico: mairon.machado@iffarroupilha.edu.br

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ARTICLE- VARIA

RESUMO

A globalização e a sociedade de consumo são discutidas em seus vieses ambientais sob uma transição escalar do global para o local. Com essa perspectiva, o presente artigo trata do efeito dos telhados brancos para a redução de temperatura interna em edifícios de São Borja, RS. A experimentação prática faz uso de habitáculos, com telhas de fibrocimento e as análises do estudo são representadas por gráficos e estatísticas. Verificou-se que, em dias de predomínio de sol, os habitáculos com telha branca apresentavam 2°C de temperatura a menos em relação a da telha cinza, sendo essa diferença menor em casos de tempo nublado ou chuvoso. Calculou-se que, por consequência da menor temperatura, sob condições ideais, uma telha branca irá resultar em uma redução de cerca de 4,4 kWh/ano/m² em consumo elétrico com condicionador de ar, o que se traduz em economia de aproximadamente R$ 2,00/ano/m² (valores da energia em São Borja). Apesar da redução considerável na temperatura média, o retorno financeiro é alcançado a longo prazo.

Palavras-Chave: Economia Doméstica. Sustentabilidade. Telhados Brancos. Sociedade de Consumo.

ABSTRACT

Globalization and consumer society are discuss in their environmental biases and with a transition between global and local scale. From an experimental research, the effect of white roofs for temperature

reduction in internal buildings at São Borja-RS, is investigated. Practical experimentation makes use of habitats, with asbestos cement tiles. Graphs and statistical analysis were used in the study. It was verified that, in days of sun predominance, the habitations with white tile had 2 °C of temperature less than the gray tile, being this smaller in cases of cloudy or rainy weather. It has been estimated that, as a consequence of the lower temperature under ideal conditions, a white tile will result in a reduction about 4.4 kWh/year/ m² in electric consumption with air conditioner, which translates into approximately R $ 2.00/year/m² (energy values at São Borja). Despite the appreciable reduction in average temperature, the financial return will be in the long term.

Keywords: Domestic Economy. Sustainability. White Roof. Consumer Society.

1 INTRODUÇÃO

Com a crescente demanda energética, decorrente da expansão do desenvolvimento pautado na produção e consumo que se adapta e globaliza desde o capitalismo mercantil, intensificando-se após as revoluções tecnológicas recentes, a degradação do capital natural ocorre em ritmo acelerado (MILLER e SPOOLMAN, 2013). Dentre os problemas ambientais gerados, Goldstein (2009) expõe o aumento da emissão de gases de efeito estufa (GEE), que trazem como principal consequência o aquecimento global.

Com o advento das revoluções industriais e a consequente guinada no desenvolvimento das sociedades, as cidades vão gradativamente se tornando o *locus* do ser humano. Mudanças na organização territorial com o desenvolvimento dos estados nacionais e na legitimidade da propriedade privada como um pilar da organização social atual acarretaram uma intensificação na urbanização. Entretanto, apenas quando a tecnologia chega ao campo (Revolução Verde) é que o urbano passa a concentrar, também em países menos desenvolvidos, as populações.

Segundo o *Cities and Biodiversity outlook* (2012), mesmo considerando os melhores cenários, as áreas urbanas atingirão, até 2030, um patamar de duas a cinco vezes maiores que os atuais. Isso implica em uma série de consequências ambientais, como: consumo exacerbado de recursos hídricos e de solos agricultáveis, perda considerável da biodiversidade e nos serviços ecossistêmicos, além de consolidar alterações climáticas de escalas locais a globais. No mesmo documento é exposto que a tendência de aumento das áreas urbanas se dá preferencialmente em países menos desenvolvidos.

Nesse contexto, as escalas locais de análise apresentam uma lista de problemas relacionados ao clima, entre os quais a inversão térmica, cânions urbanos, chuvas ácidas, ilhas de calor etc..

É fato que a maior concentração de humanos se dá em zonas térmicas intertropical e temperada norte. A primeira notadamente quente e a segunda apresentando verões e invernos intensos na maior parte dos seus climas, favorecendo o uso de eletrodomésticos com função de condicionar o ar em ambientes restritos. Cabe ressaltar que tais equipamentos demandam grandes quantidades de energia elétrica para seu funcionamento, e que a produção de energia elétrica envolve diretamente a degradação do capital natural, assim como muitas vezes, a eliminação de importantes serviços ambientais em maior ou menor grau.

Entre as alternativas para evitar um aquecimento excessivo, no caso dos verões, dentro de edificações, e assim, evitar o uso indiscriminado de eletrodomésticos e energia elétrica para resfriar tais ambientes, surgem as propostas de telhados brancos e verdes. Os telhados brancos têm a característica de serem pintados por cores claras, evitando o aquecimento excessivo. Os telhados verdes são assim denominados em função de receberem cobertura vegetal, evitando a exposição, da superfície construída, ao sol.

Este estudo discutirá, por meio de revisão bibliográfica, a relação entre a cidade, a sociedade de consumo e as consequências ambientais desse processo circulando em diferentes escalas de observação. Como

objetivo específico será apresentado um estudo experimental voltado a avaliar a técnica dos "telhados brancos" para residências atentando para as condições geográficas do município de São Borja-RS.

2 DA SOCIEDADE DE CONSUMO À (IN)SUSTENTABILIDADE DO AMBIENTE URBANO

A faceta mais recente do capitalismo é a utilização da informação em tempo real. Desde que se torna, praticamente, hegemônico, a informação em tempo real ganha caráter civil e passa a ser um trunfo das grandes corporações por meio do mercado financeiro e da indústria de bens de consumo. Desse modo, o fenômeno da globalização ganha velocidade e intensidade. Santos (2001) afirma que existe uma perversidade no processo, e que urge a necessidade, não de acabar com a globalização, mas de mudar a sua lógica, preservando as características das comunidades locais sem impor uma homogeneização socioeconômica e sociocultural.

No contexto produtivo, Ortigoza (2009) detalha que com o advento do capitalismo informacional, as principais atividades produtivas se organizam de modo global fazendo uso de uma rede geográfica, também global, de produção, concorrência e consumo que chega até as redes locais homogeneizando-as. Santos (2005) explica que as redes possuem caráter de materialidade e de ação, sendo o meio pelo qual passam a produção, a circulação e a informação. Para o autor, é desse modo que o universal se transpõe até as escalas locais.

Tal qual um produto, o espaço geográfico passa a ser consumido. Isso ocorre, como explica Ortigoza (2009), pela pressão global que acarreta uma gestão pública voltada a atrair o capital, passando pela homogeneização das cidades em detrimento das reais necessidades de sua população. Cabe ressaltar que nessa lógica produção-consumo, no capitalismo informacional, os governos são vistos como articuladores entre os detentores dos meios de produção e os consumidores. Enquanto isso ocorre, as localidades acabam por materializar o processo de produção em sua paisagem. Esse processo é a característica principal da divisão internacional do trabalho atual, da desterritorialização e do enfraquecimento dos estados nacionais perante a lógica neoliberal.

Tal dialética socioespacial implica diretamente sob a necessidade de consumo que se desponta, então, para manutenção do sistema. As relações sociais são medidas pela capacidade de obter mercadorias, o "ter" subjuga os momentos vividos. O consumo, dentro dessa lógica, passa a ser o grande organizador da sociedade global, objetifica inclusive os produtores e também a estrutura da vida cotidiana. Para Lefebvre (1991), está posta a sociedade do consumo, do efêmero, da obsolescência programada, da constante necessidade de 'ter'. Nesse contexto a cidade é o espaço do consumo e o modo de vida urbano o conteúdo daquele.

A relação com o ambiente é evidente dentro desse escopo. Inserida nessa análise, Cortez (2009) comenta que a crise ambiental é também social, e que o *modus operandis* é insustentável ambientalmente, socialmente injusto e moralmente. Tal afirmação gira em torno da incapacidade dos sistemas ambientais em suplantar a crescente demanda criada pelo próprio sistema de produção-consumo, da crise ambiental que destrói constantemente a capacidade de regeneração dos ecossistemas, e da concentração das riquezas. Concentração esta que recentemente aumentou nos países desenvolvidos e volta a crescer nos países em desenvolvimento (UNITED NATIONS, 2020).

Contudo, uma vez que a percepção do processo desencadeador da crise ambiental é evidenciada, ocorrem contracorrentes que colocam novos pontos de vista. As conferências internacionais que reúnem de tempos em tempos, há décadas, os países em prol de uma pauta ambiental global, mostram como a crise ambiental se torna política e econômica. Como símbolos dessa prática estão as correntes que pregavam o "Crescimento Zero" por um lado, e o "Crescimento a todo custo" por outro, e atualmente, a discussão do que e como seria uma "Economia Verde", e, ainda, quais níveis aceitáveis de Aquecimento Global serão admitidos.

O que se presencia como resultado, conforme Cortez (2009), é a transferência de responsabilidade em termos ambientais: Governos e mercado aliados, em uma lógica perversa colocam a responsabilidade nos consumidores, ao mesmo tempo que adaptam, por meio de novas tecnologias, novos produtos, ampliando o consumo, criando novos mercados e não abandonando completamente os antigos.

A partir de tais enfrentamentos surgem termos como “consumo responsável”, “consumo consciente”, “comércio ético e solidário”, “consumo verde” ou ainda “consumo sustentável”.

Para Toni et al. (2010), o consumo consciente seria um modo de vida responsável ambiental e socialmente. Segundo Cortez (2009), comércio ético e solidário remete à toda a cadeia produtiva, desde o produtor primário até o consumidor, mas não trata explicitamente da questão ambiental. Entretanto, esta se torna fundamental quando a ética passa a envolver todos os aspectos da vida neste planeta.

O consumo responsável trata do consumidor e dos direitos que este possui e deve reivindicar visando compreender todo o processo de produção: origem, preços, distribuição dos valores, renda dos produtores e dos comerciantes, etc.

Outra denominação adotada principalmente pelo mercado é o “consumo verde”, este, conforme o manual da *Consumers International* (2005), visa dar ao consumidor o poder de escolha por produtos que em sua cadeia produtiva não agridem o ambiente. A crítica a tal modelo surge quando apenas algumas marcas se destacam de modo amplamente distribuído nos diversos mercados consumidores, restringindo a escolha do consumidor a poucas possibilidades. Além disso, o consumidor verde atenta apenas para o aspecto tecnológico e geralmente consome produtos caros, e então, a maior parte da população não tem como se inserir nessa perspectiva. Há ainda um termo que se caracteriza por aglutinar as perspectivas citadas: consumo sustentável. Porém, independente da terminologia utilizada, Cortez comenta que:

> A maioria das pessoas nos países industrializados ainda continua numa rota de consumo ascendente e muitas outras, nos países em desenvolvimento, permanecem atoladas na pobreza. A fim de promover um novo papel para o consumo, qualquer visão terá que incluir respostas a quatro quesitos-chave: se a classe de consumidor global estará tendo uma qualidade de vida melhor em função dos seus níveis crescentes de consumo; se as sociedades poderão perseguir o consumo de forma equilibrada, especialmente harmonizando o consumo ao ambiente natural; se as sociedades poderão reformular as opções do consumo para uma escolha genuína; e se as sociedades poderão priorizar o atendimento às necessidades básicas de todos (CORTEZ, 2009, p.59).

Sob a perspectiva das cidades como objeto de consumo e lugar da morada humana, observa-se que apesar de uma retórica cada vez mais voltada para a sustentabilidade, nos países menos desenvolvidos isso está longe de ser realidade, Davis (2006) retrata por meio de intensa revisão bibliográfica o resultado da globalização materializada sobre as cidades no mundo, e constata o que chama de “Planeta Favela”. No capítulo “Ecologia de Favela”, o referido autor evidencia o resultado socioambiental do processo de exclusão e marginalização, a junção de condições desumanas de vida aliadas a condições de insalubridade extremas, bem como desastres naturais, por vezes previsíveis. Assim constata-se que apesar de passarmos por um *boom* urbano, o bem-estar das populações, que depende de uma qualidade ambiental mínima, não acompanha o ritmo.

No contexto sul-americano, o *Cities and Biodiversity outlook* (2012) mostra que as taxas de urbanização daqueles países há tempos são maiores, por exemplo, do que países europeus desenvolvidos. Tal processo fora intensificado pelos governos militares, que durante as décadas de 1960 a 1980 fomentaram, na região, uma política econômica que adotou a revolução verde no campo, sem resolver, entretanto, a questão agrária dos países em questão e causando, além de intensos conflitos no campo, a expansão desorganizada do meio urbano.

Como “Revolução Verde” entende-se a série de tecnologias que a partir de meados da década de 1960 são propostas pelos países desenvolvidos (principalmente os Estados Unidos) como a solução para a relação entre crescimento populacional e produção de alimentos. Novaes (2012) delimita algumas das principais consequências da Revolução Verde, sendo: alterações nos ciclos de acumulação primitiva da terra que passa a estabelecer a violência, roubo e grilagem como processo (assassinato de lideranças, invasão de terras indígenas e unidades de conservação, expropriação do trabalho manual e intelectual das populações tradicionais, migrações forçadas); expansão das propriedades particulares vinculadas a transnacionais; implantação de tecnologias e maquinário, sementes (transgênicas) e agrotóxicos de modo que poucas empresas detêm as patentes.

Neste milênio ocorreu pela primeira vez na história a inversão entre áreas rurais e urbanas em âmbito mundial, conforme dados do relatório Perspectivas da População Mundial (2019). Atualmente, portanto, mais de 50% da população mundial vive no meio urbano, sendo que para 2050 acredita-se que esse valor chegará a 70% sendo um terço em favelas. Grande parte desse processo de urbanização está vinculado a Revolução Verde, mas que, uma vez vendida pelos peíses desenvolvidos, por meio da Organização das Nações Unidas (ONU), como solução para a fome, acabou favorecendo o êxodo rural veloz e massivo em países em desenvolvimento (NETTO, 2013).

Portanto, por mais instrumentos teórico-conceituais, ferramentas tecnológicas ou mesmo nas inúmeras tratativas políticas o ambiente acaba por ser um fator secundário quando comparado à importância dada ao desenvolvimento econômico. As palavras de Santos (2001), quase 20 anos depois, ainda ressoam de modo preocupante uma vez que os resultados de todo esse processo sugerem a intensificação da urbanização, expropriação da mão de obra pelo êxodo rural e ampliação da desigualdade nas cidades (DAVIS, 2006) e a coisificação da questão ambiental, que de inerente à vida no planeta, passa a ser produto (CORTEZ, 2009) cada vez mais escasso na paisagem urbana.

3 CONTEXTUALIZANDO OS TELHADOS BRANCOS

Utilizando-se de uma escala mais próxima, a discussão iniciada no item anterior pode ser direcionada especificamente para o espaço urbano. Neste as tentativas de estabelecer uma ordem nessa intensa relação ser humano-natureza passa pelo planejamento. Sobre o mesmo Monteiro comenta que:

> Ao englobar os fundamentos naturais que esboçaram os primeiros elementos de um espaço que foi acrescido de todo o produto social do trabalho, espelhando uma cultura, a cidade engloba ação política (moral e ética), mediação estética, conciliando o útil funcional ao belo, numa congregação altamente acumulada de conflitantes interesses, requer a vigência de um pacto social, regido por uma ordem jurídica que assegure adequação e equidade ao que é produzido pela técnica (MONTEIRO, 2008, p.80).

Na prática existem muitas dificuldades de superar uma visão economicista do espaço que se materializa nas relações hostis diante da natureza, principalmente no ambiente urbano. Entretanto, atentando às questões ambientais, especificamente, é fato que o ser humano necessita de qualidade ambiental: ar puro, água limpa, solos agricultáveis entre outros para se desenvolver (NUCCI, 2008).

Em relação ao clima Lombardo (2009) explica que a relação entre a escala global e local, é extremamente complexa e não se dá de modo causal simples, e ainda que a influência da temperatura das cidades é irrelevante para o global, uma vez que as superfícies construídas não chegam a 1% da superfície terrestre. Entretanto no quesito lançamento de GEEs, a atual sociedade de consumo é extremamente relevante:

> Devido ao incremento no gasto de energia (para uso doméstico, transportes, para fins industriais, entre muitos outros, ditados por uma constante necessidade de reduzir as distâncias e elevar o nível de vida (KANN, 2006), as cidades são as fontes mais importantes de GEE, contribuindo com cerca

> de 85% para as emissões totais de CO2, CFCs e O3 troposférico (OKE, 1997). A elevada densidade dos poluentes na pluma urbana afeta a química da atmosfera e o clima em larga escala (CRUTZEN, 2004). Segundo alguns autores, o incremento da convecção, como resultado do aquecimento sobre as áreas urbanas, poderá contribuir para o transporte de água e de poluentes para a média e alta troposfera, com potenciais consequências em nível regional e global (CRUTZEN, 2004; SHERWOOD, 2002) (LOMBARDO, 2009, p.116).

A autora continua, e explica que de modo geral há problemas associados a modificações no balanço radioativo, alteração na circulação atmosférica próxima, aumento da poluição atmosférica, aumento da precipitação convectiva e formação de ilhas de calor urbanas (ICU), e que tudo isso é causado pela degradação ambiental de origem antrópica.

No que confere ao fenômeno das ICUs, Costanzo et al. (2016) atribuem à alta densidade populacional um aquecimento adicional, o que caracterizaria o fenômeno. Amorim et al. (2009) explicam que a principal definição das ICUs é relativa as diferenças de uso do solo que existem entre áreas com densidade de edificações, concentração de materiais de grande potencial energético de emissividade e reflectância, bem como atividades urbanas que liberam calor na atmosfera próxima, e, ainda, áreas com características opostas a estas (rurais ou periurbanas). Esse efeito, aliado ao fato de que existem regiões na Terra que, ao menos durante determinados períodos, são naturalmente quentes e úmidas, impulsionam a procura por equipamentos que amenizem a sensação de calor, tais como ventiladores e condicionadores de ar. Tais equipamentos, apesar de tornar um ambiente isolado mais confortável, contribuem para o lançamento de GEEs por meio do consumo de energia e, por vezes, do próprio funcionamento dos equipamentos.

A título de exemplo, um condicionador de ar de 12.000 BTU/h irá, além de transferir cerca de 3,5kJ de energia por segundo (relacionado ao calor que está retirando do ambiente – aproximadamente 3,5 kW) de um ambiente para outro, dissipar energia a uma potência aproximadamente de 1 kW por consequência principalmente do consumo elétrico do compressor do refrigerante do aparelho, conforme Ananthanarayanan (2013) e Tipler e Mosca (2012).

Cortez (2009), comenta que havia no Brasil perdas energéticas superiores a 50% no quesito refrigeração de prédios comerciais, sendo que seus usos não seriam racionalizados e não eram utilizados equipamentos adequados. É apenas no ano de 2018 que a manutenção de equipamentos de refrigeração do ar torna-se obrigatória para ambientes de prestação de serviços públicos e privados, conforme a Lei 13.589/18.

Lombardo (2009) explica, também, que entre os motivos para a existência de ICUs estão: emissão de calor de origem antrópica; diferentes materiais com capacidade de acumular energia térmica durante o dia e liberá-la à noite, modificação nas rugosidades dos sítios urbanos; redução da evapotranspiração devido à falta de espaços livres de edificação com presença de vegetação; modificações no balanço radioativo devido aos materiais de construção e das cores utilizadas nas superfícies.

Considerando os efeitos das ICUs sobre os seres humanos é importante ressaltar o conforto térmico da espécie. O tema é até certo ponto controverso, pois, aspectos culturais regionais implicam em variações de temperaturas ideais. No entanto algumas mensurações podem ser apresentadas, como mostra a Figura 1 analisando a umidade relativa e a temperatura.

O planejamento, desse modo, sugere soluções atuantes diante do clima urbano e que passam pela criação de um sistema de espaços livres, arborização, criação de áreas verdes e exposição de lâminas d'água. Essas soluções podem gerar melhorias no conforto térmico, estabilização de superfícies, melhor qualidade do ar, redução da poluição sonora, entre outras (NUCCI, 2008).

Em edifícios e residências, quando a radiação solar atinge a superfície dos telhados, uma parte da energia é refletida e o restante é absorvida (SABER *et al.*, 2012). A parte absorvida da energia solar resulta em um aumento na temperatura da superfície do telhado, e consequentemente, um aumento

na temperatura da residência. Graças a esse fato, sob condições desfavoráveis, a luz solar absorvida também aumenta os custos de resfriamento em edifícios e casas com ar condicionado, piora o conforto térmico e agrava a mortalidade durante ondas de calor, conforme Sproul (*et al.*, 2014). Assim, o desenvolvimento de sistemas alternativos para minimizar esses efeitos é benéfico tanto para a sociedade como para o ambiente.

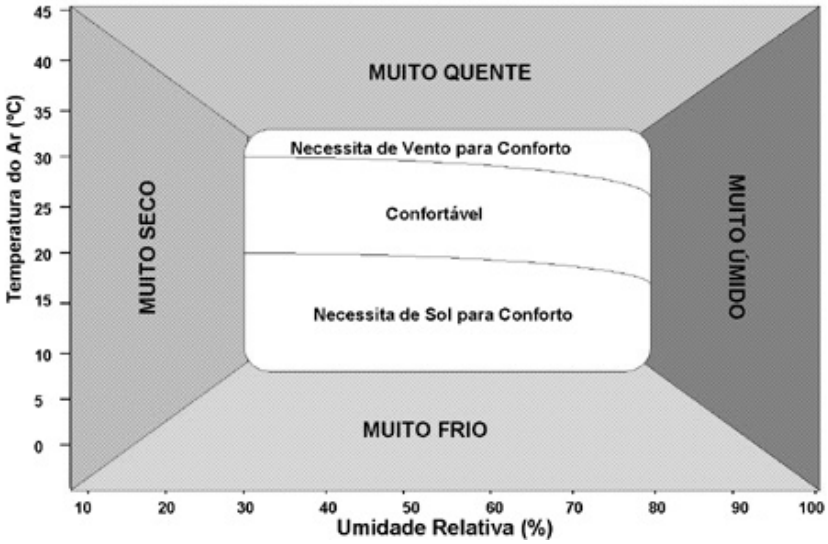


Figura 1 | Conforto térmico humano.

Fonte: Portal do Instituto Nacional de Meteorologia, 2020.

Um dos sistemas alternativos existentes é a instalação de painéis fotovoltaicos nos telhados. O uso desses painéis maximiza o aproveitamento de energia solar absorvendo-a e convertendo-a em energia elétrica. No entanto, Beise (2004) expõe que devido ao seu custo ainda relativamente alto, esse tipo de meio alternativo tem baixo uso, exceto em classes sociais mais elevadas. Outras alternativas, sugeridas por Saber et. (2012) e também por Sproul et al. (2014), tratam da pintura dos telhados com cores claras, proposta chamada de telhado branco, e o cultivo de plantas nos telhados e lajes, chamado de telhado verde.

Um telhado parcial ou totalmente coberto por algum tipo de vegetação é considerado "verde" (SPROUL *et al.*, 2014). Essa característica concede aos telhados verdes a capacidade de, segundo Smith e Roebber (2011), resfriar o ambiente – por meio de um efeito chamado resfriamento por evaporação – prover de habitat para a vida biológica, melhorar a qualidade do ar através da filtração de poluentes, algum isolamento térmico, entre outros.

Com relação aos telhados brancos, Ramos (2017) explica que seu fundamento é a aplicação da propriedade de reflexão de cores claras, o que resulta em menor absorção térmica. O princípio que justifica o uso de telhas brancas, cujo fim é o de amenizar a temperatura de um ambiente interno em relação ao ambiente externo, se dá pelo fato de que a cobertura de um edifício está, durante o dia, sob constante iluminação do sol. Assim, a energia luminosa será convertida em energia térmica, o que irá aquecer o ambiente interno, levando a um efeito indesejado em climas quentes (TESTA; KRARTI, 2017). Para Levinson e Akbari (2010), nessas situações, ao amortizar o ganho térmico do telhado, ocorrem vantagens tanto em conforto quanto na diminuição do consumo elétrico, sob o prospecto de que o uso de equipamentos eletrônicos condicionadores de temperatura será reduzido.

O telhado branco baseia-se no fenômeno físico de que cores claras refletem mais luz incidida, levando a um menor ganho energético e térmico. Geralmente, telhados são pintados com alguma tinta branca ou adquiridos já nesta cor, sendo usados principalmente em climas quentes, devido à

redução de ganho de "calor". Em razão da sua simplicidade e fácil aplicação, os telhados brancos são considerados fortes alternativas para aumento de conforto térmico e redução no uso de condicionadores de ar (LEVINSON E AKBARI, 2010).

Tendo a temperatura como uma propriedade mensurável de um sistema que expressa sua energia cinética interna, ou seja, o nível de agitação de suas moléculas, a lei zero da termodinâmica afirma que dois ou mais corpos com a mesma temperatura estarão em equilíbrio térmico, como explica Halliday et al. (2009). Esse equilíbrio térmico é o estado natural em que corpos não isolados entre si tendem a estar. Para que múltiplos corpos a diferentes temperaturas atinjam equilíbrio térmico, é necessário que haja fluxo de energia entre estes, que geralmente se dá por três processos básicos: condução, convecção e radiação térmica.

A transferência de calor via condução, no contexto de um habitáculo qualquer, irá ocorrer entre o ar externo e paredes e telhas do edifício, e, a fim de minimizar entrada de calor para o ambiente interno, a condutividade térmica dos materiais deve ser a menor possível. A cor do telhado não afeta essa propriedade, portanto não é de grande relevância ao tratar o telhado branco, mas é importante para aplicações quanto a isolamento térmico e dissipação de calor.

Siegel (2001) explica que todas as substâncias com temperatura maior que 0K perdem energia na forma de ondas eletromagnéticas. Esse fenômeno é chamado de radiação térmica. A radiação emitida pelas substâncias possui diversos níveis de frequência, sendo as mais comuns aquelas localizadas entre o infravermelho e a luz visível.

No âmbito dos telhados brancos, é importante ter o conhecimento da radiação térmica e da emissividade para reconhecer que a pintura de um telhado pode ou não ter um efeito significativo, dependendo do material sob o qual for aplicado, porém independe diretamente da cor da tinta.

Em relação aos fenômenos ondulatórios, tanto a reflexão quanto a absorção são relevantes aos telhados brancos. Uma vez que o telhado for branco, ou seja, possuir todas as cores do espectro visível sendo refletidas a partir de si, ele estará absorvendo apenas uma parte da energia incidida, evitando a entrada desnecessária de energia térmica para o ambiente interno. Os telhados brancos podem ser melhorados, segundo Xue et al. (2015), se possuírem um revestimento branco baseado em um copolímero de acrilato de estireno, o qual é capaz de cobrir todo o espectro visível e grande área do infravermelho próximo.

O município de São Borja, assim como a maior parte do estado do Rio Grande do Sul, é classificada, de acordo com o Instituto Brasileiro de Geografia e Estatística (IBGE, 2018), como clima temperado mesotérmico brando superúmido, ou seja, com temperaturas médias entre 10 °C e 15 °C e sem períodos de seca. Uma vez que a temperatura ambiente no verão supera 40°C, superior à faixa de tolerância para conforto térmico humano, a utilização de aparelhos de ar-condicionado e ventiladores para amenizar a "sensação de calor" se torna uma ação frequente e constitui-se em um local favorável à utilização de telhados sustentáveis.

4 PROCEDIMENTOS METODOLÓGICOS

A pesquisa faz uma revisão teórica sobre o processo de globalização atual e traz a luz da discussão os temas relativos ao consumo, planejamento e problemas ambientais urbanos. Por fim, trata de alternativas para a redução do aquecimento em edificações.

O experimento consistiu em monitorar e registrar, por meio de termômetros automáticos, a temperatura interna de dois habitáculos de madeira com telhas de fibrocimento, uma pintada de branco e outra coberta em cor cinza, buscando-se verificar e quantificar a diferença de temperatura nos ambientes em função da cor da telha.

4.1 PREPARO INICIAL

Foram adquiridos três termômetros digitais *data logger*, do tipo de contato, com memória interna para armazenamento de dados, da empresa *Instrutherm®*, modelo HT-810. Após o recebimento dos instrumentos, foram realizados breves testes relativos à calibração, nos quais foi verificado se as unidades exibiriam consistentemente a mesma temperatura, estando nas mesmas condições. Por alguns dias, os termômetros foram postos lado a lado simultaneamente, enquanto gravavam as temperaturas. Constatou-se que a diferença entre os termômetros era mínima (desvio padrão menor que 0,1 °C).

Foi encomendada a construção de dois habitáculos idênticos, sendo construídos de madeira de pinheiro com as seguintes dimensões: 1m. de comprimento e largura, gerando 1m² de área, e possuindo 0,7m. de altura (Figura 2). Os habitáculos foram organizados com base na proporção de uma residência de classe média da região.

Figura 2 | Imagem das casas em miniatura com telhados instalados.

Fonte: O autor, 2017.

Foi adquirida uma folha de telhado de fibrocimento de espessura de 6mm com 2m de comprimento por 1m de largura, aproximadamente, posteriormente cortada em dois pedaços iguais de 1m² cada, de forma que repousassem sem folgas sobre os habitáculos.

4.2 CONFIGURAÇÃO EXPERIMENTAL 1: AFERIÇÃO DE TEMPERATURAS DO AR

Todos os testes preliminares, assim como alguns experimentos definitivos mediram a temperatura interna (do ar) dentro dos habitáculos. Nesses casos os termômetros instalados para aferição da temperatura interna foram postos no centro do lado da caixa virado para o norte, a uma altura de aproximadamente 40cm acima da base da caixa. Para evitar o aquecimento direto por conta das paredes de madeira, entre os termômetros e as paredes foram postas pequenas placas de isopor totalizando por volta de 2cm de espessura.

4.3 CONFIGURAÇÃO EXPERIMENTAL 2: AFERIÇÃO DE TEMPERATURAS COM ÁGUA

Após análise dos dados obtidos com os experimentos apenas com ar, percebeu-se que temperaturas variavam de maneira muito brusca, oscilando muito rapidamente em comparação com o que era esperado para um local residencial interno. Para melhorar esses resultados, decidiu-se utilizar água no experimento, a fim de que haja uma inércia térmica dentro das casas.

No que diz respeito ao experimento no qual os termômetros mediram a temperatura da água, duas latas de 18 litros foram preenchidas com 10kg (e 15kg em outra fase do experimento) de

água. Os termômetros foram dispostos flutuando na superfície da água. As latas em si foram colocadas no centro dos habitáculos, mantendo distância aproximadamente igual entre a lata e cada uma das laterais. A utilização de água no experimento também permitiu a realização de cálculos básicos de energia.

5 RESULTADOS

Foram realizados quatro ensaios experimentais com os termômetros nos habitáculos, cada qual em períodos diferentes e sob diferentes condições de tempo. Em cada experimentação realizada modificaram-se alguns aspectos específicos, como a mudança da localização do termômetro de temperatura ambiente e a adição e mensuração da temperatura da água. Os índices coletados tratam-se dos dados dos termômetros *data-logger*, que registraram temperaturas à taxa de uma medida por minuto, em todos os casos.

5.1 TESTE SIMPLES SEM ÁGUA 01: AGOSTO DE 2017

O termômetro ambiente foi posto em um lugar distante dos habitáculos, sendo fixado em uma parede permanentemente sombreada, em uma área externa coberta (Figura 2).

Percebe-se que a linha que representa a temperatura do ar no telhado branco indica valores de temperaturas menores do que no telhado cinza, enquanto a linha de temperatura ambiente tem utilidade apenas como referência básica.

É possível notar que há intervalos de tempo em que todos os termômetros registravam temperaturas muito próximas. Isso ocorreu em períodos noturnos e quando o tempo estava nublado ou chuvoso, situações em que a intensidade da luz solar é reduzida ou nula.

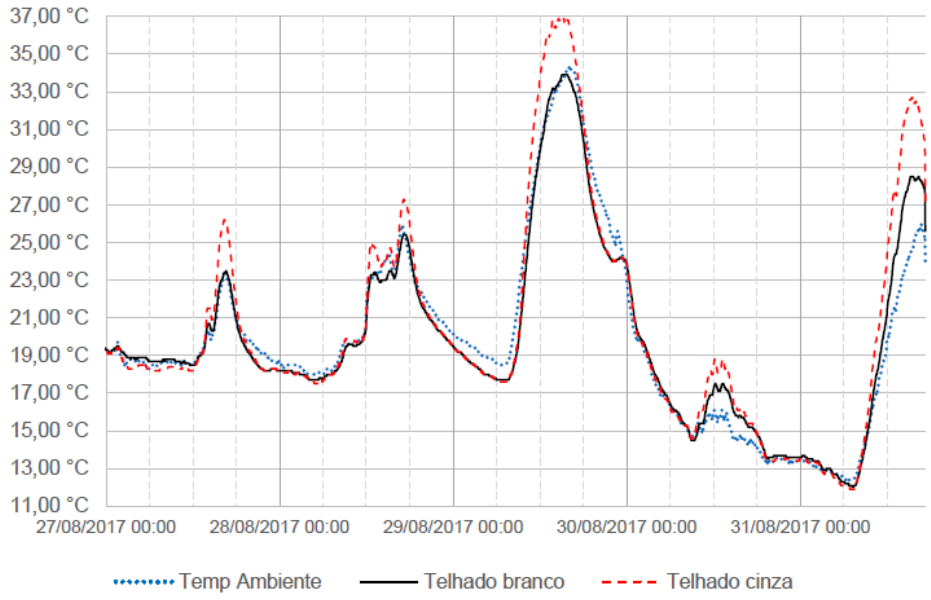
Foi realizada uma média aritmética geral de todos os valores de temperatura entre a zero hora do dia 27 até às 17h do dia 31 de agosto. Isso representa uma redução em geral de 0,57°C devido à cor do telhado.

A média anterior está, no entanto, levando em conta o horário noturno, no qual não se esperaria qualquer diferença em razão da cor dos telhados. Se realizarmos uma média aritmética das mesmas temperaturas em horários em que há incidência de luz solar, obteremos resultados diferentes, presentes na Tabela 1.

Os resultados da tabela 1 sugerem que a diferença de temperatura durante o período diurno é quase sempre superior a 0,57 °C. Assumindo que apenas os dias 29 e 31 de agosto tiveram sol pleno, a redução de temperatura média diurna foi de 2,59°C, enquanto que em um dia nublado ou chuvoso (27, 28 e 30) houve redução de aproximadamente 0,65°C.

Com relação às temperaturas máximas, o dia 29 de agosto apresentou as temperaturas mais elevadas. A temperatura ambiente máxima chegou a 34,2°C, enquanto as temperaturas máximas internas das casas com telhados branco e cinza foram, respectivamente, 33,9°C e 37°C, uma diferença de mais de 3°C.

Gráfico 1 | Representação gráfica dos resultados obtidos durante o primeiro ensaio experimental.



Fonte: O autor, 2017.

Tabela 1 | Média aritmética de temperaturas do primeiro ensaio experimental em períodos de insolação.

Dias e intervalos considerados	*Teste 01 – Média das temperaturas registradas*			
	Ambiente	*Telha Branca (TW)*	*Telha Cinza (TG)*	*ΔT (TW – TG)*
27/08 – 08HS TO 18 HS	19.96°C	20.07°C	20.61°C	0.51°C
28/08 – 08HS TO 18 HS	22.25°C	21.94°C	22.74°C	0.80°C
29/08 – 08HS TO 18 HS	29.65°C	28.99°C	31.50°C	2.51°C
30/08 – 08HS TO 18 HS	15.09°C	15.95°C	16.55°C	0.60°C
31/08 – 08HS TO 18 HS	20.15°C	22.06°C	24.74°C	2.68°C

Fonte: O autor, 2017.

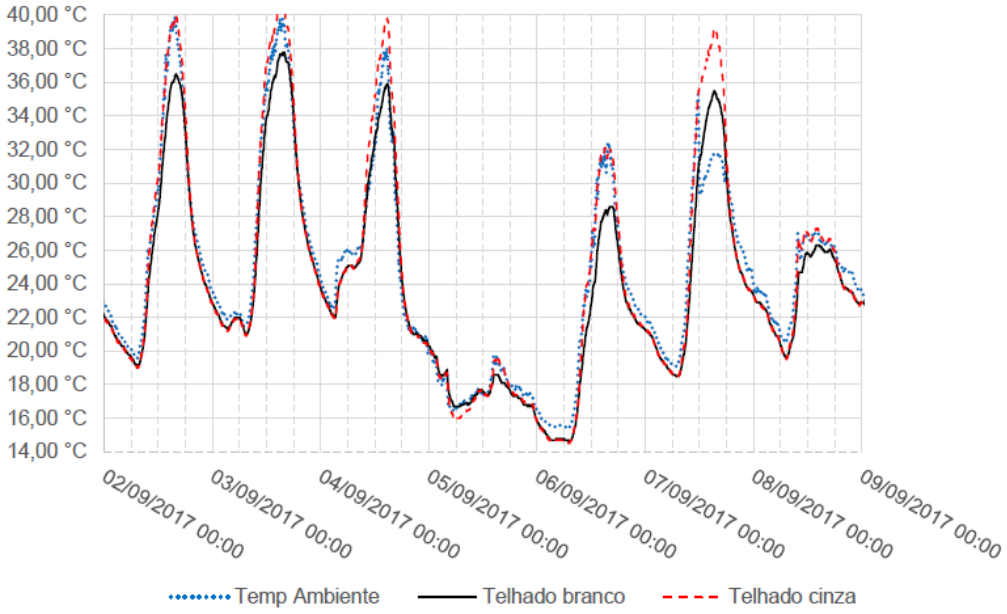
5.2 TESTE SIMPLES SEM ÁGUA 02: SETEMBRO DE 2017

Entre os dias 1 e 9 de setembro foi realizado outro teste experimental, em que a única diferença se fez no posicionamento do termômetro de temperatura ambiente, que esteve fixado ao lado externo da face sul da casa com a telha branca, separado da madeira em si por duas placas de 10mm.

Os dados entre o dia dois até a zero hora do nono dia do mês (que possuem dados completos), apontam para resultados similares aos do ensaio anterior, isto é, redução de temperatura diurna até 3°C (Figura 4).

Ao realizar médias aritméticas dos períodos com alguma incidência de sol, de maneira correspondente ao que foi feito no teste anterior, obtém-se os dados apresentados na tabela 2, que aponta para uma redução média na temperatura de cerca de 2,20 °C, nas melhores hipóteses, e inferior a 1,00 °C em situações desfavoráveis (com baixa radiação solar).

Gráfico 2 | Representação em forma de gráfico dos dados obtidos durante segunda fase dos experimentos



Fonte: O autor, 2017.

Apesar de os resultados, apenas medindo-se a temperatura do ar, serem razoavelmente consistentes entre si, não é possível, intuitivamente, verificar viabilidade econômica apenas com esses dados. Além disso, as temperaturas internas dos habitáculos variavam muito rapidamente durante o dia, tornando-se muito similares à temperatura ambiente em pouco tempo, fato que não confere com o esperado para uma casa em escala real, cuja temperatura interna oscila de maneira mais vagarosa.

5.3 TESTE COM ÁGUA 01: SETEMBRO DE 2017

Tendo em vista a rápida variação de temperatura interna verificada nos testes anteriores, procurou-se introduzir elementos que aumentariam a capacidade e inércia térmica do interior dos habitáculos. Optou-se pelo uso de água, cujo calor específico *c* é relativamente alto e amplamente conhecido na literatura científica (4,18J/g * K) (BAUER et al., 2013).

O teste foi realizado entre os dias 19 a 21 do mês de setembro e os dados dispostos em forma de gráfico. É possível perceber que a oscilação das temperaturas internas é "suavizada", se comparada às linhas da temperatura ambiente mesmo tendo o clima sido ensolarado constantemente (Figura 5).

Tabela 2 | Médias de temperatura em períodos diurnos para o segundo ensaio experimental

Dias e intervalos considerados	*Teste 02 – Média das temperaturas registradas*			
	ambiente	*Telha Branca (TW)*	*Telha Cinza (TG)*	*ΔT (TW – TG)*
02/09 – 08HS TO 19 HS	31.94°C	30.16°C	32.19°C	2.03°C
03/09 – 08HS TO 19 HS	33.91°C	32.58°C	34.60°C	2.01°C
04/09 – 08HS TO 19HS	30.33°C	30.18°C	32.04°C	1.86°C
05/09 – 08HS TO 19HS	18.00°C	17.67°C	17.86°C	0.19°C
06/09 – 08HS TO 19HS	26.30°C	23.89°C	26.29°C	2.40°C
07/09 – 08HS TO 19HS	29.60°C	29.98°C	32.65°C	2.67°C
08/09 – 08HS TO 19HS	25.92°C	24.95°C	25.78°C	0.83°C

Fonte: O autor, 2017.

A partir dos dados coletados, é possível realizar as médias acerca das temperaturas, gerando a Tabela 3, cujos resultados assimilaram-se aos dos experimentos anteriores, com uma diferença de aproximadamente 2°C em temperatura média (durante o dia) em razão da cor branca no telhado.

Tabela 3 | Médias de temperaturas em período diurno durante primeiros testes com água.

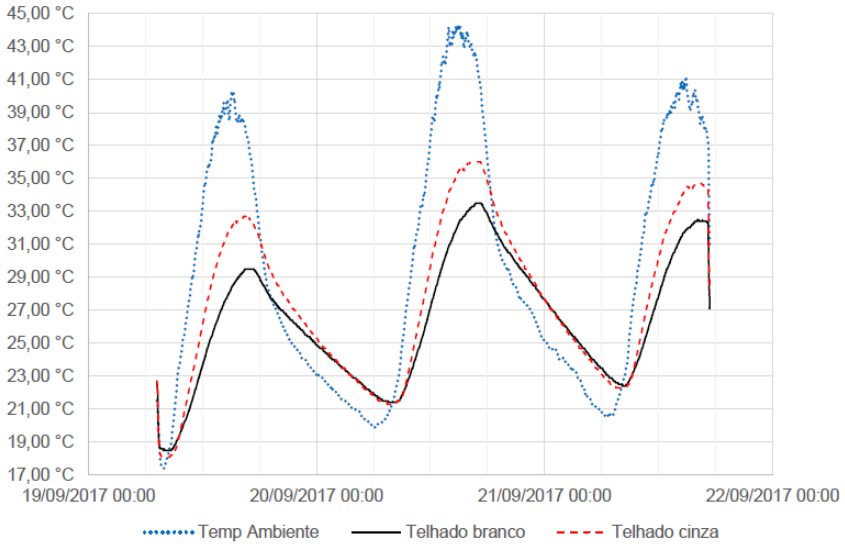
Dias e intervalos considerados	*Teste 03 – Média das temperaturas registradas*			
	Ambiente	*Telha Branca (TW)*	*Telha Cinza (TG)*	*ΔT1 (TW – TG)*
19/09 – 08HS TO 19 HS	32.18°C	25.11°C	27.32°C	2.20°C
20/09 - 08HS TO 19 HS	36.42°C	28.73°C	30.77°C	2.04°C
21/09 – 08HS TO 17H15MIN	35.10°C	28.27°C	29.99°C	1.72°C

Fonte: O autor, 2017.

Em termos de temperaturas mínimas e máximas para cada data, os valores encontrados para os habitáculos estão dispostos na tabela 4. Os dados acerca da temperatura mínima e máxima diária, assim como a diferença entre estes valores (ΔT2) da água nos habitáculos possibilita a averiguação de um potencial valor de economia financeira.

Possuindo os valores de variação de temperatura (ΔT2), da massa de água no recipiente (m) (ignorando perdas por evaporação) e o valor do calor específico da água (*c*), é possível calcular a quantidade de energia térmica que foi absorvida a menos pelo telhado branco em comparação ao telhado cinza, na forma de calor sensível, cuja equação é dada por Q=mcΔT2 (HALLIDAY *et al.*, 2009b).

Gráfico 3 | Representação gráfica dos dados obtidos durante os testes com água.



Fonte: O autor, 2017.

Tabela 4 | Valores de temperaturas mínimas e máximas para a água nas casas com telhas branca e cinza.

Date	*Mínima*		*Máxima*		*Diferença ΔT2*	
	Telha branca	*Telha cinza*	*Telha branca*	*Telha cinza*	*Telha branca*	*Telha cinza*
19/09	18.6°C	18.1°C	29.5°C	32.7°C	10.9°C	14.6°C
20/09	21.4°C	21.3°C	33.5°C	36.0°C	12.1°C	14.7°C
21/09	22.5°C	22.3°C	32.4°C	33.6°C	9.9°C	11.3°C

Fonte: O autor, 2017.

Com essas informações é possível converter o valor calórico (kJ) em energia, na unidade de kWh, e, sabendo que a tarifa residencial básica cobrada por kWh pela concessionária de energia é de R$ 0,452/kWh (excluindo ICMS; dados relativos a São Borja-RS), se torna exequível um cálculo simples acerca de economia financeira em razão da pintura do telhado, se comparado a um condicionador de ar (Tabela 5).

Por meio dos resultados obtidos na tabela 5, calculou-se um prospecto de economia de energia elétrica com base no experimento que aponta, para dias ensolarados, uma economia inferior a meio centavo por dia para cada metro quadrado de área pintada resfriada (uma vez que as casas em miniatura possuíam 1 m² de área de telhado).

Tabela 5 | Resultados de cálculos para economia financeira com os dados obtidos no primeiro teste experimental com água.

Data	*Telha*	*ΔT2 (°C)*	*Q (kJ)*	*ΔQ (kJ)*	*ΔQ (kWh)*	*Economia (R$ /dia m²)*
19/09	White	10.90	456.27	154.89	0.043025	0.006482433
	Gray	14.60	611.16			
20/09	White	12.10	506.51	108.83	0.030230	0.004554653
	Gray	14.70	615.34			
21/09	White	9.90	414.41	58.61	0.016280	0.002452853
	Gray	11.30	473.02			
Média				**107.44**	**0.029845**	**0.004496646**

Fonte: O autor, 2017.

Extrapolando esse valor para um ano de 365 dias ensolarados, ainda assim haveria uma economia de apenas R$ 1,64 por m² resfriado, assumindo que o ambiente seja resfriado por ar-condicionado durante todo o período da manhã e da tarde. Mesmo nessas melhores hipóteses, um ambiente de 50m² apresentaria uma economia de R$ 82,06 em um ano com custos com resfriamento.

Os valores encontrados para economia com custos de refrigeração anual por m², no contexto estadunidense, entre telhados brancos e telhados pretos variam entre US$ 0,1 a US$ 4,0, com um valor médio de US$ 0,40 para os casos estudados, conforme Sproul et al. (2014).

Apesar da similaridade na ordem de grandeza dos valores financeiros encontrados neste trabalho e entre os citados na pesquisa estadunidense, não é adequado confrontar esses valores apenas via conversão monetária, uma vez que muitas variáveis nas pesquisas foram distintas entre si. De qualquer maneira, valores de economia financeira da dimensão mencionada são baixos e implicam em lento retorno sobre investimento inicial.

Em termos energéticos apenas, utilizando-se do valor médio de Δ*Q* presente na tabela 5 e dividindo-o por 3, sob as condições citadas, um telhado pintado de branco poderia ter a capacidade de reduzir os ganhos energéticos (em eletricidade) em algo próximo de 3,63 kWh/ano para cada m² pintado e resfriado.

Dividindo os valores de energia *Q* do telhado branco pelos valores de energia *Q* do telhado cinza é possível encontrar uma redução em média de 18% no calor absorvido, que se levada em conta a eficiência de um ar-condicionado (dividindo o valor por 3) revela que haverá uma redução de cerca de 6% em custos com resfriamento.

Naturalmente o quanto de energia será rejeitada irá depender muito da estação e situação climática. Não obstante, os resultados obtidos são baixos se comparados aos apresentados por Synnefa et al. (2007), que identificam em sua simulação uma economia energética entre 9 e 49 kWh/m²/ano para variados locais.

5.4 TESTE COM ÁGUA 02: OUTUBRO DE 2017

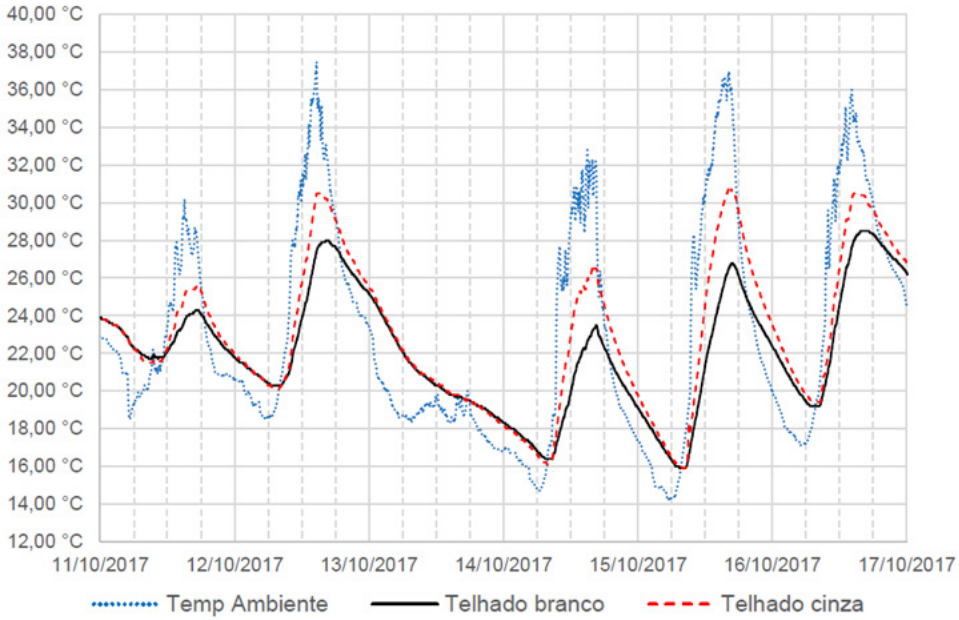
O último ensaio experimental se deu entre os dias 11 e 29 de outubro de 2017. Foi utilizada a mesma metodologia do teste anterior, sendo que a única variação entre os experimentos foi a quantidade inicial de água no recipiente interno, sendo de 15 kg neste último teste. Dado o longo período de tempo de experimentação, a representação gráfica será dividida em três gráficos para facilitar a visualização, Figura 6, Figura 7 e Figura 8. Salienta-se que os eixos verticais principais (de cada dia), correspondem à meia-noite do dia em questão, para todos os gráficos.

Uma breve análise dos gráficos nos mostra que houve grande variação nos tempos durante todo o período de experimentação, com vários dias cujo gráfico de temperatura ambiente é bastante instável durante o período diurno, indicando insolação variada (nuvens, chuvas ou vento significativo). A grande variabilidade é no entanto proveitosa, uma vez que em situação real não necessariamente haverá sol pleno em longos intervalos de dias.

Aplicando o mesmo tratamento utilizado previamente para obter média das temperaturas, obtém-se a Tabela 6, que em geral aponta para uma diferença média de cerca de 1,54°C, número inferior aos encontrados previamente, todavia compreensível em vista do grande número de dias sem insolação constante.

Para calcular a economia financeira, foi utilizado o mesmo procedimento, com o valor diferença de temperatura máxima e mínima (ΔT_2) sendo apresentado diretamente. Os horários para aferição de temperatura mínima e máxima foram das 08h e 16h30, respectivamente. Os dados obtidos se encontram na Tabela 7.

Gráfico 4 | Representação gráfica das temperaturas no segundo teste com água entre 11 a 17 de outubro.

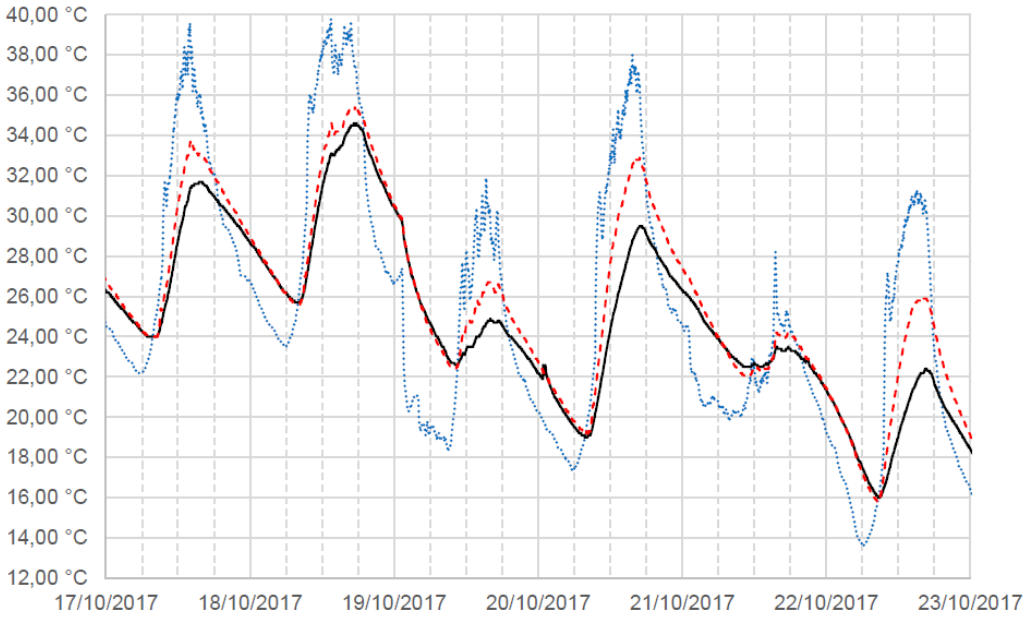


Fonte: O autor, 2017.

Nesse caso, apesar da menor diferença entre temperatura média mencionada anteriormente, os dados da Tabela 7 apontam para uma economia diária média de aproximadamente R$ 0,63 centavos por m² de área branca e resfriada (por ar-condicionado) por dia, o que totalizariam R$ 2,30/m²/ano economizados. Da mesma forma, em termos energéticos, prevê-se uma economia de 5,09 kWh/m²/ano.

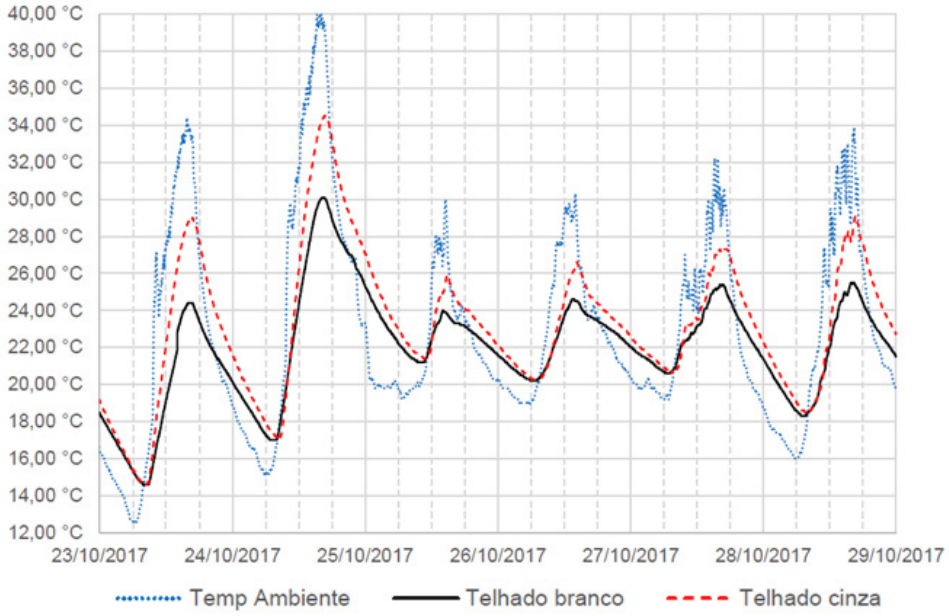
Com relação às porcentagens, há um prospecto de economia de cerca de 9% com custos com climatização, uma vez que a telha pintada de branco irá absorver quase 27% menos energia térmica do que a telha cinza.

Gráfico 5 | Representação gráfica das temperaturas no segundo teste com água entre 17 a 23 de outubro.



Fonte: O autor, 2017.

Gráfico 6 | Representação gráfica das temperaturas no segundo teste com água entre 23 a 29 de outubro.



Fonte: O autor, 2017.

Tabela 6 | Médias de temperaturas em período diurno durante segundo teste com água.

Dias e intervalos considerados	*Teste 04 – Média das temperaturas registradas*			
	Ambiente	*Telha Branca (TW)*	*Telha Cinza (TG)*	*ΔT1 (TW – TG)*
11/10 – 08HS TO 19 HS	22.70°C	22.91°C	23.51°C	0.60°C
12/10 – 08HS TO 19 HS	29.87°C	24.98°C	26.63°C	1.65°C
13/10 – 08HS TO 19HS	19.02°C	20.13°C	20.21°C	0.08°C
14/10 – 08HS TO 19HS	26.72°C	20.60°C	22.94°C	2.34°C
15/10 – 08HS TO 19HS	29.80°C	22.46°C	25.46°C	3.00°C

Dias e intervalos considerados	*Teste 04 – Média das temperaturas registradas*			
	Ambiente	*Telha Branca (TW)*	*Telha Cinza (TG)*	*ΔT1 (TW – TG)*
16/10 – 08HS TO 19HS	30.19°C	25.35°C	26.95°C	1.60°C
17/10 – 08HS TO 19HS	33.35°C	29.11°C	30.40°C	1.29°C
18/10 – 08HS TO 19HS	36.11°C	31.58°C	32.46°C	0.88°C
19/10 – 08HS TO 19HS	25.88°C	23.80°C	24.82°C	1.02°C
20/10 – 08HS TO 19HS	31.58°C	25.39°C	28.11°C	2.72°C
21/10 – 08HS TO 19HS	22.61°C	22.90°C	22.94°C	0.04°C
22/10 – 08HS TO 19HS	26.06°C	19.79°C	22.41°C	2.62°C
23/10 – 08HS TO 19HS	27.28°C	20.47°C	23.54°C	3.07°C
24/10 – 08HS TO 19HS	31.86°C	25.49°C	27.86°C	2.37°C
25/10 – 08HS TO 19HS	23.77°C	22.65°C	23.46°C	0.81°C
26/10 – 08HS TO 19HS	25.79°C	23.22°C	24.16°C	0.94°C
27/10 – 08HS TO 19HS	26.58°C	23.69°C	24.74°C	1.05°C
28/10 – 08HS TO 19HS	27.05°C	22.74°C	24.44°C	1.70°C
MÉDIA	**27.57°C**	**23.74°C**	**25.28°C**	**1.54°C**

Fonte: O autor, 2017.

De maneira geral, utilizando-se dos resultados de todos os experimentos, verificou-se uma redução de temperatura média de aproximadamente 2 °C para dias ensolarados e valores inferiores a 0,5 °C para situações em que o clima não é favorável, gerando economia em potencial cerca de quase R$ 2,00/ano por metro quadrado pintado e resfriado, o que também se traduziria em 4,40 kWh/ano/m² em energia elétrica.

Tabela 7 | Resultados de cálculos para economia financeira com os dados obtidos no segundo teste experimental com água.

Data	*Telha*	*ΔT2 (°C)*	*Q (kJ)*	*ΔQ (kJ)*	*ΔQ (kWh)*	*Economia (R$ /dia m²)*
11/10	White	2.20	138.14	100.46	0.027907	0.004205
	Gray	3.80	238.60			
12/10	White	7.70	483.48	144.42	0.040116	0.006044
	Gray	10.00	672.90			
13/10	Not applied. No temperature increase were registered during the afternoon					
14/10	White	7.10	445.81	200.93	0.055813	0.008409
	Gray	10.30	646.74			
15/10	White	10.80	678.13	251.16	0.069767	0.010512
	Gray	14.80	929.29			
16/10	White	9.30	583.95	106.74	0.029651	0.004467
	Gray	11.00	690.69			
17/10	White	7.50	470.93	81.86	0.022674	0.003416
	Gray	8.80	552.55			
18/10	White	8.60	539.99	62.79	0.017442	0.002628
	Gray	9.60	602.78			
19/10	White	1.30	81.63	119.30	0.033139	0.004993
	Gray	3.20	200.93			

Data	*Telha*	*ΔT2 (°C)*	*Q (kJ)*	*ΔQ (kJ)*	*ΔQ (kWh)*	*Economia (R$ /dia m²)*
20/10	White	10.30	646.74	207.21	0.057558	0.008672
	Gray	13.60	853.94			
21/10	White	0.30	18.84	50.23	0.013953	0.002102
	Gray	1.10	69.07			
22/10	White	6.10	383.02	238.60	0.066278	0.009986
	Gray	9.90	621.62			
23/10	White	9.80	615.34	276.28	0.076743	0.011563
	Gray	14.20	891.62			
24/10	White	13.10	822.55	257.44	0.071511	0.010744
	Gray	17.20	1079.99			
25/10	White	1.80	113.02	43.95	0.012209	0.001840
	Gray	2.50	156.98			
26/10	White	3.20	200.93	75.35	0.020930	0.003153
	Gray	4.40	276.28			
27/10	White	4.50	282.56	125.58	0.034883	0.005256
	Gray	6.60	408.14			
28/10	White	6.90	433.25	219.77	0.061046	0.009198
	Gray	10.40	653.02			
AVERAGE				**150.70**	**0.041860**	**0.006307**

Fonte: O autor, 2017.

6 DISCUSSÃO DOS RESULTADOS PRÁTICOS

A diferença na coloração do telhado produz impacto considerável na temperatura de um habitáculo, com uma redução média de 2 °C para dias ensolarados. Uma redução dessa escala é perceptível, porém implica em pouca economia com energia elétrica, acarretando em lento retorno sobre o investimento.

A pintura de telhas já instaladas na cor branca não deve possuir como objetivo primário a economia de energia elétrica, mas sim uma redução na temperatura interna e aumento da eficiência energética e térmica do edifício. Outra justificativa para utilização do método se dá em virtude do potencial efeito de redução do fenômeno de ICU em uma cidade, se adotada em larga escala, apesar de estudos inconclusivos quanto ao efeito em nível global.

Desse modo, a pesquisa está de acordo com as premissas discutidas no referencial teórico, uma vez que a redução da temperatura implica no menor consumo de aparelhos condicionadores de ar, isso gera um menor consumo de energia elétrica e consequentemente uma menor dependência de energia/ tecnologia para a manutenção do conforto térmico dos moradores.

7 CONSIDERAÇÕES FINAIS

A partir de um modelo de globalização homogeneizante, pautado no consumo e na coisificação do espaço, preferencialmente no espaço urbano, onde se concentra a população mundial, constatou-se que as questões ambientais não são incorporadas na prática das políticas norteadoras do desenvolvimento de fato.

A materialização desse processo ocorre de forma global em diferentes escalas. Em âmbito mundial, presencia-se, por exemplo, o fenômeno do aquecimento global. Em escalas locais enchentes,

deslizamentos, ou problemas climáticos como ilhas de calor urbanas são frequentes e refletem, muitas vezes, as desigualdades sociais.

Tendo em vista os problemas no modo de desenvolvimento das sociedades de consumo, constata-se que medidas visando mudar tais processos podem partir de escalas locais. Nesse contexto, os telhados brancos despontam como uma alternativa viável, pois, além do aspecto físico relacionado ao clima, podem ser alavancado com políticas públicas.

Ademais, sobre a parte técnica apresentada, este trabalho pode servir como contribuição para o acervo científico acerca do assunto, podendo a pesquisa ser aprimorada em vários aspectos, como testes com diferentes materiais de cobertura, tipos de tintas, cores e tamanho de habitáculos.

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Legislation on meliponiculture in Brazil: a social and environmental demand

Legislação sobre meliponicultura no Brasil: demanda social e ambiental

Jaqueline Reginato Koser[a]

Celso Barbiéri[b]

Tiago Maurício Francoy[c]

[a]*Faculdade de Medicina de Ribeirão, Universidade de São Paulo, Preto Ribeirão Preto, SP, Brasil*
End. Eletrônico: jaquelinekoser@gmail.com

[b]*Programa de Pós graduação em Sustentabilidade, Escola de Artes Ciências e Humanidades, Universidade de São Paulo, São Paulo, SP, Brasil*
End. Eletrônico: celso.barbieri@gmail.com

[c]*Escola de Artes Ciências e Humanidades, Universidade de São Paulo, São Paulo, SP, Brasil.*
End. Eletrônico: tfrancoy@usp.br.

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ABSTRACT

American stingless bee species have been kept and managed by local civilizations since the pre-Columbian era, with many species currently managed in commercial meliponaries. However, divergences exist among authors about the ecological utility of these practices. Some argue that meliponaries could serve to maintain local biodiversity, while others argue that they have the opposite effect. Due to pressure from beekeepers and environmentalists, there are efforts to draft specific rules that legislate production and market, focusing on conserving native bees. In recent years, these legislation have become more specific due to the use of empirical data from the scientific community and demands from social groups and producers. This paper presents a revision on Brazilian legislation as well its applicabilities and proposes alterations in the Environmental Crimes Law.

Keywords: Stingless bees. Environmental laws. Meliponiculture. Bee products.

RESUMO

As espécies de abelhas produtoras de mel e própolis nativas do continente americano têm sido usadas em práticas de manejo e reprodução por civilizações locais desde tempos pré-colombianos. Atualmente, muitas dessas espécies são manejadas comercialmente e mantidas em meliponários. No entanto, existem, na literatura, divergências sobre a utilidade ecológica dessas práticas. Alguns autores argumentam que os meliponários são fontes de manutenção da biodiversidade local, enquanto outros argumentam que eles têm o efeito oposto. Devido à pressão dos meliponicultores e ambientalistas,

há esforços para elaborar regras específicas que legislem a produção e o mercado, focando na conservação das abelhas nativas. Nos últimos anos, essas normas tornaram-se mais específicas devido ao uso de dados empíricos da comunidade científica, e buscam atender a demanda dos grupos sociais e produtores. Este artigo propõe uma revisão da legislação brasileira, bem como sua aplicabilidade, e propõem alterações na Lei de Crimes Ambientais.

Palavras-Chave: Abelhas sem ferrão. Legislação ambiental. Meliponicultura. Produtos apícolas.

1 INTRODUCTION

Native species of social bees are kept and managed in the Americas since the pre-European colonization era. This relationship is so intimate that the stingless bees of the Meliponini tribe are commonly called indigenous bees (BALLIVIÁN, 2008; NEGRÍN MUÑOZ, 2016). This tribe has around 400 cataloged species in the Neotropical region (CAMARGO; PEDRO, 2013) and corresponds to about half of the animals that pollinate tropical plants. In Brazil, depending on the biome, they are responsible for up to 90% of native flora pollination (BARBOSA et al., 2017; KERR; CARVALHO-ZILSE; NASCIMENTO, 1996).

Their honey has a market value of about eight times more expensive than hone from Apis species (GEHRK, 2010). Another important market is related to colonies and larvae disks (GEHRK, 2010; VELTHUIS; KOEDAM; IMPERATRIZ-FONSECA, 2005). Although sometimes illegally, in some regions, colony sales represent a more substantial share in the earnings of beekeepers than the sale of honey, given the popularization of the activity (KOSER; FRANCOY, 2019).

Stingless bees have a high potential for the pollination of several economically important crops (CHAM et al., 2019), such as strawberries (ALVES, 2019) and tomatoes (VINÍCIUS-SILVA et al., 2017). The maintenance of these bees in meliponaries makes the colonies transportable to agricultural systems, such as greenhouses, ensuring the presence of pollinators at the necessary time for each crop (BAPTISTA et al., 2018; JAFFÉ et al., 2015). Unlike species of the genus *Apis* (BUCHMANN, 1983), some Meliponini bees can vibrate the abdomen without damaging the flower (BUCHMANN, 1974; NUNES-SILVA; HRNCIR; IMPERATRIZ-FONSECA, 2010; VINÍCIUS-SILVA et al., 2017), avoiding floral fall and producing heavier and better quality fruits. At the same time, as they are native to the Americas, they are well adapted to the climate and offer no danger during the handling of the colonies, as they have a stunted stinger (MCGREGOR, 1976). Therefore, they are an excellent alternative for pollination in greenhouses and open environments, a market practically untapped by Brazilian beekeepers (DOS SANTOS; OTESBELGUE; BLOCHTEIN, 2018; JAFFÉ et al., 2015).

As most beekeepers do not have records and do not issue purchase and sale receipts, there are no real estimates of the economic movement of meliponiculture in Brazil. The municipality of Santa Rosa de Lima, in the Brazilian state of Santa Catarina state, is collecting this data. The city, with just over 2 thousand inhabitants, is considered a meliponiculture pole: about 70 families maintain more than 10,000 colonies, which can be multiplied and sold between 150 to 400 reais (personal communication[1]).

Meliponary is the name given to environments where colonies of stingless bees are kept. Traditionally, the formation of a meliponary involves the relocation of natural nests to a specific location. These nests may be transported with or without the trunk portion where the nest was found initially. However, in the last decades, these practices were abandoned, and the so-called rational beekeeping has developed. Nowadays, during copulation and dispersal periods, the newly fertilized queen and some workers are attracted to a trap nest. Trap nests are made with wooden boxes, PET bottles, or other artificial cavities that offer an attractive nesting site and allow free foraging for workers. Subsequently, these nests are transferred to rational hives that allow the honey collection and artificial multiplication, thus preventing the predatory removal of new colonies from nature (VELTHUIS; KOEDAM; IMPERATRIZ-FONSECA, 2005).

The cheapest and quickest way to increase the number of colonies is to multiply the nests by dividing the emerging brood combs. For this technique, only a new wooden hive and a colony large enough to divide are needed. Increasing the number of colonies is essential for obtaining bee products or even for the trade of these new colonies.

The meliponiculture, both as a subsistence practice and as a hobby, has become increasingly popular in recent years, making commercial and hobbyist beekeepers great maintainers of stingless bee colonies (BARBIÉRI, 2018; GEHRK, 2010; JAFFÉ et al., 2015; VELTHUIS; KOEDAM; IMPERATRIZ-FONSECA, 2005). The interest in the practice, and its potential for expansion, can be observed by comparing the number of members in associations and on social media pages dedicated to the subject. For example, Jaffé et al. (2015) estimated about 5,000 meliponists legally registered in Brazil, while the page Meliponicultura - Abelhas Brasileiras sem Ferrão, has around 14,000 members.

On a local scale, an example is the Associação de Meliponicultores de Blumenau (AME Blumenau), which has more than 180 members, while the web page Meliponicultores do Vale de Santa Catarina, where this municipality is located, has more than 1,200 members. However, the census of the singles beekeepers has some obstacles. Barbiéri (2018) made an online questionnaire and voluntarily obtained data from 280 meliponists in the Brazilian State of São Paulo. However, these numbers are underreported. Both the lack of access to technological tools and the fear of exposure that many beekeepers declare are some possible reasons.

Unlike traditional agricultural activities, beekeepers have the potential to help reduce the need for deforestation and the exploration of new habitats and natural resources. Also, they can promote interaction experiences between man and the environment, stimulating conservation attitudes, emotional ties with natural elements and environmental reflection, in addition to increasing popular participation in environmental policies (ATHAYDE; STEPP; BALLESTER, 2016; CARVALHO et al., 2018; CHANTHAYOD; ZHANG; CHEN, 2017; JAFFÉ et al., 2015; MADERSON; WYNNE-JONES, 2016).

However, the conservation of the diversity and genetic identity of economically exploited species is often contrary to the commercial interests of the beekeepers. In this case, definitions of management practices and standards can unite conservation and production interests, as in the case of fish, such as salmon (SCHENEKAR; LERCETEAU-KHLER; WEISS, 2014), palm trees like the butiá (NAZARENO; DOS REIS, 2014) and insects, especially bees (BONATTI et al., 2014; MUÑOZ et al., 2014; SANTIAGO et al., 2016).

The knowledge of the diversity maintained by producers can contribute to the adequacy and regulation of this activity as a recognized bank of native genetic diversity and as a source of colonies for reintroduction and conservation. Given the above, there must be a more significant commitment from conservation programs and more incentive to adopt sustainable improvement programs. It should include small farmers within this developmental scenario to expand the internal market, generating higher economic expectations and, consequently, preserving biodiversity and natural resources needed for development (SILVA et al., 2014).

There are initiatives in this regard, such as the Manduri Project, the first financed by the Brazilian Federal Government that aims the reintroduction of native bees and training of bee breeders for socioeconomic and conservationist purposes in the Rio Grande do Sul State (ASSOCIAÇÃO PAPA-MEL DE APICULTORES DE ROLANTE, 2006). Another example is the Strengthen Plan for the Apiculture and Meliponiculture Production Chain of São Paulo State (SÃO PAULO, 2018), which delimits planning units into small socio-political divisions.

However, the ecological role of meliponaries is controversial. Studies on *Apis mellifera* indicate strong disagreement on the role of artificial bee maintenance, with contradictory results indicating deterioration (DE LA RÚA et al., 2013), or the support or even the increase of local genetic diversity (HARPUR et al., 2012, 2013). The consensus is that the diversity in meliponaries reflects the handling and transportation practices that producers carry out in maintaining production (SANTIAGO et al., 2016).

Therefore, breeding and management can reflect or alter the local genetic stock. Thus, there are several factors, unfavorable and favorable, to be analyzed regarding the bee colonies' management. Additionally, it is worth to mention that essential conclusions from decades of research in conservation genetics remain within the scientific community and are often not translated into concrete actions in the development of international conservation policies (LAIKRE, 2010).

2 MELIPONICULTURE LEGISLATION DEVELOPMENT

Due to the limited knowledge about genetic diversity and the management consequences, several specific laws regulate the ASF creation seeking their natural state of conservation. The rearing of native bees colonies and its commercialization are subject to federal and state normative instruments, and, until recently, there was no specific legislation for the maintenance of social insects.

Therefore, legislation was based on the precautionary principle, mentioned in the Declaration of the United Nations Conference on Sustainable Development - Rio/92. The definition of the precautionary principle is "the guarantee against potential risks that, according to the current state of knowledge, cannot yet be identified" (MINISTÉRIO DO MEIO AMBIENTE). Thus,

> For the environment to be protected, preventive measures should be applied by States, according to their capabilities. Where there are threats of serious or irreversible risks, the lack of total scientific certainty can not be used as a reason for the postponement of cost-effective measures to prevent environmental degradation (MINISTÉRIO DO MEIO AMBIENTE).

Due to restrictive and no specific laws, the meliponiculture activity occurred, most of the times, irregularly under the legislation (CORTOPASSI-LAURINO et al., 2006; GEHRK, 2010), and until 2015, more than half of the great Brazilian commercial beekeepers pointed to the current legislation as the biggest obstacle of the activity (JAFFÉ et al., 2015). Public demonstrations in tribunes and meetings promoted by associations of municipalities with political entities demonstrated the sector difficulties and exerted considerable pressure, resulting in the evolution of legislation in recent years (DALMAGRO, 2015; G1 BA, 2017; NSC TV, 2019).

The legal framework that regulates Brazilian meliponiculture has a series of peculiarities and contradictions that can be detrimental to the development of the activity and the conservation of managed bee species. For meliponiculture, there are two types of relevant standards, those related to beekeeping and those related to the stingless bee product chains, such as honey, pollen, propolis, and others.

In the case of the rules for the keeping of stingless bees, the Portaria IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) n° 117 (BRASIL, 1997a) which regulates the trade of native wild animals (art. 10°) was one of the first, followed by the Portaria IBAMA N° 118-N (BRASIL, 1997b), which regulates the keeping of wild animals for commercial purposes. Both require individual marking (art. 7°), containing age and sex information.

The marking and individualization of each bee indicate that the elaboration of these ordinances does not consider the biology of social insects. Furthermore, the capture of endangered animals is prohibited by the Portaria n° 118-N (art. 11°), which prevents the capture of swarms by trap nests, since they are nonspecific, one cannot control which species will be captured. These two articles show that the legislation interprets stingless bees as wild animals, and categorizes their keeping as wild animal captivity.

Still in this law, the art. 20° prohibits the sale of breeding stock and for the formation of new herds and to serve as pets, contrary to the meliponiculture traditional habits and the current efforts to strengthen the activity. On the other hand, this legislation allows the IBAMA to use this resource for reintroduction programs or to implement breeding sites with a social, community, or demonstrative character (art. 12°), an excellent potential for stingless beekeepers, especially for endangered species.

Later, in 1998, the Law N°. 9,605 of Environmental Crimes was published (BRASIL, 1998), the highest instance that deals with the keeping of native species, which "Dispose about criminal and administrative sanctions derived from conducts and activities harmful to the environment, and other measures." According to art. 29°, "Specimens of wild fauna are all those belonging to native, migratory and any other species, aquatic or terrestrial, which have all or part of their life cycle occurring within the limits of the Brazilian territory, or Brazilian jurisdictional waters."

The same article determines that any interference or modification of a wild animal's nest, its keeping or commercialization of parts, eggs, nests, or derived products, is a crime when done without proper authorization. Thus, the Environmental Crimes Law creates the need for authorizations for both the keeping of stingless bees, framed in the definition of wild animals, and the commercialization of their products or nest parts.

In an attempt to make stingless beekeeping compatible for small producers, which were the majority of the public who raised stingless bees for domestic honey consumption, in 2004, the National Environment Council (Conama), in Resolução N° 346 was the first to discipline the use of wild bees, regulate the implementation of meliponaries (art. 1°) and the capture of new colonies through trap nests (art. 3°) (BRASIL, 2004).

The resolution maintains the obligatoriness for authorization for the maintenance of stingless bees for herds with more than 50 colonies. It is also dedicated to the artisanal practice of meliponiculture of endemic species in the area where the meliponary is installed (art. 5°), reaffirmed by Normative Instruction N° 169 (BRASIL, 2008). However, in addition to the Ibama Federal Technical Register (instituted by Federal Law 6.938/1981), which is required of all breeders, there is no federal system for requesting authorization to handle stingless bees, automatically pushing any beekeeper with more than 50 colonies into the irregularity.

This rule makes it impossible for the sale of honey to be the primary income source of a family since each colony produces only approximately 4 kg of honey per year. The resolution still allows transportation between federative states, only for scientific purposes and only with authorization from IBAMA (art. 6°). This article considers the political divisions of the territory as predominant in the natural distribution of the species, without considering the different phytophysiognomies that the same state may present or else the continuity of the biomes between the political denominations.

The Resolution Conama N° 346 still regulates the trap nests and the requirement that colonies maintained and marketed come from artificial multiplication methods (art. 4°), preventing predatory extraction of colonies from live tree trunks (BRASIL, 2004). Although the Resolution does not allow the extraction of colonies from nature, it establishes that deforestation or enterprises facilitate the removal of swarms from their impact area (art. 7°). This Resolution takes a vital step considering initially that bees, as well as their breeding sites, are goods of common use for the people and also the importance of meliponiculture for the local economy and the sustainability of natural environments and agricultural systems. However, it emphasizes that bees are part of the native "wild fauna" since they live naturally outside captivity.

Like the Environmental Crimes Law of 2008, art. 2° of Instrução Normativa Ibama N° 7 defines native wildlife as "every animal belonging to the native, migratory and any other non-exotic species, which has all or part of its life cycle occurring within the limits of Brazilian territory or Brazilian jurisdictional waters" (BRASIL, 2015).

The Normative Instruction N° 7 also categorizes establishments for the use and management of wild fauna in captivity (art. 3), which may be for conservation, research, or commercial purposes (BRASIL, 2015). Among the categories of commercial purposes, the one intended for commercialization is prohibited from reproducing individuals, a practice that is destined only

for establishments defined as 'commercial breeding sites". Once the reproduction process is a continuum in colonies of social insects, this regulation cannot be applied to this group.

In this case, the most appropriate definition of 'reproduction' would be that of artificial multiplication of rational colonies, and not of the individuals themselves, also not specified by Resolution 346 of Conama that deals with native bees (BRASIL, 2004). These establishments must have a Prior, an Installation, and a Use and Management Authorization if they maintain more than 50 colonies. Pre-existing breeding stock must be previously documented and authorized for capture, transport, or invoices issued by breeding or authorized traders. The use of trap nests is not regulated.

The aforementioned normative instruments did not mention any bee species. In 2014, the Portaria 444 of Conama (BRASIL, 2014) prohibited the capture, transport, storage, custody, handling, processing, and trade of species threatened with extinction, except for the sole purpose of research and conservation. The ordinance specifies bees in the thread of extinction in Brazil, namely: *Melipona capixaba* (uruçú-negra, urucu-capixaba); *Melipona rufiventris* (tujuba, uruçu-amarela-do-cerrado); *Melipona scutellaris* (urucu-nordestina) and *Partamona littoralis* (boca-de-sapo-da-paraíba), all with explored economic potential, widely cultivated by hobbyists and, especially in the case of Meliponas, with the historical socio-environmental role.

Although both laws interpret social bees under human care as "captive," they remain free and collaborate with ecosystem services. It leads many beekeepers to argue that stingless bees kept in meliponaries should be treated under the definition of "domestic fauna", described as:

> a set of fauna species whose biological, behavioral and phenotypic characteristics were altered through traditional and systematic management and zootechnical improvement processes, making them strictly dependent on man, and may present a variable phenotype, but different from the wild species that originated them (BRASIL, 2018).

This view is based on publications of different species that deal with the relationship and traditional breeding with bees, and rationalization of cultivation boxes that allows species to be raised outside their natural habitat, disease management and feeding methods (AIDAR, 1996; AIDAR; CAMPOS, 1998; BRUENING, 2001; CONTRERA; MENEZES; VENTURIERI, 2011; KERR; CARVALHO-ZILSE; NASCIMENTO, 1996; NOGUEIRA-NETO et al., 1986; ROUBIK, 2018; VENTURIERI, 2008; VILLAS-BÔAS, 2012).

There is also evidence that the species *Melipona quadrifasciata* (mandaçaia), threatened with extinction, was, in fact, extinct in the state of Rio Grande do Sul and is being reintroduced by producers and hobbyists (DÍAZ et al., 2017; MARQUES et al., 2003; WITTER; BLOCHTEIN, 2009). Reintroduction is taking place in a disorderly manner and without due control over the genetic and ecological identity of the species, as it is not allowed, and for this reason, there are no parameters to be followed. However, it constitutes proof of the close dependence that this species has on man to re-establish itself in its once natural environment, and that these producers can become allies in the conservation of the species and the maintenance of the genetic variability and ecosystem services.

With the meliponiculture activity gaining recognition and considering the art. 8º from Complementary Law Nº 140 (BRASIL, 2011) that establishes as the responsibility of States the approval of the operation of wild fauna breeding sites, a lot of different state laws are being published. They have in common the fact that they are more aligned with the methods of capturing colonies by trap nest and the methods of multiplying the previously existing colonies. Some states have their legal instruments that regulate regional authorizations for breeding, and in some cases, without agreement with the Resolution Conama N° 346, as shows the technical advice 00122/2018/CONJUR-MMA/CGU/AGU of the Legal Advice of the Union.

For example, the Law 16.171 (SANTA CATARINA, 2013) and the Decree 178 (SANTA CATARINA, 2015) that regulates it, which stand out for liberating the handling of bees and their products, as well as the purchase of nests and brood combs, without the need to present proof of rural ownership, and, provided that the transport is done within the political limits of the state of Santa Catarina, by issuing an Animal Transit Guide (GTA). In the Rio Grande do Sul, there is the Law 14.763 (RIO GRANDE DO SUL, 2015) that regulates meliponiculture, and the Normative Instruction (IN) SEMA 3 (RIO GRANDE DO SUL, 2014) which is a list of the 24 species of native bees that are allowed to be kept in the state.

However, this list is widely criticized for excluding *M. quadrifasciata*, which is one of the most cultivated species, and some producers argue that it would be native. According to this IN, meliponaries with up to 100 colonies are exempt from obtaining the operating authorization (art. 7°), more permissive than the Portaria of Conama of 2004, that indicates 50 colonies. Besides, the transportation of colonies or part of them is permitted in the territory of Rio Grande do Sul, without authorization (art. 13°). Other states have initiatives, such as Law 13.905 in the state of Bahia (BAHIA, 2018), the Resolution CEMAAM 22 in Amazonas state (AMAZONAS, 2017), the *Ad referendum* Resolution 007 from Goiás (GOIÁS, 2017), Law 19.152 from Paraná (PARANÁ, 2017), and is pending the Project of Law 4.943 from Minas Gerais (MINAS GERAIS, 2014), each one with its peculiarities.

3 STINGLESS PRODUCTS

If the native bees breeding and commercialization presents obstacles, it is no different with their products. Stingless bee honey and propolis are subject to the rules of the Milk and Derivatives Division (DILEI), Ministry of Agriculture (MA) subordinate. The main guidelines are from Decree 9.013 (BRASIL, 2017), that dispose about the industrial and sanitary inspection of products of animal origin and present several advances about the previous Decree, 30.691 (BRASIL, 1952), that inserted bee products to the same regulations for butcher products, hunting, fishing, milk, and eggs.

They are also subject to the IBAMA Ordinance N° 117 as they come from wild animals. However, this does not make any mention of bees or bee products. (BRASIL, 1997a).

Although native bees honey is found for sale in local stores, the marketing of stingless bee products is hampered by the lack of adequate specific quality parameters for honey and propolis, due to its exclusive and divergent characteristics of *Apis* sp. products. The Normative Instruction 11 (BRASIL, 2000) defines honey by its process of obtaining (2.2.2.), where it fits like the one obtained by "draining the uncapped combs without larvae"; "Pressing the combs without larvae"; "Centrifugation of uncapped combs without larvae," clearly ignoring the existence of bee species that do not form combs in their colonies, as is the case of all species of native bees.

This instruction also presents reference values for physical-chemical characteristics, designed to meet the demand for *A. mellifera* honey. However, several of these attributes are not achieved by the honey of stingless bees. Also, the large variability of characteristics that native bees exhibit, even though they are raised in the same place, is an indication that the legislation must establish parameters for each species (BILUCA et al., 2016; DUARTE et al., 2018).

As an example, honey from *Melipona subntida* (jandaíra), one of the most cultivated species in northeastern Brazil, does not meet the humidity and diastasis activity conformities (ALMEIDA-MURADIAN et al., 2013) and, in most studies, no native bee species meets the recommended maximum humidity values. *M. quadrifasciata*, grown throughout the Atlantic Forest, exhibits moisture values higher than twice the reference value (BILUCA et al., 2016 e refs.). In the case of *Melipona mondury* (urucu-amarela), only the activity of diastasis is within limits accepted by current legislation (ALVEZ et al., 2018).

The "Selo Arte" was created with the Law N° 13.680 (BRASIL, 2018) and brought advances to the marketing of stingless bee honey since artisanal products of animal origin, which underwent regional inspections (municipal or state) are now allowed to be commercialized throughout the national territory and must present, for this purpose, the Selo Arte and follow its rules of application on the packaging of handmade products. Like the MBEE company, which focuses on the dissemination of the use of products of native species in haute cuisine, which, from the Municipal Inspection Seal (SIM) of the municipality of Atibaia-SP, starts to market its products throughout the national territory. Another exceptional case is the PROJETO HEBORÁ, a collaborative network that trains peasant women for the meliponiculture and marketing of honey, which with "Selo Arte," finds the possibility of reaching a wider consumer audience and, consequently, supporting more families in vulnerable situations.

Thus, the "Selo Arte" regulation (Portaria CDA 01/2020) represents a reduction of stingless honey marketing bureaucracy, because it does not have inspection criteria at the federal level. Thus, in the states and municipalities where there are regulations for native bee honey, the products approved in the regional inspections and which fit as artisanal products are released from having the Federal Inspection Seal (SIF) to sell their products outside the municipality or state where they have undergone inspection process.

However, there is still a need to develop physical-chemical and sanitary criteria for the honey from stingless bees in several states. Another possibility is to update the criteria to fit the enormous diversity of species in different regions. For the elaboration of federal criteria, a considerable research effort would be necessary to define the differences in the physicochemical attributes of native honey, avoiding making the norm restrictive, to harm the commercialization of the products.

The diverse Brazilian biomes and the distinct biodiversity of each of them create geographical features, including the characterization of honey, which would be difficult to approach by federal laws, more general. There are state efforts to meet this demand. The pioneer was the state of Bahia, with the Portaria ADAB 207, which regulates the quality of honey for bees of the genus *Melipona*, and, if practical, could be extended to other genera by analogy as a method of integrating the standard (BAHIA, 2014).

In the state of São Paulo, there is the Technical Regulation on Identity and Standard of stingless honey, through Resolution SAA-52 (SÃO PAULO, 2017), based on the article by Camargo, Oliveira, and Berto (2017), covering 6 Genera of Meliponini. Such resolution needs revision and the inclusion of data of more bee species from different regions of the state of São Paulo. It would better contemplate the diversity of characteristics of their honey, which vary significantly, both according to the species and the region since the humidity, free acidity, pH, and HMF index vary much more than what is predicted by the ordinance and still meet all the sanitary requirements necessary for consumption.

The state of São Paulo also has the State Plan for the Strengthening of the Beekeeping and Meliponiculture Production Chain (SÃO PAULO, 2018), which uses small administrative units to monitor activity. These units are used for other actions of an environmental nature and in need of pollination, such as forestry, production of avocado, cotton, and coffee, and became part of the survey of the number of colonies, bee pasture and honey production from the creation of this plan. With the infeasibility of knowing the entire population structure on a fine-scale of all bee species in the region, the adhesion of small units goes according to the recommendations for the conservation of wild and commercially exploited species (LINNELL, 2005).

4 FINAL CONSIDERATIONS

It is evident the concern and efforts that the federal and state spheres are investing in improving the practices of handling and processing the products of native bees, aiming to achieve the preservation objectives guaranteed by the constitution and also the guarantee of economic gains for the population.

Empirical studies on specificities in genetic diversity, artificial nutrition, the spread of diseases and practices in obtaining by-products from stingless bees, for example, should be evaluated in the writing of standards that respect the biology of native social species so that they do not be an obstacle for the meliponiculture activity strengthening and the culture maintenance.

Currently, there are projects in process that will influence the future of the activity, the Project of Law N° 6560 (BRASIL, 2019c), which institutes the National Policy to Encourage Honey Production and the Development of Quality Bee and Honey Products and Services, presents a series of potentially positive aspects for the beekeeping chains. However, it must be taken into consideration that the activity of meliponiculture is very different from the well-established apiculture.

The policy should encourage the development of techniques and technologies for meliponiculture, as well as prioritize meliponiculture over apiculture, considering that stingless bees are native to Brazil, unlike the widely cultivated *A. mellifera*. There is also a Project of Law that seeks to regulate the professions of Technologists in Apiculture and Meliponiculture and that of Specialist in Apiculture and Meliponiculture, which, if established, will boost the technologies of cultivation and exploration (BRASIL, 2019b).

The legislation must also incentive the keeping of Meliponini species in their areas of natural occurrence, including endangered species, to direct meliponiculture as an income-generating activity, to also become a conservation tool. Such policies may also include payment for environmental services for registered honey farmers who keep endangered species in their area of occurrence, dealt with in Project of Law N° 5028 (BRASIL, 2019a). Restrictions on the number of swarms of each species that can be maintained should be relaxed since the production of honey is small. The same applies to the restrictions that specify the species that can be attracted to trap nests since the beekeeper has no control over the attracted species.

There are groups of beekeepers that aim to make stingless bees domestic animals from the legal point of view, which would bring new problems for the conservation of bees at all levels, colonies, populations, and species, and would alter the interpretation of all the legislation mentioned in this brief history.

The possibility of transforming stingless bees into domestic animals from a legal point of view would damage their conservation. However, there is the possibility of treating meliponiculture without all the limitations of Resolution Conama N° 346: determine basic rules for the activity, making income generation for the beekeepers compatible and the conservation of the Meliponines, changing the Environmental Crimes Law as an example of what happens with the fishing activity, and then, creating a National Policy of Meliponiculture, entirely based on technical-scientific aspects.

The Environmental Crimes Law treats fishing as an exception to Fauna, that is, as a fishing resource, except in cases of endangered species, governed by Law N° 11,959 (BRASIL, 2009). The need to review the Environmental Crimes Law is due to the hierarchy of federal laws over state ones, which would then take into account local specificities.

In addition to technical parameters on bee products that respect each species biology, these suggestions would be good alternatives to regulate meliponiculture as an activity that promotes sustainability. It meets the objectives established by the International Initiative for the Conservation and Sustainable Use of Pollinators (CONVENTION ON BIOLOGICAL DIVERSITY), maintaining, in addition to bee biodiversity, agricultural biodiversity and the conservation of pollination-dependent plants.

NOTES

1 | Interview given by the technician responsible for Eggs, Dairy and Honey of the Municipality of Santa Rosa de Lima, Luiz Miguel Rech, to Jaqueline Reginato Koser in 07/04/2020.

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Legislação sobre meliponicultura no Brasil: demanda social e ambiental

Legislation on meliponiculture in Brazil: a social and environmental demand

Jaqueline Reginato Koser[a]

Celso Barbiéri[b]

Tiago Maurício Francoy[c]

[a]*Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, SP, Brasil.*
End. Eletrônico: jaquelinekoser@gmail.com

[b]*Programa de Pós-graduação em Sustentabilidade, Escola de Artes, Ciências e Humanidades, Universidade de São Paulo, São Paulo, SP, Brasil*
End. Eletrônico: celso.barbieri@gmail.com

[c]*Escola de Artes, Ciências e Humanidades, Universidade de São Paulo, São Paulo, SP, Brasil.*
End. Eletrônico: tfrancoy@usp.br

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ARTICLE- VARIA

RESUMO

As espécies de abelhas produtoras de mel e própolis nativas do continente americano têm sido usadas em práticas de manejo e reprodução por civilizações locais desde tempos pré-colombianos. Atualmente, muitas dessas espécies são manejadas comercialmente e mantidas em meliponários. No entanto, existem, na literatura, divergências sobre a utilidade ecológica dessas práticas. Alguns autores argumentam que os meliponários são fontes de manutenção da biodiversidade local, enquanto outros argumentam que eles têm o efeito oposto. Devido à pressão dos meliponicultores e ambientalistas, há esforços para elaborar regras específicas que legislem a produção e o mercado, focando a conservação das abelhas nativas. Nos últimos anos, essas normas tornaram-se mais específicas devido ao uso de dados empíricos da comunidade científica, e buscam atender à demanda dos grupos sociais e produtores. Este artigo propõe uma revisão da legislação brasileira, bem como sua aplicabilidade, e também alterações na Lei de Crimes Ambientais.

Palavras-chave: Abelhas sem ferrão. Legislação ambiental. Meliponicultura. Produtos apícolas.

ABSTRACT

The American stingless bees species have been used in management and breeding practices by local civilizations since the pre-Columbian era. Currently, many of these species are managed commercially and maintained in meliponaries. However, divergences exist among authors about the ecological utility

of these practices. Some argue that meliponaries could serve to maintain local biodiversity while others argue that they have the opposite effect. Due to pressure from beekeepers and environmentalists there are efforts to draft specific rules that legislate production and market focusing on conservating native bees. In recent years, these norms have become more specific due to the use of empirical data from the scientific community and demands from social groups and producers. This paper presents a revision on Brazilian legislation as well its applicabilities and proposes alterations in the Environmental Crimes Law.

Keywords: Stingless bees. Environmental laws. Meliponiculture. Bee products.

1 INTRODUÇÃO

Espécies de abelhas sociais nativas das Américas, produtoras de mel e própolis, estão sujeitas às práticas de manejo desde os tempos das civilizações pré-colonização europeia. Essa relação é tão íntima que comumente as abelhas da tribo Meliponini são chamadas de abelhas sem ferrão (ASF) ou abelhas indígenas (BALLIVIÁN, 2008; NEGRÍN MUÑOZ, 2016). A tribo Meliponini abriga cerca de 400 espécies catalogadas na região Neotropical (CAMARGO; PEDRO, 2013) e correspondem a cerca de metade dos animais que polinizam plantas tropicais. No Brasil, dependendo do bioma, são responsáveis por até 90% da polinização da flora nativa (BARBOSA *et al.*, 2017; KERR; CARVALHO-ZILSE; NASCIMENTO, 1996).

O mel das ASF tem alto valor de mercado, podendo ser comercializado cerca de oito vezes mais caro do que o mel das abelhas do gênero *Apis* (GEHRK, 2010). Outro mercado importante é o de colônias matrizes e discos de larvas (GEHRK, 2010; VELTHUIS; KOEDAM; IMPERATRIZ-FONSECA, 2005). Embora às vezes, ilegalmente, em algumas localidades a venda de colônias representa uma parcela mais importante nos ganhos dos meliponicultores do que a venda de mel, dada a popularização da atividade (KOSER; FRANCOY, 2019).

As abelhas sem ferrão têm alto potencial na polinização de diversas culturas economicamente importantes (CHAM *et al.*, 2019), como, por exemplo, morangos (ALVES, 2019) e tomates (VINÍCIUS SILVA *et al.*, 2017). A manutenção dessas abelhas em meliponários torna as colônias transportáveis para os sistemas agrícolas, como estufas, garantindo a presença de polinizadores no momento necessário para cada cultivo (BAPTISTA *et al.*, 2018; JAFFÉ *et al.*, 2015). Ao contrário das espécies do gênero *Apis* (BUCHMANN, 1983), algumas abelhas da tribo Meliponini são capazes de vibrar o abdômen sem danificar a flor (BUCHMANN, 1974; NUNES SILVA; HRNCIR; IMPERATRIZ-FONSECA, 2010; VINÍCIUS SILVA *et al.*, 2017), evitando a queda floral e produzindo frutos maiores e de melhor qualidade. Ao mesmo tempo, como são nativas das Américas, são bem adaptadas ao clima e não oferecem perigo durante a manipulação das colônias, já que possuem ferrão atrofiado (MCGREGOR, 1976). Consistem, portanto, em excelente alternativa para polinização em estufas e ambientes abertos, mercado praticamente inexplorado pelos meliponicultores brasileiros (DOS SANTOS; OTESBELGUE; BLOCHTEIN, 2018; JAFFÉ *et al.*, 2015).

Como a maior parte dos meliponicultores não possuem registros e não emitem notas de compra e venda, não há estimativas reais da movimentação econômica da meliponicultura no Brasil. O município de Santa Rosa de Lima, no estado de Santa Catarina, está coletando esses dados. A cidade, com pouco mais de 2 mil habitantes, é considerada um polo da meliponicultura: cerca de 70 famílias mantêm mais de 10.000 colônias matrizes, que podem ser comercializadas entre 150 e 400 reais (comunicação pessoal[1]).

Meliponários é o nome dado aos ambientes onde as colônias de abelhas sem ferrão são mantidas. Tradicionalmente, para a formação de um meliponário, os ninhos eram realocados para o local especificado para a instalação deste, com ou sem a porção do tronco onde se encontravam. Entretanto, já há algumas décadas, têm se desenvolvido a criação chamada de racional, em que, durante a época de cópula e dispersão, a rainha recém-fecundada e algumas operárias são atraídas para um ninho-isca. Ninhos-isca são feitos com caixas de madeira, garrafas PET ou outras cavidades artificiais que ofereçam um local atraente para a nidificação e permitam o forrageamento livre das operárias. Posteriormente,

esses ninhos são transferidos para colmeias racionais que permitem a coleta de mel e a multiplicação artificial, evitando assim a retirada predatória de novas colônias da natureza (VELTHUIS; KOEDAM; IMPERATRIZ-FONSECA, 2005).

A forma mais barata e rápida para aumentar o número de colônias é a multiplicação dos ninhos por meio da divisão dos discos de cria, onde é necessária apenas uma nova colmeia de madeira e uma colônia populosa o suficiente para ser dividida. Aumentar o número de colônias é importante para a obtenção dos subprodutos de abelhas ou mesmo para o comércio dessas novas colônias.

A meliponicultura, como prática de subsistência e como um hobby, vem se popularizando intensamente nos últimos anos, fazendo com que os estoques comerciais e hobbistas sejam grandes mantenedores de colônias de abelhas sem ferrão (BARBIÉRI, 2018; GEHRK, 2010; JAFFÉ *et al.*, 2015; VELTHUIS; KOEDAM; IMPERATRIZ-FONSECA, 2005).

O interesse pela prática, e o seu potencial de expansão, pode ser observado comparando-se o número de membros em associações e em páginas dedicadas ao tema em plataformas como o Facebook. Por exemplo, Jaffé *et al.* (2015) estimaram cerca de cinco mil meliponicultores legalmente registrados no Brasil, enquanto que a página Meliponicultura – Abelhas Brasileiras sem Ferrão conta com 14 mil membros. Localmente, um exemplo é a Associação de Meliponicultores de Blumenau (AME Blumenau), que conta com mais de 180 associados, enquanto que o Grupo Meliponicultores do Vale de Santa Catarina, onde este município está inserido, conta com mais de 1.200 membros.

Já o levantamento do número exato de meliponicultores tem entraves. Barbiéri (2018), disponibilizando um questionário *on-line*, respondido de forma voluntária, obteve dados de 280 meliponicultores do estado de São Paulo. Entretanto, esse valor é subnotificado. A falta de acesso às ferramentas tecnológicas pelos produtores e o medo à exposição que muitos declaram são algumas das possíveis razões.

Ao contrário das atividades agrícolas tradicionais, meliponicultores têm o potencial de colaborar para a redução da necessidade de desmatamento e exploração de novos *habitat* e recursos naturais. Além disso, podem promover experiências de interação entre o homem e o ambiente, estimulando atitudes de conservação, de laços emocionais com os elementos naturais e de reflexão ambiental, além de aumentar a participação popular em políticas de cunho ambiental (ATHAYDE; STEPP; BALLESTER, 2016; CARVALHO *et al.*, 2018; CHANTHAYOD; ZHANG; CHEN, 2017; JAFFÉ *et al.*, 2015; MADERSON; WYNNE-JONES, 2016).

Entretanto, a conservação da diversidade e da identidade genética das espécies economicamente exploradas frequentemente se contrapõe aos interesses comerciais da maioria dos criadores de espécies nativas. Definições de práticas e normas de manejo são capazes de unir os interesses de conservação e de produção, como nos casos de peixes, como o salmão (SCHENEKAR; LERCETEAU-KHLER; WEISS, 2014), palmeiras, como o butiá (NAZARENO; DOS REIS, 2014), e insetos, sobretudo abelhas (BONATTI *et al.*, 2014; MUÑOZ *et al.*, 2014; SANTIAGO *et al.*, 2016).

O conhecimento da diversidade mantida pelos produtores pode contribuir para a adequação e a regulamentação dessa atividade como um banco reconhecido da diversidade genética nativa e como fonte de colônias matrizes para fins de reintrodução e conservação. Diante do exposto, é imprescindível que haja maior empenho de programas de conservação e mais incentivo à adoção de projetos de melhoramento sustentável que incluam o pequeno agricultor dentro desse cenário desenvolvimentista com fins de ampliação do mercado interno, gerando maior expectativa econômica e, consequentemente, preservando a biodiversidade e os recursos naturais necessários ao desenvolvimento (SILVA *et al.*, 2014).

Existem iniciativas nesse sentido, como o Projeto Manduri, o primeiro financiado pelo governo federal brasileiro, que visa à reintrodução de abelhas nativas e sua criação para fins socioeconômicos e conservacionistas no Rio Grande do Sul (ASSOCIAÇÃO PAPA-MEL DE APICULTORES DE ROLANTE, 2006), e, mais recentemente, o Plano de Fortalecimento da Cadeia Produtiva da Apicultura

e da Meliponicultura do Estado de São Paulo (SÃO PAULO, 2018), que separa as unidades de planejamento em pequenas divisões sociopolíticas.

Entretanto, o papel ecológico dos meliponários é controverso. Estudos com *Apis mellifera* indicam forte discordância no papel da manutenção artificial de abelhas, com resultados contraditórios indicando deterioração (DE LA RÚA *et al.*, 2013), ou a sustentação, ou mesmo aumento (HARPUR *et al.*, 2012; 2013) da diversidade genética local. O consenso é que a diversidade em meliponários reflete as práticas de manejo e transporte que os produtores realizam na manutenção da produção (SANTIAGO *et al.*, 2016). Assim, a criação pode refletir ou alterar o estoque genético local. Dessa forma, existem diversos fatores, desfavoráveis e favoráveis, a serem analisados quanto ao manejo de colônias de abelhas. Contudo, conclusões importantes de décadas de pesquisa em genética da conservação permanecem dentro da comunidade científica, e não são traduzidas em ações concretas no desenvolvimento de políticas internacionais para a conservação (LAIKRE, 2010).

2 DESENVOLVIMENTO DA LEGISLAÇÃO SOBRE MELIPONICULTURA

Devido o desconhecimento da diversidade genética e das consequências do seu gerenciamento, diversas leis específicas regulam a criação das ASF buscando a conservação do seu estado natural. A criação e a comercialização de colônias de abelhas nativas estão sujeitas a instrumentos normativos federais e estaduais, sendo que, até pouco tempo, não havia legislação específica para a manutenção de insetos sociais.

Portanto, as leis foram baseadas no princípio da precaução, citado na Declaração da Conferência das Nações Unidas sobre Desenvolvimento Sustentável – Rio/92. O princípio da precaução é definido como "a garantia contra os riscos potenciais que, de acordo com o estado atual do conhecimento, não podem ser ainda identificados" (MINISTÉRIO DO MEIO AMBIENTE). Dessa forma,

> Para que o ambiente seja protegido, serão aplicadas pelos Estados, de acordo com as suas capacidades, medidas preventivas. Onde existam ameaças de riscos sérios ou irreversíveis, não será utilizada a falta de certeza científica total como razão para o adiamento de medidas eficazes, em termos de custo, para evitar a degradação ambiental (MINISTÉRIO DO MEIO AMBIENTE).

Devido às leis restritivas e pouco específicas, a atividade meliponicultora ocorria, na maioria das vezes, irregularmente perante a legislação (CORTOPASSI-LAURINO *et al.*, 2006; GEHRK, 2010), e até 2015, mais da metade dos grandes meliponicultores comerciais brasileiros apontavam a legislação vigente como o maior empecilho da atividade (JAFFÉ *et al.*, 2015). Manifestações em tribunas e reuniões promovidas por associações de municípios com entidades políticas demonstraram as dificuldades do setor e exerceram grande pressão, resultando na evolução da legislação nos últimos anos (DALMAGRO, 2015; G1 BA, 2017; NSC TV, 2019).

O arcabouço legal ao qual a meliponicultura está submetida atualmente no Brasil possui uma série de particularidades e contradições que podem ser prejudiciais ao desenvolvimento da atividade e conservação das espécies de abelhas manejadas. Para a meliponicultura, existem dois tipos de normas relevantes: as relativas à criação das abelhas e as relativas à cadeia dos produtos das abelhas sem ferrão, como mel, pólen, própolis, entre outros.

Tratando-se das normas relativas à criação das abelhas sem ferrão, uma das primeiras normas aplicadas foi a Portaria Ibama (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis) n° 117 (BRASIL, 1997a), que regula o comércio de animais silvestres nativos (art. 10°), seguida pela Portaria do Ibama n° 118-N (BRASIL, 1997b), que normatiza os criadouros de animais silvestres com fins econômicos. Ambas exigem a marcação individual dos indivíduos (art. 7°), contendo a informação de idade e sexo.

A marcação e a individualização de cada um dos indivíduos evidenciam que a elaboração dessas portarias não considera a biologia dos insetos sociais. Ademais, a captura de animais ameaçados de extinção é vetada pela Portaria n° 118-N (art. 11), o que inviabiliza a captura de enxames por ninhos-isca, uma vez que são inespecíficos, ou seja, não se pode ter controle sob qual espécie se irá capturar. Esses dois artigos mostram que a legislação interpreta as ASF como animais silvestres, e a sua criação se categorizaria como animal silvestre em cativeiro.

Ainda nesta lei, o art. 20 veta a venda de matrizes para a formação de novos plantéis e para servirem de animais de estimação, sendo contrário aos hábitos tradicionais de meliponicultura e dos esforços atuais de fortalecer a atividade. Por outro lado, é prevista a possibilidade de o Ibama utilizar esse recurso para programas de reintrodução ou implementação de criadouros com caráter social, comunitário ou demonstrativo (art. 12), um potencial importante dos criadores de abelhas sem ferrão, principalmente das espécies ameaçadas.

Mais tarde, em 1998, é publicada a Lei Nº 9.605 de Crimes Ambientais (BRASIL, 1998), a instância mais alta que trata da criação de espécies nativas, que "Dispõe sobre as sanções penais e administrativas derivadas de condutas e atividades lesivas ao meio ambiente, e dá outras providências". De acordo com o art. 29, define o que são animais silvestres pertencentes à fauna brasileira: "São espécimes da fauna silvestre todos aqueles pertencentes às espécies nativas, migratórias e quaisquer outras, aquáticas ou terrestres, que tenham todo ou parte de seu ciclo de vida ocorrendo dentro dos limites do território brasileiro, ou águas jurisdicionais brasileiras." (BRASIL, 1998).

O mesmo artigo determina que qualquer interferência ou modificação de um ninho de animal silvestre, sua criação ou comercialização de partes, ovos, ninhos ou produtos derivados, é crime, quando realizadas sem as devidas autorizações. Assim, a Lei de Crimes Ambientais gera a necessidade de autorizações tanto para a criação de abelhas sem ferrão, enquadradas na definição de animais silvestres, quanto para a comercialização dos seus produtos ou partes dos ninhos.

Buscando compatibilizar a criação de abelhas sem ferrão por pequenos produtores, que em sua maioria criavam abelhas sem ferrão para consumo doméstico do mel, em 2004, o Conselho Nacional do Meio Ambiente (Conama), na Resolução N° 346, foi o primeiro a disciplinar a utilização das abelhas silvestres, regular a implantação de meliponários (art. 1°) e a captura de novas colônias por meio de ninhos-isca (art. 3°) (BRASIL, 2004).

A resolução mantém a necessidade de autorização para a manutenção de abelhas sem ferrão para plantéis com mais de 50 colônias e que se dediquem à prática artesanal da meliponicultura de espécies de ocorrência geográfica natural na área de instalação do meliponário (art. 5°), reafirmado pela Instrução Normativa n° 169 (BRASIL, 2008). Porém, além do Cadastro Técnico Federal do Ibama (instituído pela Lei Federal 6.938/1981), que é exigido a todos os criadores, não há um sistema federal para se solicitar a autorização de manejo de abelhas sem ferrão, empurrando automaticamente qualquer meliponicultor com mais de 50 colônias para a irregularidade.

Essa regra impossibilita que a venda do mel seja o principal meio de vida de uma família, pois cada enxame pode produzir cerca de apenas 4 quilos de mel por ano. A resolução ainda permite o transporte entre estados, apenas para fins científicos, somente com autorização do Ibama (art. 6°). Esse artigo considera as divisões políticas do território como predominantes na distribuição natural das espécies, sem considerar as diversas fisionomias vegetais que um mesmo estado pode apresentar, ou então a continuidade dos biomas entre as denominações políticas.

A Resolução Conama N° 346 ainda regulamenta os ninhos-isca e a obrigatoriedade de que as colônias mantidas e comercializadas sejam provenientes de métodos de multiplicação artificial (art. 4°), prevenindo que as colônias sejam retiradas de troncos de árvores ainda vivas, evitando assim a extração predatória da espécie (BRASIL, 2004). Apesar da Resolução não permitir a extração de colônias da

natureza, estabelece que os desmatamentos ou empreendimentos facilitem a retirada dos enxames da sua área de impacto (art. 7°). Essa Resolução dá um passo importante considerando inicialmente que as abelhas, bem como seus criadouros, são bens de uso comum do povo e também a importância da meliponicultura para a economia local e para a sustentabilidade de ambientes naturais e sistemas agrícolas. Porém, ressalva que as abelhas, por viverem naturalmente fora do cativeiro, constituem parte da "fauna silvestre" nativa.

Assim como a Lei de Crimes Ambientais de 2008, a fauna silvestre nativa é definida pelo art. 2° da Instrução Normativa do Ibama N° 7 como "todo animal pertencente à espécie nativa, migratória e qualquer outra não exótica, que tenha todo ou parte do seu ciclo de vida ocorrendo dentro dos limites do território brasileiro ou águas jurisdicionais brasileiras" (BRASIL, 2015).

A Instrução Normativa n° 7 também categoriza os estabelecimentos de uso e manejo de fauna silvestre em cativeiro (art. 3°), podendo ser para fins de conservação, pesquisa ou comercial (BRASIL, 2015). Entre as categorias de fins econômicos, aquela destinada à comercialização é vedada de realizar a reprodução dos indivíduos, prática resguardada para estabelecimentos definidos como "criadouros comerciais". A dificuldade de aplicação dessa normativa para os insetos sociais se dá pela continuidade do processo de reprodução dos indivíduos de uma colônia.

Nesse caso, a definição de "reprodução" mais adequada seria a de multiplicação artificial das colônias racionais, e não dos indivíduos em si, também não especificado pela Resolução 346 do Conama que trata das abelhas nativas (BRASIL, 2004). Esses estabelecimentos devem possuir a Autorização Prévia, de Instalação, e a de Uso e Manejo, caso mantenham mais de 50 colônias. Os plantéis preexistentes devem ser comprovados documentalmente por autorizações e licenças de captura, de transporte ou notas fiscais emitidas por criadouros ou comerciantes autorizados. Não é regulamentado o uso de ninhos-isca.

Os Instrumentos Normativos supracitados não mencionam nenhuma espécie de abelhas. Até que em 2014 foi editada a Portaria 444 do Conama (BRASIL, 2014) que proíbe a captura, transporte, armazenamento, guarda, manejo, beneficiamento e comércio de espécies ameaçadas de extinção, a não ser com o objetivo exclusivo de pesquisa e conservação. A portaria especifica as abelhas em extinção no Brasil, sendo elas: *Melipona capixaba* (uruçu-negra e uruçu-capixaba); *Melipona rufiventris* (tujuba, uruçu-amarela-do-cerrado); *Melipona scutellaris* (uruçu-nordestina) e *Partamona littoralis* (boca-de-sapo-da-paraíba), todas com potencial econômico explorado, amplamente cultivadas por hobbitas e, especialmente no caso das Meliponas, com papel socioambiental histórico.

Embora ambas as leis interpretem as abelhas sociais sob cuidados humanos como "cativas", elas permanecem em liberdade e colaborando com os serviços ecossistêmicos, o que leva muitos produtores a defenderem que as ASF mantidas em meliponário deveriam ser tratadas sob a definição de "fauna doméstica", descrita como:

> conjunto de espécies da fauna cujas características biológicas, comportamentais e fenotípicas foram alteradas por meio de processos tradicionais e sistematizados de manejo e melhoramento zootécnico tornando-as em estreita dependência do homem, podendo apresentar fenótipo variável, mas diferente da espécie silvestre que as originou (BRASIL, 2018).

Essa visão tem como argumento publicações de diversas espécies que tratam sobre a relação e criação tradicional das abelhas, e racionalização das caixas de cultivo que permite que as espécies sejam criadas fora do *habitat* natural, manejo de doenças e métodos de alimentação (AIDAR, 1996; AIDAR; CAMPOS, 1998; BRUENING, 2001; CONTRERA; MENEZES; VENTURIERI, 2011; KERR; CARVALHO-ZILSE; NASCIMENTO, 1996; NOGUEIRA NETO *et al.*, 1986; ROUBIK, 2018; VENTURIERI, 2008; VILLAS-BÔAS, 2012) .

Há ainda evidências de que a espécie *Melipona quadrifasciata* (mandaçaia), ameaçada de extinção, foi de fato extinta no estado do Rio Grande do Sul e está sendo reintroduzida pelos produtores e hobbistas (DÍAZ *et al.*, 2017; MARQUES *et al.*, 2003; WITTER; BLOCHTEIN, 2009). A reintrodução está ocorrendo de forma desordenada e sem o devido controle sobre a identidade genética e ecológica da espécie, pois não é permitida e, por esse motivo, não há parâmetros a serem seguidos. Porém, constitui uma prova da estreita dependência que essa espécie tem do homem para se restabelecer em seu ambiente outrora natural, e de que esses produtores podem se tornar aliados na conservação da espécie e na manutenção da variabilidade genética e dos serviços ecossistêmicos prestados pela espécie.

Com a atividade meliponicultora ganhando reconhecimento, e considerando o art. 8º da Lei Complementar nº 140 (BRASIL, 2011), que estabelece como responsabilidade dos estados a aprovação do funcionamento dos criadouros da fauna silvestre, estão sendo publicadas leis estaduais específicas, bastante heterogêneas. Elas têm em comum o fato de estarem mais alinhadas com os métodos de captura de colônias por ninho-isca e os métodos de divisão das colônias já existentes. Alguns estados possuem regulamentos próprios que disciplinam as autorizações regionais de criação, e em alguns casos sem concordância com a Resolução Conama N° 346, como aponta o parecer 00122/2018/Conjur-MMA/CGU/AGU da Consultoria Jurídica da União.

Pode-se citar como exemplo a Lei 16.171 (SANTA CATARINA, 2013) e o Decreto 178 (SANTA CATARINA, 2015) que a regulamenta, que se destacam por liberarem o manejo de abelhas e seus produtos, assim como a compra de ninhos e favos de cria, sem necessidade de apresentação de comprovante de proprietário rural, e desde que o transporte seja feito dentro dos limites políticos do estado de Santa Catarina, mediante a emissão de Guia de Trânsito Animal (GTA). No Rio Grande do Sul, existe a Lei 14.763 (RIO GRANDE DO SUL, 2015), que regulamenta a meliponicultura, e a Instrução Normativa (IN) Sema 3 (RIO GRANDE DO SUL, 2014) que traz uma lista das 24 espécies de abelhas nativas que são permitidas de serem mantidas no estado.

Porém, essa lista é bastante criticada por excluir a *M. quadrifasciata*, que é uma das espécies mais cultivadas, e alguns produtores argumentam que seria nativa. De acordo com essa IN, ficam dispensados da obtenção da autorização de funcionamento os meliponários com até 100 colônias (art. 7°), mais permissiva do que a portaria do Conama de 2004, que indica 50 colônias.

Além disso, é permitido no território do Rio Grande do Sul, sem necessidade de autorização, o transporte de colônias ou parte delas (art. 13). Outros estados apresentam iniciativas, como a Lei 13.905 no estado da Bahia (BAHIA, 2018), a Resolução Cemaam 22 do Amazonas (AMAZONAS, 2017), a Resolução Estadual *Ad referendum* 007 de Goiás (GOIÁS, 2017), Lei 19.152 do Paraná (PARANÁ, 2017), e está em trâmite o Projeto de Lei 4.943 de Minas Gerais (MINAS GERAIS, 2014), cada uma com suas peculiaridades.

3 PRODUTOS MELIPONÍCOLAS

Se a criação e comercialização das abelhas nativas apresentam entraves, não é diferente com seus produtos. Mel e própolis de ASF estão sujeitos às normas da Divisão de Leite e Derivados (Dilei), subalterna ao Ministério da Agricultura (MA). As principais diretrizes são do Decreto 9.013 (BRASIL, 2017), que dispõe sobre a inspeção industrial e sanitária de produtos de origem animal e apresenta diversos avanços em relação ao Decreto anterior, 30.691 (BRASIL, 1952), que insere no art. 2° os produtos apícolas às mesmas regulações de derivados de açougue, caça, pesca, leite e ovos (BRASIL, 1952). Estão sujeitos também à Portaria do Ibama N° 117 por serem provindos de animais silvestres, porém, esta não faz nenhuma menção sobre abelhas ou produtos apícolas (BRASIL, 1997a).

Apesar de o mel de abelhas nativas ser encontrado à venda em comércios locais, a comercialização de produtos de ASF é dificultada por não haver parâmetros de qualidade adequados para mel e própolis de abelhas nativas, devido às suas características exclusivas e divergentes dos produtos de *Apis* sp.

A Instrução Normativa 11 (BRASIL, 2000) define o mel pelo seu processo de obtenção (2.2.2.), onde se enquadra como sendo aquele obtido por "escorrimento dos favos desoperculados, sem larvas"; "prensagem dos favos, sem larvas"; "centrifugação dos favos desoperculados, sem larvas", claramente ignorando a existência de espécies apícolas que não formam favos em suas colônias, caso de todas as espécies de abelhas nativas.

Nessa instrução são ainda apresentados valores de referência de características físico-químicas, elaboradas para atender à demanda do mel de *A. mellifera*. Porém, vários desses atributos não são alcançados pelo mel de ASF. Além disso, a própria variabilidade de características que as abelhas nativas exibem, mesmo sendo criadas no mesmo local, é indicativo de que a legislação deve estabelecer parâmetros para cada uma das espécies (BILUCA *et al.*, 2016; DUARTE *et al.*, 2018).

Como exemplo, o mel de jandaíra (*Melipona subntida*), uma das espécies mais cultivadas no nordeste brasileiro, não atende às conformidades de umidade e atividade de diástase (ALMEIDA-MURADIAN *et al.*, 2013) e, na maior parte dos estudos, nenhuma espécie de abelha nativa atende aos valores recomendados de umidade máxima, sendo que *M. quadrifasciata*, cultivada em toda a Mata Atlântica, exibe valores de umidade maiores do que o dobro do valor de referência (BILUCA *et al.*, 2016). No caso da *Melipona mondury* (uruçu-amarela), apenas a atividade da diástase está dentro dos limites aceitos pela legislação atual (ALVEZ *et al.*, 2018).

O "Selo Arte" foi criado com a Lei 13.680 (BRASIL, 2018) e trouxe avanços em relação à comercialização dos méis de abelhas sem ferrão, uma vez que os produtos artesanais de origem animal, que passaram por fiscalizações regionais (municipal ou estadual) passam a ter a sua comercialização permitida em todo o território nacional devendo apresentar, para isso, o Selo Arte e seguir as suas normas de aplicação na embalagem dos produtos artesanais. A exemplo da empresa MBEE, focada na difusão do uso de méis nativos na alta gastronomia, que a partir do Selo de Inspeção Municipal (SIM) do município de Atibaia-SP, passa a comercializar seus produtos em todo o território nacional.

Outro caso de destaque é o Projeto Heborá, uma rede colaborativa que capacita mulheres camponesas para a meliponicultura e comercialização de mel, que, com o Selo Arte, encontra a possibilidade de atingir um público consumidor mais amplo e, por consequência, apoiar mais famílias em situação vulnerável.

Dessa forma, a regulamentação do Selo Arte (Portaria CDA 01/2020) representa uma desburocratização para a comercialização do mel de abelhas sem ferrão, já que não possui critérios de inspeção em nível federal. Assim, nos estados e municípios em que existem regulamentos para os méis de abelhas nativas, os produtos aprovados nas inspeções regionais, e que se enquadrem como artesanais, são desobrigados de possuírem o Selo de Inspeção Federal (SIF) para comercializar seus produtos fora do município ou estado em que passaram por processo fiscalizatório de inspeção.

Porém, ainda existe a necessidade da elaboração de critérios físico-químicos e sanitários para a comercialização do mel de abelhas sem ferrão em diversos estados, ou mesmo a atualização dos critérios físico-químicos em regiões em que o mel de poucas espécies de abelhas sem ferrão foi amostrado, uma vez que algumas espécies possuem méis com alta acidez e, mesmo respeitando todos os critérios sanitários, não passam no teste da inspeção. Para a elaboração de critérios federais, seria necessário um grande esforço de pesquisa para definir as diferenças nos atributos físico-químicos dos méis nativos, evitando tornar a norma restritiva, de forma a prejudicar a comercialização dos produtos.

Os diversos biomas brasileiros e a biodiversidade distinta de cada um deles criam características regionais, inclusive de caracterização do mel, que seriam de difícil abordagem por leis federais, mais generalistas. Existem esforços estaduais para atender a essa demanda. O pioneiro foi o estado da Bahia, com a Portaria Adab 207 que regula a qualidade do mel para abelhas do gênero *Melipona*, e, em caso prático, poderia se estender a outros gêneros por analogia como método de integração da norma (BAHIA, 2014).

No estado de São Paulo, há o Regulamento Técnico de Identidade e Padrão do mel de abelhas sem ferrão, por meio da Resolução SAA-52 (SÃO PAULO, 2017), baseado no artigo de Camargo, Oliveira e Berto (2017), que abrange seis gêneros de Meliponini. Tal resolução merece revisão e inclusão de dados de mais espécies de abelhas de diferentes regiões do estado de São Paulo, de forma a contemplar a diversidade de características de seus respectivos méis, que variam muito, tanto de acordo com a espécie quanto com a região, que apontam que a umidade, acidez livre, pH e índice HMF variam muito mais do que o previsto pela portaria e ainda assim atendem todos os requisitos sanitários necessários para o consumo.

O estado de São Paulo também conta com o Plano de Fortalecimento da Cadeia Produtiva da Apicultura e da Meliponicultura do Estado (SÃO PAULO, 2018), que usa pequenas unidades administrativas para o acompanhamento da atividade. Essas unidades são usadas para outras ações de cunho ambiental e com necessidade de polinização, como silvicultura, produção de abacate, algodão e café, e passaram a fazer parte do levantamento de quantidade de colônias, pasto apícola e produção de mel a partir da criação desse plano. Com a inviabilidade de conhecer toda a estrutura populacional em fina escala de todas as espécies apícolas da região, a adesão de pequenas unidades vai de acordo com o recomendado para a conservação de espécies selvagens e exploradas comercialmente (LINNELL, 2005).

4 CONSIDERAÇÕES FINAIS

É evidente a preocupação e os esforços que as esferas federais e estaduais estão dispensando para a melhoria das práticas de manejo e de beneficiamento dos produtos das abelhas nativas, visando alcançar os objetivos de preservação garantidos pela Constituição e também a garantia de ganhos econômicos para a população. Estudos empíricos sobre as especificidades na diversidade genética, nutrição artificial, disseminação de doenças e sobre práticas na obtenção dos subprodutos de abelhas sem ferrão, por exemplo, devem ser avaliados na redação de normas que respeitem a biologia das espécies sociais nativas, de forma que não seja um empecilho para o fortalecimento da atividade da meliponicultura e a manutenção da cultura.

Atualmente, há Projetos de Lei em trâmite que influenciarão o futuro da atividade, o Projeto de Lei N° 6.560, que Institui a Política Nacional de Incentivo à Produção Melífera e ao Desenvolvimento de Produtos e Serviços Apícolas e Meliponícolas de Qualidade, apresenta uma série de aspectos potencialmente positivos para as cadeias da apicultura e meliponicultura. Deve-se levar em conta, porém, que a atividade da meliponicultura é muito diferente da já bem estabelecida Apicultura.

A política deve estimular o desenvolvimento de técnicas e tecnologias para a meliponicultura, bem como priorizá-la em relação à apicultura, tendo em vista que as abelhas sem ferrão são espécies nativas do Brasil, ao contrário das amplamente cultivadas *A. mellifera*. Há ainda um Projeto de Lei em aperfeiçoamento que busca regulamentar as profissões de Tecnólogo em Apicultura e Meliponicultura e de Especialista em Apicultura e Meliponicultura, que, caso estabelecidas, irão impulsionar as tecnologias de cultivo e exploração (BRASIL, 2019b).

A legislação também deve incentivar a criação das espécies de Meliponini em suas áreas de ocorrência natural, incluindo espécies ameaçadas de extinção, de forma a direcionar a meliponicultura enquanto atividade geradora de renda, a também tornar-se uma ferramenta de conservação. Tais políticas podem também incluir pagamento por serviços ambientais para meliponicultores cadastrados que criem as espécies ameaçadas em sua área de ocorrência, tratado no Projeto de Lei n° 5.028 (BRASIL, 2019a). Restrições sobre o número de enxames de cada espécie que pode ser mantido devem ser relaxadas, visto que a produção de mel é pequena, da mesma forma que as restrições que especificam as espécies que podem ser atraídas para ninhos-isca, visto que a escolha do enxame está além do controle do meliponicultor.

Existem movimentos de meliponicultores que visam tornar as abelhas sem ferrão animais domésticos do ponto de vista legal, o que traria novos problemas para a conservação das abelhas em todos os níveis, colônias, populações e espécies, e alteraria a interpretação de toda a legislação supracitada neste breve histórico.

A possibilidade de transformar os meliponíneos em animais domésticos do ponto de vista legal traria prejuízos para sua conservação, mas há a possibilidade de tratar a meliponicultura sem todas as limitações da Resolução do Conama N° 346: determinar regras básicas para a atividade, compatibilizando a geração de renda para os meliponicultores e a conservação dos meliponíneos, alterando a Lei de Crimes Ambientais a exemplo do que acontece com a atividade pesqueira, e, então, criar uma Política Nacional de Meliponicultura, devidamente fundamentada em aspectos técnico-científicos.

A Lei de Crimes Ambientais trata a pesca como uma exceção à fauna, ou seja, como recurso pesqueiro, exceto em casos de espécies ameaçadas, disciplinado pela Lei nº 11.959 (BRASIL, 2009). A necessidade da revisão da Lei de Crimes Ambientais se deve à hierarquia das leis federais sobre as estaduais, sendo estas que então levariam em consideração as especificidades locais.

Essas sugestões, além de parâmetros técnicos sobre os produtos apícolas que respeitem a biologia de cada espécie, seriam boas alternativas para regulamentar a meliponicultura enquanto atividade promotora da sustentabilidade, indo ao encontro dos objetivos estabelecidos pela Iniciativa Internacional para a Conservação e Uso Sustentável de Polinizadores (CONVENTION ON BIOLOGICAL DIVERSITY), mantendo, além da biodiversidade das abelhas, a biodiversidade agrícola e a conservação das plantas dependentes de polinização.

NOTAS

1 | Entrevista concedida pelo responsável técnico de Ovos, Laticínios e Mel da Prefeitura Municipal de Santa Rosa de Lima, Luiz Miguel Rech, a Jaqueline Reginato koser em 07/04/2020.

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Socio-environmental accounting system in health management: a case study at the Vision Institute

Sistema contábil socioambiental para gestão em saúde: um estudo de caso no Instituto da Visão

Tatiana Camasmie Abe[a]

Simone Georges El Khouri Miraglia[b]

[a]Universidade Federal de São Paulo, Unifesp, São Paulo, SP, Brasil
E-mail: tatiana_abe@yahoo.com.br

[b]Universidade Federal de São Paulo, Unifesp, São Paulo, SP, Brasil
E-mail simone.miraglia@unifesp.br

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ABSTRACT

In recent years, the society has increased the pressure on institutions to improve their social and environmental efforts, in addition to economic considerations in decision-making and internal behavior. This study analyzes the applicability of socio-environmental management tools in the health care sector through the partial application of the Environmental Management Accounting System called SICOGEA – Generation 3. This is an investigative and descriptive case study conducted at the Vision Institute (São Paulo Institute of Studies and Research in Ophthalmology, Brazil), where information was collected through semi-structured interviews. The results demonstrated that the studied institution has a level of general sustainability of 22.4%, which is considered "Weak." This means that although it conducts certain initiatives for environmental management, the institution may be causing damage to the environment.

Keywords: Environmental management. Socio-environmental Accounting System. Sustainability.

RESUMO

A sociedade vem aumentando nos últimos anos a pressão sobre as instituições que não observam os aspectos sociais e ambientais, além do econômico, na tomada de decisão e conduta interna. Este estudo tem como objetivo analisar a aplicabilidade de uma ferramenta gerencial socioambiental na Gestão em Saúde, por meio da aplicação parcial do Sistema Contábil Gerencial Ambiental (SICOGEA) – Geração 3. A natureza da pesquisa é exploratória e descritiva e se caracteriza como um estudo de caso no Instituto da Visão (Instituto Paulista de Estudos e Pesquisas em Oftalmologia, Brasil) utilizando-se de entrevistas semiestruturadas. O resultado obtido demonstrou que a instituição estudada possui um grau geral de sustentabilidade de 22,4%, que é considerado "Fraco", segundo

a metodologia utilizada, o que significa que, embora existam algumas iniciativas na área da gestão ambiental, a instituição pode causar danos ao meio ambiente.

Palavras-Chave: Gestão ambiental. Sistema contábil socioambiental. Sustentabilidade.

1 INTRODUCTION

Organizational business decisions are typically based solely on economic considerations, which has triggered or aggravated socio-environmental problems in many countries over the years. In the search for solutions to such problems, the idea of sustainable development emerged, which is based simultaneously on three dimensions: economic, social, and environmental. Therefore, it is a strategy to meet the needs of current generations without compromising the needs of future generations (BRUNDTLAND, 1988).

The use of socio-environmental management tools has become widely used by institutions that seek to control the impact of their activities on the environment. Comprehensive environmental management requires collaboration between several departments within an institution since the interaction between administration and production influences the effectiveness of the process (SANTOS et al., 2001).

In this context, this study applies the first step of the third phase of the Environmental Management Accounting System called SICOGEA, which examines environmental, social, and economic indicators. This is a qualitative-quantitative model that helps to diagnose institutional activities in a socio-environmental scope, identify critical points regarding sustainability, and structure a management plan to address areas in need of improvement (PFITSCHER, 2004).

This was the first time SICOGEA was applied in the health sector in São Paulo, SP, Brazil. The health sector represents one of the most complex and far-reaching sectors, particularly in terms of the interrelated impacts that the environment has on the health of the population. According to the World Health Organization (WHO) data from 2011, global health expenditures amounted to approximately 9% of gross world product (WHO, 2014).

Healthcare managers are facing the challenge of modernizing their management models to include principles of excellence and quality in different areas. Building an integrated and managerial health system is necessary to meet the expectations and health needs of the population (Lorenzetti *et al.*, 2014).

2 OBJECTIVES

This study aimed to evaluate whether the application of a socio-environmental accounting system for a healthcare facility is feasible and to analyze the results of this application. The assessment was performed as a case study at the São Paulo Institute of Studies and Research in Ophthalmology (IPEPO), also known as the Vision Institute, in São Paulo, SP, Brazil.

We implemented a partial application (first step of the third phase) of the SICOGEA methodology in IPEPO to analyze the contribution of the tool to the institution and the flexibility of the system.

This paper highlights the pioneering application of SICOGEA in the State of São Paulo, as well as the low cost of implementing the methodology and the improvements offered by the socio-environmental management tool in a particular environment.

3 LITERATURE REVIEW

Since the 1950s, a significant change has been observed around the world in the way people view the economy and its association with society (DE CASTRO *et al.*, 2011). This change intensified after World War II, mainly because of the fear of pollution from nuclear radiation. In 1962, the environmental movement gained notoriety with the publication of Rachel Carson's book, "Silent Spring," which criticized the health effects of synthetic pesticides in agriculture and highlighted the need for the preservation of the environment to protect human health (JACOBI, 2005; NASCIMENTO, 2008). It was noticed that the physical, social, and economic environments were intrinsically linked, and the deterioration of the environment could lead to negative outcomes in people's health.

Consequently, the United Nations Conference on the Human Environment was convened in Stockholm, Sweden in 1972. This conference implemented the Declaration on the Human Environment, also known as the Stockholm Declaration, and established the principles for international environmental issues, including human rights, natural resources management, pollution prevention, and the relationship between the environment and development (NOHARA et al., 2006).

Due to the increasing pressure from the interested parties, the adoption of environmental management systems (EMSs) as a tool for integrating policies, programs, and corporate practices for environmental protection became more widespread among national and multinational companies around the world (MORROW; RONDINELLI, 2002; SIMON et al., 2012). Many EMSs were created and, specifically in Brazil, the systems involved environmental accounting, social balance, value-added statements, global reporting initiatives, integrated reporting, and management of environmental aspects and impacts. The Environmental Management Accounting System SICOGEA was recently added to the suite of environmental management tools used in Brazil, and its prominence has developed rapidly.

3.1 ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

An EMS is a management tool that enables an entity to monitor and control the impact of its activities on the environment through a set of processes (TINOCO; KRAEMER, 2008). Researches indicate that EMS implementation has some advantages, such as conserving raw materials and inputs, satisfying customers' environmental expectations, satisfying criteria for bank loans, limiting risk, reducing insurance costs, and maintaining good relations with the community (BARATA *et al.*, 2007; SANTOS, 2013). Moreover, customer loyalty is highlighted as a financial benefit (Feng *et al.*, 2016).

However, it is worth remembering that improper implementation, misaligned with the company's strategy or without a thorough understanding of the purpose, can lead to non-recovery of investment (LUCAS & NOORDEWIER, 2016).

Internationally, the most commonly used EMSs are the International Organization for Standardization (ISO) 14000 (International Organization for Standardization 2015) and the Eco-Management and Audit Scheme (EMAS). In Brazil, two other prominent EMSs are Management of Environmental Aspects and Impacts (GAIA) and SICOGEA.

3.2 MANAGEMENT OF ENVIRONMENTAL ASPECTS AND IMPACTS - GAIA

The GAIA method, created by researcher Alexandre Lerípio, manages the environmental performance of organizations based on ISO 14000. According to Nardelli and Griffith (2003), ISO 14000 is a series of standards updated by the ISO, to standardize the voluntary implementation of EMSs in various sectors and help companies to manage their products, services, and processes in a way that does not negatively affect the environment and the community. The GAIA method focuses on achieving

environmental sustainability through the study of organizational processes and their relationship with the environment (LERÍPIO, 2001). In addition to adhering to initial ISO guidelines, it also proposes continuous improvement and prevention.

3.3 ENVIRONMENTAL MANAGEMENT ACCOUNTING SYSTEM – SICOGEA

SICOGEA was based on the GAIA method and consists of an environmental management tool developed in Brazil that links accounting of environmental impact with controls (PFITSCHER, 2004). According to Uhlmann (2011), this method represents a management model combined with the Accounting and Environmental Management tool, which is applicable to the organizations in different sectors. The model allows the evaluation of environmental events and transactions as well as assists in the identification of critical points regarding sustainability.

Fifty-five publications were identified (articles, final course papers, theses, dissertations) that examined SICOGEA, published during the period from 2003 to 2018. These publications cover a wide variety of sectors, such as trade companies, infrastructure (energy distribution, sanitization), hospitals/health, industry, government agencies, general services, education, and technology (Figure 1).

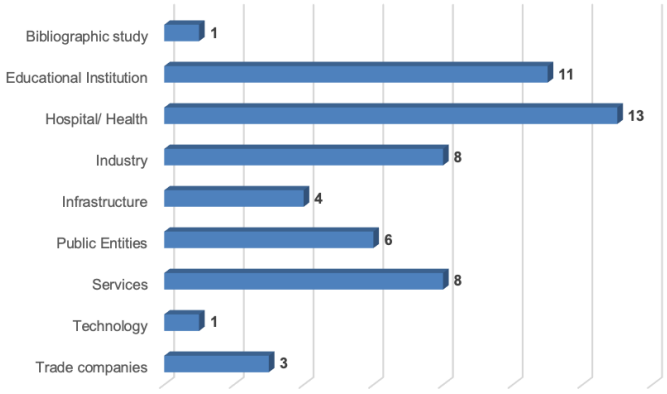

Figure 1 | Publications on SICOGEA from 2003 to 2018 by sector.

Source: Elaborated by the author.

This literature review shows the prominence of the health sector in these studies. Twelve studies were done in the healthcare industry, representing a plurality at 26% of the total studies identified in the study period. According to Pfitscher (2004), SICOGEA has three distinct phases (Figure 2):

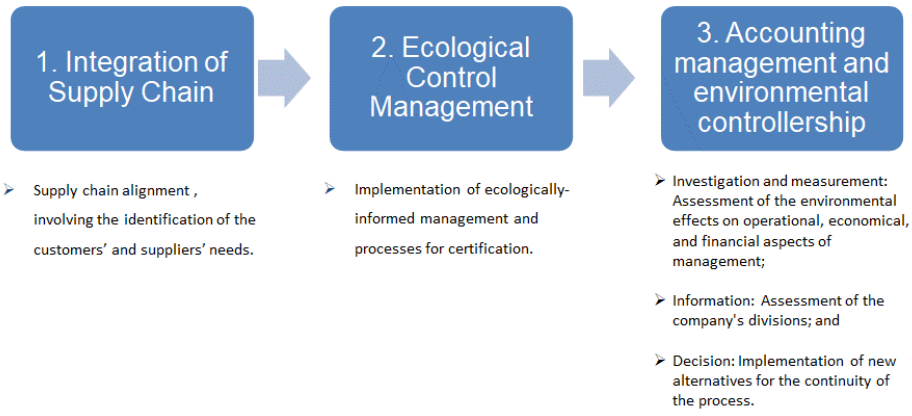

Figure 2 -| SICOGEA phases.

Source: Elaborated by the author, adapted from Pfitscher (2004) and Nunes (2010).

This study will focus on the first step of the third phase, called "Investigation and measurement". This step's goal is to evaluate the environmental performance of the institution using a checklist structured based on groups and subgroups. The next step is to raise awareness and secure commitments from those involved in the sectors that require environmental improvement. In the "Information" step, a detailed mapping of the value chain is performed, developing an inventory of environmental aspects and impacts. In the "Decision" step, suggestions provided by the model are implemented as well as actions that could reveal further opportunities for improvement are proposed while considering the technical feasibility and accounting of these actions (NUNES, 2010). Since SICOGEA's creation, it has been updated twice, with Generation 3 released in 2011 that further maximizes the model's structure.

4 METHODS

The methodology adopted in this study was investigative and predominantly qualitative (GIL, 2002). The case study was conducted at the Vision Institute, for evaluating the partial application of the Environmental Management Accounting System called SICOGEA - Generation 3.

The approach being qualitative and quantitative, the inherent characteristics are: (i) restriction in the application of the methodology, as it was a case study in a specific institution, and consequently, its results cannot be generalized broadly to other institutions (however, this fact do not reduce its importance to compile the knowledge base for future studies) and (ii) the analysis relied on the competence of the responses obtained in the interviews.

This study implemented the "Investigation and measurement" step of the third phase of SICOGEA – Generation 3, which consists of the following items: a) sustainability and environmental strategy that defines key groups and subgroups for the checklist and semi-structured interviews, calculates levels of sustainability, defines environmental performance, and establishes a concise action plan; b) commitments that allow for verification that they align with the mission, vision, policies, and goals of the strategy; c) a sensitivity check of the interested parties that engage with and monitors participants and their perception of their responsibilities in the context of their institution's social and environmental responsibilities.

For each item on the checklist that was used to frame the interviews, the researcher assigned a value on a scale of zero to five points or N/A (not applicable) and weighting to each item. It is possible to calculate the points achieved in each question, multiplying the possible points by the weighting, as the scale proposed from information supplied by the respondent to the researcher.

By dividing the sum of the points achieved by the total possible points, we could determine the level of sustainability of the institution (Figure 3):

$$\text{General level of sustainability: } \frac{\textit{Points achieved}}{\textit{Possible points}}$$

Figure 3 | Formula for the general level of sustainability.

Source: Nunes (2010).

To avoid distortions in the level of general sustainability of the institution, as a result of key groups and subgroups of different sizes, it was necessary to weight the contributions of each one, using the following formulas (Figure 4):

$$\%\ Contribution\ of\ the\ subgroup = \left\{\left(\frac{Total\ of\ possible\ points\ of\ the\ subgroup}{Total\ of\ achieved\ points}\right) \times \left(\frac{100}{Total\ amount\ of\ subgroups\ in\ the\ questionnaire}\right)\right\} \times 100$$

$$\%\ Contribution\ of\ the\ key-group = \left\{\left(\frac{Total\ of\ possible\ points\ of\ the\ key-group}{Total\ of\ points\ achieved}\right) \times \left(\frac{100}{Total\ amount\ of\ key-groups\ in\ the\ questionnaire}\right)\right\} \times 100$$

Figure 4 | Formulas for the weighted percentage contribution of the subgroups to the key group.

Source: Nunes (2010)

After an initial interview with the General Superintendent of the institution, the checklist was finalized, consisting of 134 questions associated with key groups and subgroups and a corresponding weight assigned to each question.

The interviews were conducted from April 13 to May 5, 2016, with five employees responsible for the following areas: human resources, contracts, accounting, ambulatory, and surgical centers.

There was no review of supporting documentation related to the interview content as part of this case study since the partial application proposed in this study did not cover this type of investigation.

5 RESULTS

IPEPO, or the Vision Institute, is a non-governmental and non-profit organization (association) founded in 1990 and staffed by professors from the Medical School of the Federal University of São Paulo, Brazil. IPEPO provides medical services through diagnostics, clinical treatments, and surgeries in assistance or teaching projects, with a mission to contribute to advances in ophthalmology and make them accessible to all.

The vision and mission of IPEPO are fully compatible with the goal of sustainability as well as the desire to be a national leader in eye health. The IPEPO clinical and administrative staff in 2015 totaled 72 employees.

The resources managed by IPEPO originated from concerned health providers, protocols, grants, and contracts/agreements primarily with the Brazilian Unified Health System (SUS). According to the data from 2015, IPEPO held 242,936 visits/procedures, of which 91% (221,807) were patients of the SUS, and the remaining 9% (21,129) were private patients, patients of health operators, and patients of the Municipal Public Server Hospital (IPEPO, 2016).

From 2011 to 2015, 644,577 visits were conducted, of which 92% (590,118) were referred by the SUS and 8% (54,459) referred by other calls. In the same period, IPEPO presented an annual growth rate of approximately 9.75% per year, as shown in the following figure (Figure 5):

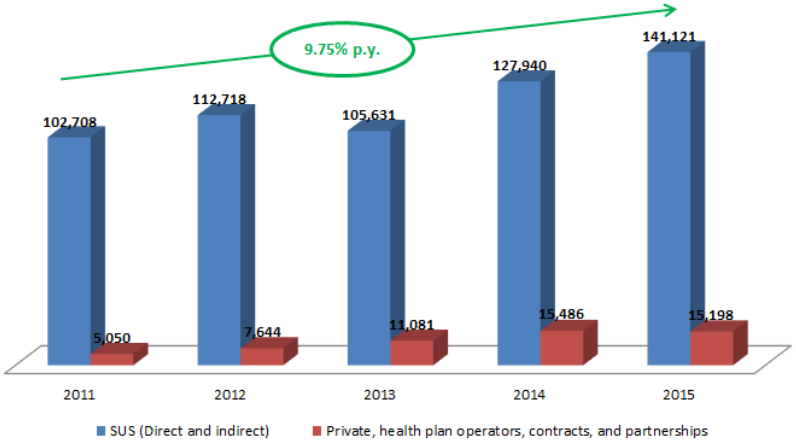

Figure 5 | Visits conducted at IPEPO from 2011 to 2015.

Source: Elaborated by the author.

IPEPO was chosen for this research because of the accessibility to data necessary for the completion of this study, which aligns with its origin as an institution of professors from the Medical School of the Federal University of São Paulo, Brazil. Presently, the institution does not have a socio-environmental tool for management support, although it is interested in growing sustainably.

5.1 RESULTS OF SICOGEA APPLICATION

Considering the weighted score of each question, the level of general sustainability (percentage of achievement) was obtained for each key group and subgroup, as follows (Table 1):

Table 1 | Level of general sustainability.

Level of general sustainability				
Key group	*Subgroup*	*Points achieved*	*Possible points*	*Percentage of achievement*
SERVICES RENDERING	Suppliers	0.2	19	1.1%
	Treatment of patients	8.4	19	44%
	Waste Treatment	4.0	21	19%
	Maintenance	1.6	10	16%
HUMAN RESOURCES	Team	9.2	26	35%
	Management	7.0	27	26%
INTERNAL MARKETING	Socio-environmental responsibility	3.2	11	29%
FINANCE	Environmental accounting and auditing	4.0	35	11%
TOTAL		**37.6**	**168**	**22.4%**

Source: Primary data.

The level of general sustainability was then compared with the assessment of sustainability and environmental performance (Table 2), following the "Sustainability and Environmental Strategy" step (discussed in the Methods section).

Table 2 | Assessment of sustainability and environmental performance.

Result	*Sustainability*	*Development*
Less than 20%	Terrible	It may have significant negative impacts on the environment.
Between 21% and 40%	Weak	It may cause damage but occurs infrequently.
Between 41% and 60%	Regular	It meets the governmental standard.
Between 61% and 80%	Good	Beyond the standard, there are some aspects and attitudes that enhance the environment.
Higher than 80%	Great	High environmental value with ecological production and pollution prevention.

Source: Adapted from Nunes (2010) and Pfitscher (2004).

The general performance of the institution, according to the checklist and the weighted score, was 22.4%. This result points to a general performance considered "Weak," which means that, although they have some environmental initiatives, the institution may have an overall negative impact on the environment. Considering the field of work and activities of the IPEPO, the possible impacts on the environment can occur indirectly, for example, through improper disposal, garbage-polluting suppliers, low efficiency or recycling when replacing electronic equipment, lack of reuse when possible, and resistance to reform, among others.

SERVICES RENDERING

This key group is made up of a few subgroups: suppliers, treatment of patients, waste treatment, and maintenance. The percentage of achievement for this key group is 21%, considered "Weak."

The first subgroup, "Suppliers", presented a level of general sustainability of 1.1%. This result is mainly because purchases and/or hiring of suppliers are conducted with sole priority of meeting the standards of the Coordination of Health Surveillance of the Municipal Health Department of São Paulo (COVISA), with no other initiative, policy, or internal incentive to drive consideration of environmental aspects when procuring from suppliers.

The subgroup "Treatment of patients," which entails the processes by which patient visits are conducted, presented a general sustainability level of 44%, a result considered "Regular", indicating that the institution meets the appropriate standard and introduces and maintains actions that seek social and environmental recovery. According to the respondents, the institution follows the standards of COVISA regarding the health and safety of persons.

The subgroup "Waste treatment" refers to the institution's treatment of waste generated from health services. The level of general sustainability obtained was 19%, considered "Terrible" because there is a high chance that the institution is impacting the environment. This result is partly due to the lack of treatment of liquids when washing containers containing infectious waste.

The subgroup "Maintenance" assessed the actions of the institution regarding the conduction of reforms, repairs, construction, furniture, and utensils disposal, among others. The result was 16%, considered "Terrible," which is mostly due to the lack of prioritization and focus on the impact on the environment in the planning and execution of works and maintenance necessary for its activities. Additionally, the institution has no defined processes that guide recycling or storage of harmful materials and does not recall inappropriate materials identified in building maintenance.

HUMAN RESOURCES

The key group of Human Resources is made up of the subgroups Team and Management, and presented a general sustainability level of 31%, considered "Weak." In the subgroup "Team", the level of sustainability achieved was 35%, considered "Weak." According to the respondent, the institution offers basic benefits to its employees, such as health insurance, meal allowance, and childcare allowance. It also has a career and salary plan structure. However, there is no effective prioritization of the development of its human capital and no established methods or processes to encourage creative or innovative thinking, to encourage the voluntary participation of employees in social projects, to empower internal staff to preserve natural resources, or to track indicators of staff management by department.

In the subgroup "Management", the level of general sustainability obtained was 26%, which also considered "Weak." Although the management of the institution is very active in social projects and continuously seeks to provide an adequate number of people to care for patients, other aspects related to internal communication of strategies, guidelines, and institutional values still have great opportunities for improvement.

INTERNAL MARKETING – SOCIO-ENVIRONMENTAL RESPONSIBILITY

This key group specifically addresses actions within the scope of socio-environmental responsibility and internal marketing actions. The result of 29% is considered "Weak," which is primarily because of the absence of any initiatives related to internal conduct and communication regarding socio-environmental responsibility.

The institution seeks to monitor indicators of patient satisfaction, provide communication channels, and use information collected to promote improvements. However, it could focus more on the inclusion of socio-environmental actions in its community projects, including the identification of needs and assessment of satisfaction of the communities in which it works, and even on the communication to its patients about its appreciation for and concern with the environment.

FINANCE: ENVIRONMENTAL ACCOUNTING AND AUDITING

This key group of Finance related to environmental accounting and auditing with a performance of 11%, which is considered "Terrible." This reflects the lack of prioritization of environmental aspects, as it does not have any procedures in place to capture environmental information, does not use financial tools to analyze these aspects, nor have any indicators of efficiency or management in this sense.

5.2 EFFICIENCY INDEX PER KEY GROUP AND SUBGROUP

Concerning the general level of sustainability of the institution at 22.4%, a distribution of the relative contribution of each key group to this result is shown below (Table 3):

Table 3 | Contribution per key group

Contribution per key Group	
Services Rendering	37.8%
Human Resources	43.1%
Internal Marketing	8.5%
Finance	10.6%
TOTAL	**100%**

Source: Primary data.

Based on data from Table 3, the key group "Human Resources" had the highest contribution to the points achieved, accounting for a total of 43.1% of the total points, followed by "Services Rendering" with 37.8%. The key group with the smallest contribution was "Internal Marketing", with 8.5%, followed by "Finance" with 10.6% of the total number of points achieved. The relative contribution of each subgroup to the total result was also analyzed, and is presented in Table 4:

Table 4 | Contribution by subgroup

Contribution by subgroup	
Suppliers	0.5%
Treatment of patients	22.3%
Waste treatment	10.6%
Maintenance	4.4%
Team	24.5%
Management	18.6%
Socio-environmental responsibility	8.5%
Environmental accounting and auditing	10.6%
TOTAL	**100%**

Source: Primary data.

Data presented in Table 4 shows that the subgroup with the greatest contribution was the subgroup "Team" with 24.5%, followed by the subgroup "Treatment of patients" with 22.3%, which is consistent with the replies obtained from employees in the interviews, demonstrating the targeting of resources to patient care and the employees.

The smallest contributions came from the subgroups "Suppliers" with 0.5%, "Maintenance" with 4.3%, and "Socio-environmental responsibility" with 8.5%.

5.3 ANALYSIS OF FINANCIAL STATEMENTS

Based on financial statements of IPEPO that are available to the public, we performed a financial accounting analysis for the period from 2012 to 2016[1], from which we noted the following.

The total assets of IPEPO, which represents the set of goods and rights of the entity, was R$19,207, which represents an increase of 46% over the previous year (R$13,194) and 102% compared to 2012 (R$9,501). Of the total assets in 2016, it is possible to verify that 46% (R$8,844) lies in cash and cash equivalents, its most liquid group of assets.

Regarding liabilities, it is observed that obligations and short-term debts showed successive increases of over 50% in the last two years, from R$3,326 (in 2014) to R$5,135 (2015) and reaching R$8,040 in 2016. However, the percentage distribution of obligations during the examined period did not significantly change, except in the reduction of equity from 60% of the total liabilities in 2012 to 49% in 2013, which demonstrated a reduction in dependence on their resources.

As part of the analysis, the researcher produced a pro-forma statement based on the following adjustments: exclusion of social incomes, since they represent donations and conference resources; incomes and expenses from the same source were reported in one figure as net income; and incomes/expenses were only considered if they related to the SUS, financial projects, taxes, depreciation, and other expenses. The remainder was considered to be the provision of services in general. Following this method, the obtained pro-forma results are listed in Table 5.

Table 5 | Pro-forma statement

Amounts in Brazilian reais	*2012*	*2013*	*2014*	*2015*	*2016*
SUS INCOME/EXPENSES	1,939,174	694,782	-16,093	-667,722	475,291
FINANCIAL PROJECT INCOME/EXPENSES	252,276	314,437	322,154	518,546	293,739
RESULTS FROM PROJECTS	0,370	185,455	258,867	219,769	345,266
RESULTS WITH SERVICES RENDERING	-745,383	-689,506	-898,859	-115,228	-1,117,799
TAXES AND OTHERS	-158,561	-117,205	-199,794	-236,027	-347,459
PRO-FORMA OPERATIONAL RESULT	1,287,876	387,963	-533,725	-280,662	-350,962
SOCIAL INCOME	108,107	0,977	416,369	537,331	2.671,638
PRO-FORMA TOTAL RESULT	1,395,983	388,940	-117,356	256,669	2,320,676

Source: Created by the author.

In this pro-forma statement, significant deterioration was observed: IPEPO went from seeing a profit of R$1,288 in 2012 to a loss of -R$351,000 in 2016. The contribution of the SUS incomes/expenses, which in 2012 was R$1,939, reduced to R$475,000 in 2016 and was negative at -R$668,000 in 2015.

The financial analysis of the institution's data assists in understanding the maturity level and decisions made by the administration as well as indicates areas for improvement in the business decisions and use of resources.

6 DISCUSSION

Environmental management systems can assist managers in addressing complex issues, as they can break down the issue into multiple variables and reduce the fragmentation of knowledge and resources available, through engagement with stakeholders to develop an integrated multidisciplinary approach or continuous monitoring of the results from changes to variables (VIRAPONGSE *et al.*, 2016).

SICOGEA, developed in 2004, gained attention in Brazil as a free, easy-to-use tool that was developed locally. It was initially applied and tested in an ecological rice production chain and, over the ensuing years, other studies demonstrated its applicability to companies and entities from other sectors, such as hospitals, residences, hotels, supermarkets, and textiles, demonstrating the versatility of SICOGEA (NUNES, 2009; BERNADETTE *et al.*, 2013).

To make comparisons between entities, SICOGEA provides a set of tools, which were used in research that evaluated sustainable practices in science and technology institutes, in particular the Massachusetts Institute of Technology, Swiss Federal Institute of Technology Zurich, and three Brazilian institutions. The research developed and applied a framework that considered social, economic, and environmental aspects. The Global Reporting Initiative (GRI), International Sustainable Campus Network (ISCN), Public Administration Environmental Agenda (A3P), and SICOGEA were all considered in the framework (GUSTAVO DE LIMA et al., 2016).

Although IPEPO was not the first non-profit institution to be studied using SICOGEA, it was the first in São Paulo City (São Paulo State, Brazil). By calculating its general sustainability level of 22.4%, this can now be compared with other institutions, including other health care organizations, located within the State of Santa Catarina (Brazil).

Table 6 presents IPEPO's main results in comparison to other entities, all located in Florianópolis City (Santa Catarina State, Brazil). Entity #1 is a medium-sized hospital with an average monthly attendance of 1,200 patients (PAMPLONA et al., 2010); Entity #2 is a public hospital, an integral part of the health service of the Brazilian Army, founded in 1869 (Danúbia *et al.*, 2012); and Entity #3 is a private institution in the area of cardiology composed of approximately 233 collaborators (FONTES, 2012).

Table 6 | Comparison of some results of IPEPO with other institutions

Group/subgroup	*Entity #1*	*Entity #2*	*Entity #3*	*IPEPO*
SUPPLIERS	66.67%	41.05%	84.29%	0.5%
TREATMENT OF PATIENTS	75%	57.69%	59%	22.3%
HUMAN RESOURCES	70%	74.81	84.85	43.1%
ENVIRONMENTAL ACCOUNTING AND CONTROLLERSHIP	17.65%	60%	47.23%	10.6%
LEVEL OF GENERAL SUSTAINABILITY	56.58% (REGULAR)	61.01% (GOOD)	66.79% (GOOD)	22.4% (WEAK)

Source: Created by the author.

These institutions were chosen based on data obtained from other applications of SICOGEA in the healthcare sector, which were the available applications that were the most comparable with IPEPO, but still differ in their level of environmental maturity as well as operation.

In the "Suppliers" subgroup, the private institution of cardiology showed in Table 6 presented results above 84%. In this subgroup IPEPO presented the lowest environmental performance was "Suppliers" (0.5%), mainly due to the absence of an internal policy that defines and regulates socio-environmental considerations concerning them, such as requiring, for example, environmental certification or involvement in social programs on the part of the supplier or a definition of socio-environmental goals or skills.

In the "Human Resources" subgroup, the entities from Florianópolis showed in Table 6 presented results above 70%. IPEPO reached 43.1%, which accounts for the most positive highlight of IPEPO's promotion of social projects such as the Amazon Project called "Catarata do Baixo Amazonas." However, the low participation and involvement of employees in strategic planning, as well as the absence of a leadership assessment to review established skills or indicators of managerial efficiency and adherence with the overall strategy, reduced the results of IPEPO in this subgroup.

In the subgroup "Treatment of patients", IPEPO obtained 22.3%, representing its second-highest result among the subgroups examined for this comparison, which was roughly consistent with the results of other entities presented in Table 6. For entities #2 and #3, this was their greatest individual result obtained among the subgroups, with 75% and 59%, respectively. This demonstrates the prioritization of patient treatment by these institutions. IPEPO meets the current standards and regulations regarding patient treatment; however, there is still an opportunity for improvement in terms of its recycling processes, ongoing campaigns of rational use of resources, and encouragement of internal initiatives that offer solutions to minimize negative effects on the environment.

Environmental accounting and controllership had the worst result for entities #1 (47.23%) and #3 (17.65%), which was not different from IPEPO that had a "Terrible" status (10.6%) in this group. This was due to the fact that the institution possesses only goals and indicators of financial and accounting efficiency and has yet to implement any other tools or socio-environmental indicators, such as the voluntary disclosure of the Social Balance or Added Value Statement.

Most applications of SICOGEA implement the first step of the third phase, because of the cost-benefit relationship. This step can demonstrate the importance of "Investigation and measurement" for

administrators of institutions to become more informed about their current status and to identify areas of improvement. This also demonstrates the challenge of completing the full application of the method because of its complexity and the investment of time and resources required for each step and phase.

Some of the main advantages of this method are its relatively low cost of implementation and its framework that facilitates management over time by analyzing the results of the questionnaire, supporting decision making and planning given a proposed financial accounting analysis and sustainability assessments of key groups, and engaging stakeholders around the diagnosis and concise plan of management.

Regarding the disadvantages, the quality of the results depends on the quality of the interviews and the flexibility to adapt the questionnaire limits the comparability of the results between different institutions. Additionally, there is an absence of information on entities that have expanded their use of SICOGEA to other phases and steps, thus limiting the analysis of the method as a whole.

Possible correlations between socio-environmental investment and business performance are a recurring theme in the literature. In a study by Cristófalo *et al.* (2016), an assessment was made of the performance of companies that comprise the Index of Corporate Sustainability (ICS) of the B3 (Brazil´s Stock Market) in contrast with companies from the same sectors that are not in the index, to observe whether or not sustainability practices contribute to the valuation of companies, using data from 2006 to 2014.

However, it was not possible to determine a correlation between all of the ICS companies and their value (this correlation was observed only in two economic sectors), highlighting some of the challenges faced in quantifying or analyzing financial returns concerning socio-environmental investments. In China, for example, a study showed a positive correlation between environmental measures and the companies' values in the country's stock exchange; however, the significant financial impact did not occur in the same period in which environmental actions are carried out, they were realized the following year (SONG *et al.*, 2017).

Lannelongue et al. (2017) demonstrated a specific benefit for entities that do not require high investment: the adoption of environmental management measures positively influencing the productivity of employees. The measures strengthened the social role that the entity carried out, which was recognized by its staff, partners, and society. Johnstone (2019) mentioned, as part of a systematic analysis of environmental management systems in small to medium-sized enterprises, the benefits of long-term performance improvements could be immediately realized through employee engagement in environmental initiatives.

7 CONCLUSIONS

The general sustainability level for IPEPO based on the SICOGEA checklist method was 22.4%, which indicates a weak level of sustainability and that the institution may be causing damage to the environment and society, despite running some positive initiatives.

There were some limitations to this research due to the data collection method of filling out a questionnaire during semi-structured interviews. Additionally, due to the restricted and limited access to the main IPEPO authorities, the awareness of the interested parties and follow-up of participants were only partially fulfilled.

Considering the mission and vision of IPEPO, in light of the results obtained by the application of SICOGEA, it would be relevant to the administration of the institution to adopt a management tool that allows the monitoring and evaluation of its social, environmental, and financial sustainability. The SICOGEA method is applicable to the health care sector, assisting managers and teams to understand the current situation of the institution and to target future actions.

Further research should target the expansion of applying SICOGEA in the health care sector and, if possible, focus on an additional sector to broaden the base of knowledge to help institutions to determine how adopting these management tools can guide their management of resources and performance, in addition to improving the research tools developed in Brazilian universities.

NOTES

1 | Data from 2011 were not considered due to a restructuring process that occurred in this period, significantly affecting the performance.

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Impacts of the Fomento Program on Family Farmers in the Brazilian Semi-Arid region and its relevance to climate change: a case study in the region of Sub medio São Francisco

Impactos do Programa de Fomento sobre os Agricultores Familiares do Semiárido Brasileiro e sua relevância frente às mudanças climáticas: um estudo de caso na região do Submédio São Francisco

Patrícia Mesquita[a]

Ricardo Theophilo Folhes[b]

Louise Cavalcante[c]

Luciana Vieira de Novais Rodrigues[d]

Beatriz Abreu Santos[e]

Saulo Rodrigues-Filho[f]

[a]*Post-Doctoral Researcher (INCT- ODISSEIA), Center for Sustainable Development, University of Brasília, Brasília, DF, Brazil*
E-mail: patriciasmesquita@gmail.com

[b]*Professor and Researcher, Núcleo de Altos Estudos Amazônicos (NAEA), Federal University of Pará, Belém, PA, Brazil*
E-mail: rfolhes@gmail.com

[c]*Phd Student in Public Administration and Policy Group, Wageningen University and Research (Wageningen, NL) and Associate Junior Researcher at the Center for Sustainable Development, University of Brasília, Brasília, DF, Brazil*
E-mail: louise.cavalcantedesouzacabral@wur.nl

[d]*Consultant at the Inter-American Institute for Cooperation on Agriculture (IICA), Brasília, DF, Brazil*
E-mail: lunovaisrodrigues@gmail.com

[e]*Associate Researcher (INCT-ODDISEIA), Center for Sustainable Development, University of Brasília, Brasília, DF, Brazil*
E-mail: beatriz.abreu92@gmail.com

[f]*Associate Professor, Center for Sustainable Development, University of Brasília, Brasília, DF, Brasil*
E-mail: srodrigues@unb.br

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ARTICLE- VARIA

ABSTRACT

For some years, Brazil established itself as a leader in strategies of strategies and programs aimed at reducing the social vulnerability of the most vulnerable populations. In this context, the Program for the Promotion of Rural Productive Activities (*Fomento* Program), created in 2011, had as one of the main objectives to stimulate the generation of work and income, and promote food and nutritional security for rural, indigenous, traditional and settled populations of agrarian reform. In the Northeast, and more specifically in the Semi-arid region, the relevance of this Program stands out even more concerning climate projections, which indicates that such areas will suffer from more extreme drought in the face of climate change, affecting populations dependent on climate-sensitive activities. Therefore, given the diversity of impacts of the *Fomento* Program reported in the literature, this article sought to present results on the perception of the Program's impacts from 28 family farmers, interviewed through qualitative research in four municipalities in the state of Bahia in 2017. In addition to the socio-productive aspects, the research sought to understand the Program's impacts in the context of climate change for the study region. The results point to a positive perception by the interviewees, mainly related to changes in production and technical assistance based on the Paradigm of Co-existence with the Semi-arid Region.

Keywords: Semi-arid. Fomento Program. Climate Change. Family farming.

RESUMO

Por alguns anos, o Brasil se consolidou como referência no que tange às estratégias e programas voltados à diminuição da vulnerabilidade social das populações mais vulneráveis. Nesse contexto, o Programa de Fomento às Atividades Produtivas Rurais, criado em 2011, teve como objetivo principal estimular a geração de trabalho e renda, e promover a Segurança Alimentar e Nutricional de populações rurais, indígenas, tradicionais e assentados da reforma agrária. No Nordeste, e mais especificamente no Semiárido, a relevância do Programa se destaca ainda mais frente às projeções de modelos climáticos, que indicam que tais áreas sofrerão com eventos mais extremos de seca diante das mudanças climáticas, afetando as populações dependentes de atividades sensíveis ao clima. Logo, diante da diversidade de impactos do Programa de Fomento relatados na literatura, o artigo buscou apresentar resultados sobre a percepção dos impactos do Programa do ponto de vista de 28 agricultores familiares, entrevistados por meio de pesquisa qualitativa em quatro municípios dos estados da Bahia em 2017. Além dos aspectos socioprodutivos, a pesquisa procurou compreender os impactos do Programa frente às mudanças climáticas para essa região de estudo. Os resultados apontam para uma percepção positiva por parte dos entrevistados, principalmente relacionada às mudanças na produção e em uma assistência técnica baseada no paradigma da convivência com o semiárido.

Palavras-Chave: Semiárido. Programa de Fomento. Mudanças climáticas. Agricultura familiar.

1 INTRODUCTION

Since the early 2000s, Brazil has been recognized for social protection strategies aimed at reducing the vulnerability of rural and urban populations to hunger and food insecurity. The Zero Hunger Program in 2001 (later called Zero Hunger Strategy) linked the search for the reduction of food insecurity associated with the fight against poverty. i.e. it brought Food and Nutrition Security (FNS) policy closer to social protection policies, generating positive impacts based on a multidimensional and focused approach (PAES-SOUSA, 2013). Ten years later, as part of the "Brazil without Misery Program" (BSM), the Program for the Promotion of Rural Productive Activities was established (Law No. 12.512/2011) (*Programa de Fomento*, in Portuguese).

The goals were to stimulate job and income generation, promote FNS, and encourage the participation of beneficiaries in social, educational, technical and vocational training, as well as encouraging their participation in associations and cooperatives (BRAZIL, 2011). With target groups that include rural, indigenous, traditional and settled populations of the agrarian reform, the Program has been demonstrated to be effective in generating a multitude of impacts, derived from the technical assistance and rural extension (Ater) provided for two years, and a non-reimbursable financial aid, which is applied to a productive project chosen by the producers and according to their reality (based on specific needs and environment).

The positive impacts are manifold, such as improvements in productive and non-productive resources, in income and productive capacity, in FNS, in the access to other public programs, among others in the different regions of Brazil. Concerning productive resources, the increase in the means of production has been reported as the key factor that enables the increase, expansion and diversification of production for self-consumption (PORTO, 2014; MELLO et al., 2015).

In addition to the increase in the means of production, the profit and economy from production have been related to the increase in household goods such as home appliances and cell phones (BERBIGIER, 2016). The agroecological approach, promoted by many Technical Assistance and Rural Extension (Ater) institutions, has also contributed to increasing production and its diversification, respecting traditional knowledge and prioritizing the socioeconomic conditions of beneficiaries (PORTO, 2014). Furthermore, the Program also presents benefits concerning actions leading to gender equality, with women as the preferred target audience and representing 70% of beneficiaries in 2009 (MENDONÇA et al, 2015). Concerning productive projects, small animal breeding is predominant in several regions of the country but mainly in the Northeast, where ruminant breeding has proved to be the main economic activity promoted and developed by small beneficiary producers during the periods of water shortage (DI VILLAROSA, 2016; RODRIGUES, 2016).

The significance of the Program emerges, even more, considering that climate models have indicated that the Brazilian Northeastern Semi-arid region will experience more extreme drought events in the face of climate change (IPCC, 2014). According to the IPCC Fifth Report (2014), the average annual temperature increase in the region should be between 2.0°C (RCP scenario 2.6) and 5.0°C (RCP scenario 8.5) by 2100. This may contribute to changes from semi-arid to arid conditions, which implies in decreases of the regularity of water supply. Projections indicate that by the year 2050, the Semi-arid will become an arid environment, observing its edaphoclimatic conditions. Thus, those dependent on climate-sensitive activities (e.g. agriculture) will be exposed to more intense impacts, such as irreversible productive losses, which may increase their vulnerability and force them to abandon and sell their land and migrate to urban and marginal areas with other types of vulnerabilities.

Semi-arid populations, as well as other traditional peoples that have their livelihoods directly affected by climate conditions, are among the most vulnerable to climate change due to their high climate sensitivity and low institutional capacity to minimize risks and respond to negative impacts (LAHSEN et al., 2010; LINDOSO et al, 2014; MORTON, 2007). In this context of interconnection between climate and vulnerability of the northeastern smallholder farmers, it is noteworthy that in 2011-2018 the Semi-arid suffered the greatest drought in recent decades affecting almost 9 million people (MARENGO et al., 2016).

Thus, given the multitude of impacts attributed to the *Fomento* Program and its potential positive impacts in face of changes in climate, this research aimed to understand the impacts of the Program on productive and socioeconomic characteristics that may favor family farmers resilience and persistence in the Semi-arid region in the long term. The article considers the relevance of the Program based on the reflection that the strengthening of production activities today may help farmers to be better adapted to the expected climatic changes.

2 THEORETICAL FRAMEWORKS

2.1 PROGRAM INSTITUTIONALIZATION

The trajectory of public policies designed for family farming in Brazil began in the 1990s, with the creation of policies with two different approaches. First, agricultural policies encompassing credit, infrastructure, price policy, and second, agrarian policies involving land regularization and agrarian reform, implemented mainly through the National Program to Strengthen Family Agriculture (PRONAF - 1995) (GRISA, SCHNEIDER, 2015).

As these policies did not contribute to an improvement in development indicators, the second phase of policy creation was focused on social and assistance policies, which had effects on rural development and productive inclusion. In a third phase, policies were focused on vulnerable groups, such as small family farmers, indigenous people, and traditional communities, so they could have improved access to better conditions of agricultural and labor markets and well-being (GRISA, SCHNEIDER, 2015). The creation of PRONAF, the Crop Guarantee Program, BSM, the National School Feeding Program (PNAE), the Food Acquisition Program (PAA) and the *Fomento* Program illustrates the incorporation of that trajectory to public policies.

The *Fomento* Program is regulated by Decree no. 9.221/2017 and is currently implemented by the Ministry of Citizenship (formerly MDS - Ministry of Social Development), under the Special Secretariat of Social Development. However, until 2017 it was jointly implemented by the MDS and the Special Secretariat for Family Agriculture and Agrarian Development of the former Ministry of Agrarian Development (SEAD/MDA).

Among the target groups, are those in a situation of food insecurity, and poverty and extreme poverty (mean income of the household R$170[1] and R$ 85, respectively), which are selected with the use of various government databases, among them IBGE (Brazilian Institute of Geography and Statistics) census, PNAD (National Household Sample Program) and The Single Registry of Social Programs of the Federal Government (*Cadastro Único*, in Portuguese) (CAMPELO et al., 2014). The expected outcomes of the Program are increases in income, resources, and food security, and reduction in the number of families in poverty and vulnerability in rural areas, as well as among traditional peoples and communities.

For the implementation of the Program, eligible populations are included in a guiding list formulated by the Ministry, which the Ater institutions use for the selection and mobilization of beneficiaries. In addition to this strategy, an 'active search' is also used, aiming at searching for populations invisible to the State, which are usually in isolated locations and with no access to any public policies, and sometimes, not even official identification documentation.

To participate, all beneficiaries must already be (or become) registered in the *Cadastro Único* (Single Registry of Social Programs) and have the Declaration of Aptitude to Pronaf (DAP). From January/2012 to May/2018, 247,077 families were included in the *Fomento* Program, mostly from the Northeast and North region (BRAZIL, 2019). Regarding the Northeast and the Semi-arid Region, it is worth mentioning the creation of the Semi-arid *Fomento* in 2013, aimed at families that already had a water storage structure for production and were negatively impacted by the prolonged drought (since 2011). This initiative had the objective of assisting in the recovery of productive capacity through a single transfer of R$ 3.000[2] and technical assistance to family farmers.

3 METHODOLOGY

Fieldwork and interviews with beneficiaries of the *Fomento* Program were carried out in October/2017, in the Submédio São Francisco region of the state of Bahia. The research was developed in a partnership between the Climate Network (Rede CLIMA - Regional Development sub-network) at the Center for Sustainable Development (CDS) of the University of Brasilia and the former Ministry of Social Development (MDS). A total of 28 beneficiaries were visited in the municipalities of Juazeiro, Casa Nova, Uauá, and Canudos, with the aid of field technicians of Ater institutions. The qualitative interview, which usually took around 2 hours, aimed to understand the impacts of the *Fomento* Program on the beneficiaries, as well as their limitations, and interconnection with other factors, such as climatic.

After tabulated, the interviews were analyzed quantitatively, as provided in the results, to provide a more general picture of the sample. The research team understands the limitations of the used methods but believes that the findings, specific to the studied region and sample, can be applied for further research in future studies on the multiple impacts of the Program.

4 RESULTS

Among the beneficiaries of the *Fomento* Program interviewed, 57.14% of the households were represented by women, 35.71% by men, and 7.14% by both. Most of the interviewees were over 50 years old, with only 28.56% under that age, 39.29% between 51-60 years old, and 21.43% over 60 years old[3]. Regarding the number of inhabitants per household, 7.14% reported the presence of one resident, 39.29% of 2-3 residents, 46.43% of 4-5, and 7.14% above 5. Regarding the number of dependents (<18 yrs. old), 50% of the households had 1-2 dependents, 39.29% with none, and 7.14% above 2. Following the age structure of the interviewees, 42.86% of domiciles had retired people, with 28.57% of the total respondents with 1 inhabitant receiving retirement benefits, and 14.29% with 2 beneficiaries.

Of the total interviewed, 100% had already developed some agricultural productive activity before the *Fomento*, with 64.29% having already received some form of technical assistance along this time. Among the various types of productive projects possible in the scope of the Program, 42.86% invested in livestock and infrastructure/equipment, 25% in livestock, 10.71% in infrastructure/equipment, 7.14% in livestock/crop/infrastructure/equipment, and 3.57% only in crops. In most cases, the projects were chosen individually (77.78%), jointly with the technician (14.81%) or only by the technician (7.41%).

In response to the Program, 53.57% reported a change in their main production, with most carrying out their productive activities in the backyard (*quintal produtivo*) and another area (*roça*) (64.29%). Only 21.43% of the interviewees carried out some form of crop irrigation, with almost all of them having a 1st Water Cistern (water reservoir for domestic consumption) and 50% having a 2nd Water Cistern (water reservoir for production) (Table 1).

Table 1 | Impacts of the Fomento on farmer's production

Changes in production	*%*	*Production site*	*%*
YES	53.57%	Backyard	25.00%
NO	32.14%	Another area	10.71%
NR	14.29%	Backyard/another area	64.29%
Irrigation	*%*	*1st Water Cistern*	*2nd Water Cistern*
YES	21.43%	92,86%	50.00%
NO	71.43%	7,14%	50.00%
NR	7.14%	-	-

**NR-No Response. Source: Author (2020).*

Of those interviewed, 100% declared to sell products produced with the help of the *Fomento* Program, either in a specific/formal way or in the negotiation of production surplus with occasional buyers, usually neighbors. The latter was cited as buyers in 42.86% of the cases, together with other consumers (trade fairs, markets, middlemen, etc.). However, 35.71% cited sales to neighbors only (Table 2).

Ater was classified as having a positive influence by almost all the beneficiaries of the *Fomento* (92.86%), with most being accompanied by a single technician throughout the implementation process (in 85.71% of households). When asked if only with the income or only with the technician they would have been able to develop their productive projects, more than 60% declared they would not have reached the proposed objectives.

Table 2 | Fomento's impact on farmer's autonomy and sales

Sale of Fomento's production	*%*	*Sale to neighbors*	*%*
Yes	100.00%	Yes	42.86%
No	-	Only	35.71%
		No	21.43%
Ater influence	*%*	*Number of technicians along with the project*	*%*
Positive	92.86%	Only one	85.71%
Negative	-	More than one	14.29%
Neutral	3.57%		
Income	3.57%		
Would be able to work on the project only with:			
Income	*Technicians*		
Yes	35.71%	Yes	25.00%
No	60.71%	No	67.86%
NR	3.57%	NR	7.14%

Source: Author (2020).

Concerning impacts, several changes were attributed due to the participation in the Program. Among the most notable are: well-being (92.46%), acquisition of technical knowledge (89.29%), income (71.43%), diet changes (64.29%), home improvements and the acquisition of goods with the income from the project (60.71%), increased confidence as a producer (57.14%) and participation in new government programs (53.57%). Changes in the relationship with the community, acquisition of new equipment, production of new varieties of food, health improvements, participation in new groups (associations, cooperatives, etc.), and improvement in the family relationship were cited in smaller proportions (Table 3).

Table 3 | Fomento's impacts

Impacts	*Yes*	*No*	*NR*
PURCHASE OF GOODS	60.71%	28.57%	10.71%
WORK EQUIPMENT ACQUISITION	42.86%	53.57%	3.57%
HOME IMPROVEMENTS	64.29%	35.71%	-
CONFIDENCE AS A FARMER	57.14%	35.71%	7.14%
KNOWLEDGE ACQUISITION	89.29%	7.14%	3.57%
CHANGE IN FEEDING/DIET	64.29%	35.71%	-
PARTICIPATION IN NEW GROUPS	21.43%	75.00%	3.57%

Impacts	*Yes*	*No*	*NR*
PARTICIPATION IN NEW PROGRAMS	53.57%	46.43%	-
PRODUCTION OF NEW VARIETIES OF FOOD	32.14%	60.71%	7.14%
WELL-BEING	92.86%	7.14%	-
RELATIONSHIP WITH COMMUNITY	42.86%	39.29%	17.86%
FAMILY RELATIONSHIP	17.86%	60.71%	21.43%
INCOME	71.43%	14.29%	14.29%
HEALTH	32.14%	53.57%	14.29%

Source: Author (2020).

Finally, almost all the interviewees mentioned that climate had a great impact on their projects (92.86%) and understood the Project as an aid for Co-existence with the Semi-arid and extreme drought events (92.86%).

5 DISCUSSION

The *Fomento* Program encouraged several changes in the patterns of productive activity and socioeconomic characteristics of the interviewed farmers. In general, participation in the Program led to changes in the main productive activity of several interviewees. This pattern was also mentioned by Mello *et al.* (2015) who demonstrates that *Fomento* has been having a positive impact on the diversification of farmers' productive activities, which often also occurs through the expansion of non-agricultural activities, also adopted by the Program.

The diversification of productive activities has been discussed by several authors (KELLY; ADGER, 2000; FINAN, NELSON, 2001) and is considered an important aspect in terms of reducing the vulnerability of producers to various impacts, whether climatic or socioeconomic. Investment in activities with different degrees of resilience to impacts provides a chance for farmers to survive in at least one activity in the face of shocks, as opposed to what may occur in the face of an impact that specifically affects their productive activity (MELLO et al., 2015). In this case, a change in the predominant activity instigated by the *Fomento* Program may be an indication of the expansion of farmer's productive capacity (for new activities) or even an attempt to innovate, experiment and learn from the technical assistance provided.

In several cases it was observed that the possibility of producers choosing their own productive project, according to personal ambitions and skills, allowed them to fulfill a desire to cultivate something specific that they already wanted ("*To be able to choose the dream ...*"), to expand activities without investment ("*I could improve the livestock, with animals of higher quality*"), or improve activities that previously had less weight in their productive balance ("*I liked I was able to raise chickens*").

There were also several reports of production expansion to the areas of the backyard, in addition to the field, which promoted a change in family dynamics for some households. On some occasions, women were cited as active in the operation of the productive project, especially because they were mostly developed in the backyard, and because their husbands worked in more distant places, taking care of the crops and animals or doing daily work in other farms (e.g.: woman led the *Fomento* project in the yard, while the man continued with goats and sheep on the field). Female empowerment in the process of productive inclusion is one of the expected results of the Program (MENDONÇA et al., 2015), and has also been reported in other initiatives (Brandão et al, 2016), in a case study on female empowerment from socio-productive inclusion strategies in Sergipe. According to complementary interviews undertaken in November/2018 with institutional actors involved in the planning of the Program (MDS, Brasília-Federal District), Fomento has women as privileged beneficiaries during the selection process.

Among the most relevant impacts reported were those on life quality, education as a producer (i.e. new technical knowledge relevant for production), income, food, improvements and acquisition of goods, confidence as a producer and knowledge about new government programs. Life quality was mentioned as improved due to several factors, such as the acquisition of reserve livestock for sale in case of illness; higher quality of livestock, with higher sales value; more project experience; possibility to maintain productive activities and having protected animals (in pigsties, etc.); and participation in several group activities, which promoted learning.

As observed, well-being was a subjective measurement and subject to the impacts on income, food, knowledge, acquired improvements, etc. The question of knowledge acquisition as a producer was reported as a result of the greater monitoring by Ater technicians made available during the Program. Here was highlighted knowledge about natural remedies for herds/crop (e.g. salts), vaccines, better livestock management, more guidance (in general but especially in meetings), and the exchange of knowledge with technicians. In some experiences of the Program in Bahia, innovations that would increase the exchange of experiences between technicians and beneficiaries were mentioned, such as the insertion of participative methodologies and the extension of Ater contracts (from 2 years defined by the Program, to 3 years) (DI VILLAROSA, 2016).

The aid for the construction of diversified projects and with the appreciation of beneficiaries' traditional knowledge also added to the process of knowledge construction (PORTO, 2014). Besides, the issue of increasing confidence as a producer, also related to the increase of acquired knowledge and productive capacity, was relevant in the findings. The improved producer confidence was justified by the feeling of assurance in knowing how to produce better due to new knowledge (e.g. vaccines, feeds), due to increased number and genetic improvements in the livestock, motivation due to the restructuring of production and herds, and due to the possibility of materializing changes in production that were not possible before (due to lack of financial resources and technical support).

The income improvement was noted as being linked to the possibility of producing for sale, but in most cases as an increase without tangible measure, through savings in the purchase of food items ("*It improved a little ... now I save with the purchase of meat*"; sale of chicken to buy rice, other meat, and products; sale of eggs/chicken helping to buy school supplies). It should be noted that during the interview there was a perception of discomfort on the part of those interviewed regarding income issues, which could also be related to reports of increased income without mentioning the increase in monetary income.

Property improvements (home and productive infrastructure) and other acquisitions were also mentioned, which would be an indication of income, as also observed by Rodrigues (2016). Among these, the acquisition of household appliances (refrigerator, stove, freezer, television), furniture (cabinets, chairs, sofas), motorcycles, tires, clothing, and equipment and infrastructure acquired directly via the *Fomento* project were noteworthy. Porto (2014) reports that this income improvement would also be associated with the marketing strategies adopted by the beneficiaries.

Those with greater specialization in production (focusing on a single product) achieved an increase in monetary income, while other producers ended up generating "reserves of value" similar to savings, for use with immediate needs, or savings in the face of self-consumption of food produced, with decreased need for purchase in formal and informal markets. Regarding sales capacity, it was observed that about 71% of the sample had selling problems, which would also be linked to the limited increase in monetary income observed in studies. Bernardi (2015) reports that the limited results about the increase in monetary income would be linked to the fragility of selling products, related to the lack of organized groups for the sale and lack of access to markets. Di Villarosa (2016), also cited that the commercialization channels commonly used are the informal ones, which are linked to the limited access to formal markets for production outflow.

In our study, it was also observed that almost 80% of the beneficiaries had neighbors as buyers for the production, with almost 35% having exclusively these actors as customers. Among the mentioned difficulties for commercialization were: the insufficient scale of production, high supply of the same products in the community (e.g. chicken and eggs), insufficient transport and middleman, lack of money to buy food and fatten animals, competition with traditional producers from the cities (e.g. poultry farms with cheaper eggs), and products without sanitary inspection. The lack of slaughterhouses and the certificate of sanitary inspection have already been reported as impediments to commercialization for several producers under other productive inclusion programs of the Brazilian federal government.

Di Villarosa (2016) reports that in several municipalities where such equipment and processes are not available, it is impossible to sell products of the Cisterns Program to fairs and other formal and institutional markets (such as the Food Acquisition Program - PAA, and the National School Feeding Program -PNAE). Di Villarosa (2016) also mentions that due to the lack of regular slaughterhouses, there is greater commercialization of live animals by the producers of *Fomento*, which would lead to lower profits, causing greater difficulties in overcoming food insecurity.

Regarding food security, a central theme of the *Fomento* Program, some studies have shown positive impacts (BERBIGIER, 2016; MELLO et al., 2015; PORTO, 2014). However, those impacts would be linked to the type of productive project, production (and food) diversification, and even to land size, as discussed by Costa and Teixeira (2016). These authors observed that in another region of Bahia state (*Sertão do São Francisco*), farm/plot sizes were the main limiting factor for the successful implementation of the *Fomento* Program. The small size would limit production sufficient for self-consumption, and the lack of land ownership certification would be an impediment to access rural development policies and programs, which sometimes led to the abandonment of plots, especially in agrarian reform settlements. Because of these cases, it was suggested that advances in the promotion of agrarian reform were needed. The limitation of access to land would also be linked to the choice of non-agricultural productive projects in the *Fomento* Program, as mentioned by Berbigier (2016).

Concerning the type of productive project developed, the choice is predominant for small animal breeding in several *Fomento* projects in the Northeast, as Costa and Teixeira (2016), Di Villarosa (2016) and Porto (2014) highlight. Such a pattern was also observed in the results of the survey, where about 42% invested only in livestock, while 85% in livestock as one of the activities (more infrastructure, cultivation, etc.). In these were observed herds of sheep, goats, chickens, and pigs.

Di Villarosa (2016) observed that in dryland areas, more distant from irrigated areas of the *Sertão do São Francisco* Territory, 46% of projects were for animal breeding (mostly sheep), whereas in irrigated areas of the São Francisco River, where there is insufficiency or absence of land of appropriate size, the most common would be crop planting and more rarely non-agricultural projects. The presence of small ruminant projects (sheep and goats) in dryland areas is related to the better adaptation of those animals to Semi-arid regions, and the number of these projects is even intensified, along those linked to infrastructure, and with the planting of drought-resistant species (e.g.: palm), with the approaching of drought periods (DI VILLAROSA, 2016; RODRIGUES, 2016).

It is important to highlight the many described impacts of climate on implemented productive projects, a pattern also mentioned in other surveys (PORTO, 2014; VILLAROSA, 2016). In the interviews, the climate (represented by temperature and water scarcity) was mentioned as the greatest difficulty for farmers to produce and live off agriculture. Climate affected their choice for productive projects, the production developed its commercialization, and also the producer's perception related to the continuity of production initiated during the Program. For example, for some, the project choice was influenced by the belief that goat rearing would be more complicated than chickens in the drought: "*drought for goats and sheep is worse*"; "*increase goat in the drought, increases the cost with feed*"; "*feeding chicken with feed in the yard is easier in the drought*". However, other farmers reported that it was better to invest in goats/ sheep because

chicken rearing would be more fragile to heat and lack of water. According to Di Villarosa (2016), the drought would also have promoted the search for greater diversification of production and project changes by producers, a pattern that cannot be observed in our results.

Among the mentioned impacts of climate on production were: "*Everything is more expensive, income decreases because you have to buy food [for animals] when it doesn't rain*"; "*it gets in the way because it doesn't produce anything*"; "*Drought is hurting us. We are slow [in production], here it's good when it's raining...*"; field crops, dry fruits and vegetables, and abandoned plots due to lack of water; goat deaths due to lack of food, and poisoning/death of animals due to ingestion of a perennial plant (known as pine nuts or parsley, according to the technician).

As results from climate, the following impacts were also mentioned: 1) on income: "little income [as a result of the Program]... the drought gets in the way"; "I've had the urge to give up [chicken farming]... the price of feed has increased"; 2) on food: "the family does not consume cheese and goat milk... it is not available in the drought, and it gets expensive"; 3) on commercialization: "goats are lean and ugly... so cheap and difficult to sell"; "the animals get so thin by the drought, hence people do not buy"; delay in production, due to the need and inability to buy chicken feed; lack of money to buy food for sheep ["...baby sheep get crippled"]; and 4) perceptions about the continuity of projects (e.g.: it manages to continue if the drought does not continue for a long time; if it rains it is possible to continue because many animals had already died in the drought; and loss of 70% of the goat herd, with no prospect of increasing it due to the impossibility of producing/purchasing food. Some of the findings presented herein were also observed by Di Villarosa (206), while Porto (2014) highlighted the role of other programs, such as those that increase the producer's water capacity (e.g. Cisterns Program), to increase the positive results of the *Fomento* Program in the Brazilian Semi-arid.

As noted in our survey, more than half of those interviewed reported participation in new programs/policies due to participation in *Fomento*. According to the Program Logic Model (*personal communication*) Ater's technicians, in addition to the other activities related to *Fomento* (from project choice to execution), should contribute to the participation of beneficiaries in other policies related to production (such as credit, access to water, institutional markets and others) and related with the safeguarding of human and social rights enshrined in constitutional and infra-constitutional norms (water, education, health, sanitation, etc.).

The research results highlighted the importance of Ater at various times, as well as the presence of beneficiaries who had never been accompanied by any type of technical assistance. For almost all the interviewed farmers, the presence of technicians was positive, with 60% stating that they would not have been able to develop the productive project if they had only received the financial aid. In research carried out in different Brazilian contexts, a common conclusion was reached: without Ater, the *Fomento* Program would not have had the same positive results, and here this type of assistance was also considered fundamental by the interviewees (RODRIGUES, 2016; BERNARDI, 2015; SAMBORSKI, 2016). Studies have pointed to rural extension as a major driver of change in the countryside, through long-term monitoring and within guidelines discussed by civil society and public institutions.

At the time of the survey, half of those interviewed were also quoted as saying that after participating in the Program, they were able and possibly would have the knowhow to develop the same project without the support of technicians, after having their support for the two years. The individualized monitoring, with the objectives of increasing the channels of integration and exchange in the communities, the elaboration of projects based on the will and productive experience of families, the support by a multidisciplinary team composed of technicians from the region (with knowledge about the local specificities), and the specific education of technicians considering different publics focused by productive inclusion programs would be an essential factor for this construction of autonomy (MELLO et al., 2015).

To increase the probability of success, some authors also suggest the period of technical assistance should be extended beyond the two years planned (PORTO, 2014), as a way that monitoring becomes continuous, not only focused on the implementation and execution of activities, a strategy already adopted individually by some local institutions, as mentioned in the case of Bahia by Di Villarosa (2016).

This strategy highlights the fostering of initiatives made by local executing institutions, so activities can continue beyond planned deadlines. In the state of Ceará, for example, Porto (2014) reports that families assisted by Ematerce in the 2012-2016 *Fomento* Program were encouraged to participate in other programs, but mainly in credit ones through the Bank of the Northeast Agro-Friendly Program (*Agroamigo*, in Portuguese). However, in addition to the role of Ater's technicians, research indicates the importance of articulations carried out at the municipal level for positive arrangements between programs, and amplification of their results. That is, besides an adequate vertical articulation between the federative entities (Union, states and municipalities), a fact not always possible given political-party disputes, there is a need for horizontal arrangements between organizations of the three federative entities and civil society at the municipal territorial scale (PAIVA et. al, 2014; PORTO, 2014; BERNARDI, 2015; BERBIGIER, 2016; COSTA, TEIXEIRA, 2016).

Although it is possible to identify access to other social policies and public services, challenges remain in broadening families' access to services provided by municipal institutions, especially those related to social assistance services (PORTO, 2014). The difficulty exists in particular in the building of partnerships to achieve access to families, due to limited human and financial resources. In this sense, Costa and Teixeira (2016) argue that to maintain the sustainability of family agriculture, it is also necessary to structure an institutional environment to promote the articulation between policies and programs.

As an example, the authors cited the experience of the *Sertão do São Francisco* region, where the Federal Government promoted articulation with other federal institutions such as Codevasf (São Francisco and Parnaíba Valley Development Company) and Embrapa. (Brazilian Agricultural Research Corporation). The Bahia State Government was responsible for two innovations aimed to promote inter-institutional and programmatic articulation. Regarding the first, a bonus was inserted in the contracts of Ater institutions, while a significant monetary bonus was paid to the organization and the agent for the articulations made with programs of credit (PRONAF), insurance (*Garantia Safra*), institutional procurement programs (PAA, PNAE), with the National Program of Biodiesel Production and Use, and Productive Bahia.

Moreover, in addition to the increase in various impacts abovementioned that contribute to reducing family farmers' social vulnerability in the Semi-arid region of Brazil, it is worth highlighting the role of the Program and especially of the Ater in helping to co-exist with the Semi-arid region and in various characteristics that increase adaptation to climate change. Of those interviewed, about 92% said they believed the Program helps in this regard, because: "*the person can have income and then they stay or come back from the city*"; "*people are thinking about leaving, but then [Fomento] helps in the community and improves survival*"; "*if the person applies it right, it helps them [to stay]*"; "*if I did not have this, I would want to leave ...*"; and "*Ater teaches a lot of lessons*".

Some of the knowledge acquired from the Ater were highlighted, such as the use of agroecological techniques, the attempt to diversify production, learning about home remedies, about more adapted irrigation (e.g. drip irrigation), the use of plant and animal species more adapted to the climate, animal genetic improvement, food, and fodder storage, several of which are cited by studies on production changes that favor adaptation to climate change (SMIT, SKINNER, 2002; BRADSHAW; et al 2004; LIN, 2011; GRAINGER-JONES, 2012; SIVAKUMAR et al, 2005; NHEMACHENA, HASSAN, 2007).

In these terms, Davies (2009) highlights the important role of agricultural extension in the face of adaptation and mitigation to climate change by disseminating adaptation measures that prepare farmers for increased climate variability and uncertainties, creating contingency measures to deal with risks, and

helping to alleviate the consequences of climate change (with information on droughts, floods, etc.). More related to adaptation, the author suggests as main areas: 1) the dissemination of technological and management information - new climate information, innovative technologies, use of information systems, and knowledge about the insertion of new resistant cultivars/livestock, agroforestry, and other techniques that increase the adaptation of crops/livestock; 2) the development of capacities - strengthening adult and non-formal education, through the use of various media and demonstration schools (highlighting the benefits of using techniques that increase their resilience), and that still increase their capacity for planning, problem-solving, critical thinking, negotiation, leadership and proactivity; and 3) extension service as a facilitator in the implementation of policies and programs - connecting farmers with different public and private actors linked to other services in the rural sector, and those linked to investments in adaptation strategies and other markets, as well as taking farmers' problems and demands to other actors, in addition to helping them prepare proposals and negotiations.

The author concludes that an extension service is an important tool in adapting to climate change because, besides having the potential to promote increased productivity and poverty reduction, it can help in the area of adaptation and mitigation.

Initiatives that include technical assistance may also encourage farmers to invest their time and work in their productive projects and to be able to dedicate themselves to long-term projects, thus avoiding constant short-term and seasonal migrations in search of work outside the rural region (CORREIA, BARBIERI, 2019).

In our sample, it was reported that younger inhabitants move from rural areas attracted by opportunities in the city centers, and due to lack of opportunities in most rural areas, with homes characterized by inhabitants within a higher age group (over 50 years old), with few inhabitants and dependents. This situation reinforces the role of the *Fomento* Program and its importance in encouraging younger farmers to remain active and productive, even in the face of the complications linked to climate change and the multiple attractive factors of urban centers.

6 CONCLUSIONS

The *Fomento* Program provided a diversity of positive impacts for the beneficiaries interviewed, ranging from increases in production and its diversity to issues involving gender equality and knowledge acquisition.

For the semi-arid region, where social vulnerability and institutional fragility are strong components in a climate change context, the presence of programs that improve the adaptability of the most vulnerable is crucial. In addition to this program, and considering policies with a greater social impact in rural areas, it is necessary that the climatic factor is considered and addressed in the various social strategies adopted, not only in environmental ones, as commonly observed.

Social programs can contribute to adaptation to climate change, also, to have their results possibly impacted by the climate. Concerning technical assistance, essential for the success of the *Fomento* Program, the results indicate the need for greater investment in programs that have Ater as a central element, in addition to promoting an increase in the duration of such actions. As mentioned in the study, several of the changes observed and recognized in the literature to increase the productive capacity of farmers are generally implemented by Ater technicians without prior knowledge of their potential in the face of the impacts of climate change.

Besides, we highlight the importance of the *Fomento* Program for Brazil and family farmers as a whole. In the current Brazilian moment (in a context of social, behavioral and economic changes due to the COVID-19 pandemic), it is necessary to pay attention to the importance of maintaining small production spaces as well as their geographic location, since short food supply chains are very important to supply cities. It is also worth reflecting on other types of impacts to which society will be exposed in the future,

in addition to those resulting from the climate, and what changes in values must be pursued so that humanity can maintain a healthy and diversified food supply in any context. Hunger had been present at various moments in the history of civilization and it should be cherished to be kept away from the daily life of urban and rural areas, especially in developing countries.

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NOTES

1 | Equivalent to 33 and 17 USD on April 13, 2020.

2 | Approximately 580 USD.

3 | Difference to 100% referring to NR – no response.

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Reforest or perish: ecosystem services provided by riparian vegetation to improve water quality in an urban reservoir (São Paulo, Brazil)

Refloreste ou pereça: serviços ecossistêmicos providos pela vegetação ripária para melhorar a qualidade da água em um reservatório urbano (São Paulo, Brasil)

Mariana Amélia Arantes Adas[a]

Elisa Hardt[b]

Simone Georges El Khouri Miraglia[c]

Décio Semensatto[d]

[a]*LabInSciences (Laboratory of Integrated Sciences), Universidade Federal de São Paulo (Unifesp), Diadema, SP, Brasil.*
E-mail: mariana.adas@gmail.com

[b]*LECon (Laboratório de Ecologia Aplicada e Conservação), Departmento de Ciências Ambientais, Universidade Federal de São Paulo (Unifesp), Diadema, SP, Brasil.*
E-mail: elisa.hardt@unifesp.br

[c]*LESPA (Laboratório de Economia, Saúde e Poluição Ambiental), Departmento de Engenharia Química, Universidade Federal de São Paulo (Unifesp), Diadema, SP, Brasil.*
E-mail: simone.miraglia@unifesp.br

[d]*LabInSciences (Laboratory of Integrated Sciences), Departmento de Ciências Ambientais, Universidade Federal de São Paulo (Unifesp), Diadema, SP, Brasil.*
E-mail: decio.semensatto@unifesp.br

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ABSTRACT

We estimated the economic value of ecosystem services provided by the legally protected vegetation in riparian zones (RPA- riparian protected areas) of watercourses of the Guarapiranga Reservoir watershed (São Paulo, Brazil), considering two scenarios: (i) the value of ecosystem services provided if the RPA recovery complies with the applicable environmental legislation; and (ii) the year 2030, maintaining the urbanization rate and the loss of vegetation cover in the watershed observed between 1986 and

2010. Accomplishing the first scenario demands reforesting 5,917.5 ha of the RPA, which may reduce the annual expenses with chemicals for water treatment and save USD 181.774 per 1000 m3 of treated water. For 2030, we estimated a loss of 6,220 ha of vegetation cover in the RPA (1986 as the initial reference). The loss of ecosystem services provided by RPA would result in an accumulated increase of about USD 318 million in water treatment costs between 2011 and 2030.

Keywords: Riparian conservation. Water quality. Water supply. Natural resources management. Environmental valuation. Reforestation.

RESUMO

Estimamos o valor econômico dos serviços ecossistêmicos providos pela vegetação ripária protegida (RPA) das margens e afluentes da Represa Guarapiranga (São Paulo, Brasil), considerando dois cenários: (i) o valor dos serviços ecossistêmicos providos se a RPA for recuperada consoante a legislação ambiental aplicável; e (ii) o ano de 2030, mantido o ritmo de urbanização e perda de cobertura vegetal na bacia observados entre 1986 e 2010. O cumprimento do primeiro cenário demanda reflorestar 5917,5 ha da zona ripária, o que deve reduzir o gasto anual com reagentes e economizar USD 181,774 por 1000 m3 de água tratada. Para 2030, estima-se a perda de 6.220 ha de cobertura vegetal na zona ripária (1986 como ano inicial de referência). A perda de serviços ecossistêmicos providos pela RPA resultaria em um aumento acumulado de USD 318 milhões em custos de tratamento de água bruta entre 2011 e 2030.

Palavras-Chave: Conservação de zonas ripárias. Qualidade da água. Abastecimento público. Manejo de recursos naturais. Reflorestamento.

1 INTRODUCTION

Ecosystem services arise from the links between natural capital and human well-being, direct and indirect benefits generated by the complex interactions between the components of natural capital (COSTANZA et al., 1997). Despite their importance for the maintenance of life on the planet, most of these goods and services are not incorporated in traditional markets and economic transactions, which does not favor their conservation (COSTANZA et al., 2017; DE GROOT et al., 2012).

Variations in water quality as a consequence of land use and coverage changes are mainly due to surface runoff of organic matter and other substances from the activities developed (residences, industries, and others) and the discharge of effluents collected or not, which flow to the associated water bodies (FIQUEPRON et al., 2013; MOKONDOKO et al., 2016).

The decrease in water quality is also related to the reduction of vegetated areas, especially in riparian zones, that perform a series of ecosystem services, such as maintenance of water production, filtering of substances and organic matter, erosion control, nutrient cycling, biological control, and food production (CELENTANO et al., 2017; GUNDERSEN et al., 2010; MELLO et al., 2018; SWEENEY et al., 2004). Studies report an inverse relationship between the presence of vegetation in watersheds and the number of chemicals applied for raw water treatment and the respective financial costs, that is, the higher vegetation covers the better water quality (BRITO et al., 2018; BROGNA et al., 2017; ERNST et al., 2004; FIQUEPRON et al., 2013).

The types of eco-hydrological functions carried out by native vegetation vary according to their position in the relief so that it must be present in all relief types of the watershed to provide all the associated ecosystem services (TAMBOSI et al., 2015). Although usually occupying a fairly strict landscape area, riparian zones play a relevant role in the chemical and physical quality of water as it is a component of interchange between contiguous lands and the aquatic body (CHASE et al. 2016; MOKONDOKO et al., 2016).

The action of the riparian zone in the protection of water resources can vary according to the density of the vegetation bands, the ecological succession stage, the season, and conservation status and the

type of vegetation and preserved bandwidth (BROGNA et al., 2017; LOVELL & SULLIVAN, 2006). Much of the ecosystem services provided by forests are related to regulatory functions, such as erosion prevention, pollution control, and water purification (BROGNA et al., 2018; GONZÁLEZ et al., 2017). Ecosystem management by the maintenance of these water services is generally more cost-effective in comparison to the implementation of artificial technologies or mitigation measures (GONZÁLEZ ET AL., 2017; GROLLEAU & MCCANN, 2012).

Taking this into account, this article presents an economic valuation to estimate losses of ecosystem services associated to water quality regulation due to the loss of vegetation cover in riparian zones in the Guarapiranga Reservoir watershed, responsible for the water supply of about 20% of the population of São Paulo Metropolitan Region (SPMR).

Considering the scenario of degradation of the Guarapiranga reservoir, which has eutrophic waters since the 1980s (FONTANA et al., 2014), and its importance for the metropolitan public supply system, it is crucial that the ecosystem services provided by the vegetation cover are better understood, especially regarding the water quality regulation, as well as the importance of recovering riparian areas to guarantee public supply.

Hence, the general objective of this work was to estimate the direct use value of ecosystem services associated with water quality regulation provided by the vegetation cover under legal protection in the riparian zones of the watershed (RPA, riparian protected area). To do so, based on previous assessment estimates, we worked with two hypothetical scenarios: (i) the value of the ecosystem services provided if the arboreal cover of RPAs in the watercourses were restored; and (ii) the estimation of the value of ecosystem services provided by RPAs in the year of 2030, maintaining the rate of urbanization and loss of vegetated areas in the watershed observed from 1986 to 2010.

In this way, it was possible to compare the legal compliance scenario (i) with the recent scenario (2012) and the trend scenario (2030) and prospect if no conservation intervention is put into practice. We expect that evaluating economic costs for possible losses and gains of ecosystem services may assist in the land use planning and management for water public policies.

2 MATERIAL AND METHODS

2.1 STUDY AREA

The Guarapiranga watershed is located in the southwest portion of the São Paulo Metropolitan Region (SPMR), Brazil (Figure 1). The watershed has a drainage area of 611.3 km2, equivalent to 8% of the SPMR territory.

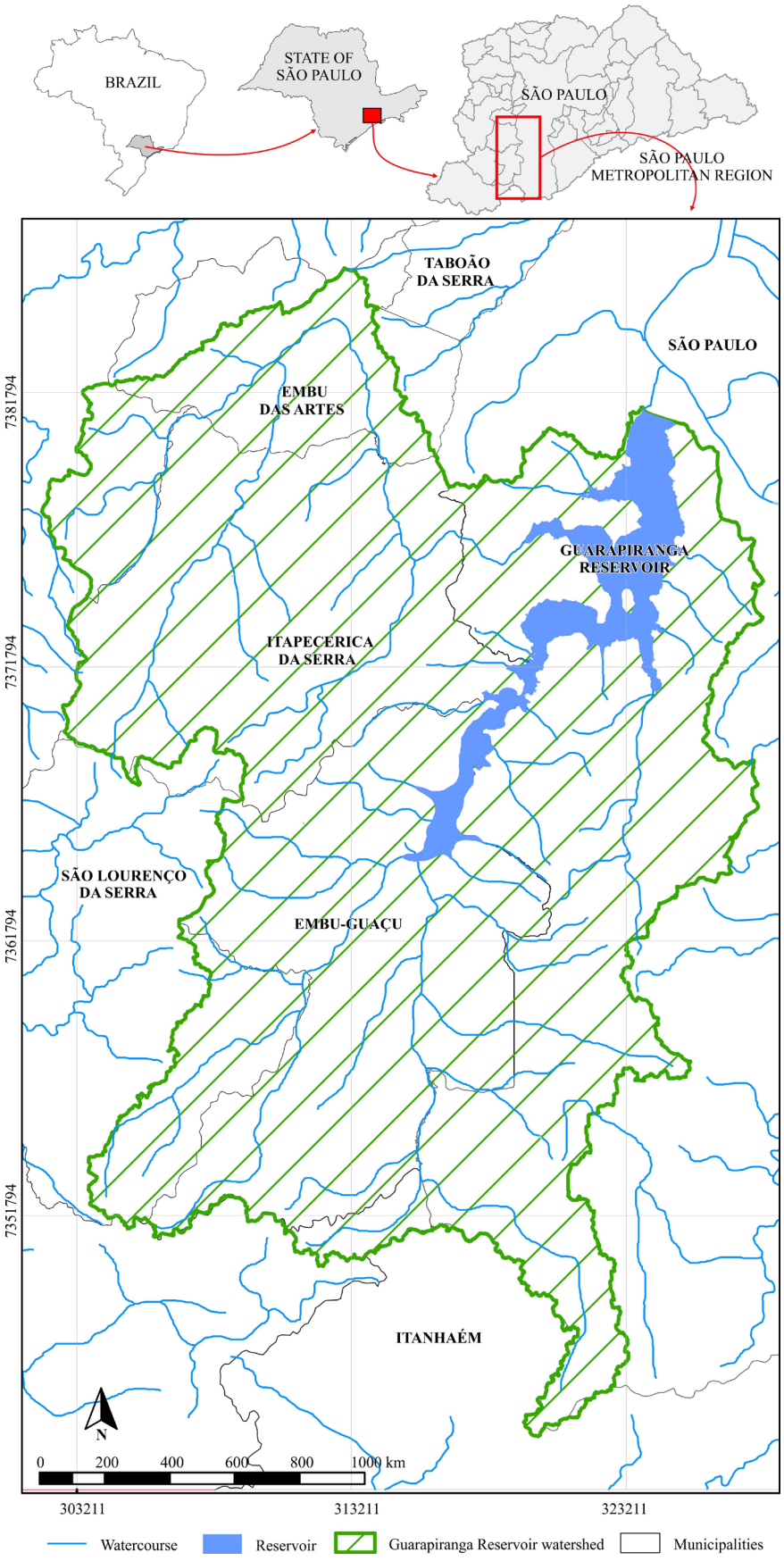

Figure 1 | Guarapiranga Reservoir watershed (green area) and municipalities in the SPMR, Brazil.

Source: Own elaboration by treating data from the cartographic base of the Hydrography of the São Paulo Metropolitan Region and Baixada Santista (IGC/SP).

The Guarapiranga Supply System (GSS) is the second-largest producer of water for the SPMR, with a flow of 14 m3/s, usually supplying 3.8 million inhabitants (20% of the SPMR population). In March 2015, during a hydrological crisis in São Paulo, the GSS supplied 5.2 million inhabitants and became the largest water producer temporarily (SABESP, 2015).

The dam was built around 1906, initially intended to regulate the flow of the Tietê River during the dry season and to complement the power generation (ARAÚJO, 2017). The reservoir became a source for public supply only in 1928 when the surrounded areas started gradually to demand more water for residential and recreational buildings, such as holiday clubs with marinas. The irregular urban settlements, quite populous, started forming in 1970 without sanitary infrastructure, leading to the current scenario, characterized by environmental impacts and social conflicts (ANDRADE et al., 2015; ARAÚJO, 2017).

The watershed landscape is a transitional territory of heavily urbanized northern and western areas of the SPMR, especially around the reservoir, and Atlantic Forest preserved areas, which include the headwaters of the Embu-Guaçu and Santa Rita rivers on the cliffs of Serra do Mar. There are also floodplains partially preserved in the southern and western portions (ANDRADE et al., 2015; SÃO PAULO, 2011).

In early 2000 more than half of the areas around the reservoir were altered by intense anthropic activity and the population was just over 755,000 inhabitants; most of it concentrated northwest and east of the reservoir, where population densities ranged from 94.2 to 100.4 inhabitants/ha (IKEMATSU, 2014; OTOMO et al., 2015; SÃO PAULO, 2011). The historical process of territorial occupation over the last decades and the growing resident population mark the conflict between the environmental function of the watershed, as a producer of water for the public supply of the SPMR, and the potential residential expansion function, because it represents one of the few remaining areas available for human occupation in the metropolitan region (IKEMATSU, 2014).

WATER QUALITY

Previous studies show that the water quality of the Guarapiranga Reservoir is directly related to the characteristics of land use and cover, as well as the availability of sanitary infrastructure and operational efficiency (FONTANA et al., 2014; LEAL et al., 2017; SEMENSATTO & ASAMI, 2017). In 2000, 88% of the households in the watershed had water supply but only 53% were connected to the sewerage system (SÃO PAULO, 2011). The loads from domestic sewage in urban areas accounted for 93.6% of the estimated total phosphorus input generated in the watershed (SÃO PAULO, 2011).

More than half of the Guarapiranga Reservoir area presents significant changes caused by anthropic impacts (LEAL et al., 2017), mainly caused by the flow of untreated sewage to the reservoir that became eutrophicated (FONTANA et al., 2014). The situation is worse in the rainfall season when water quality declines due to more intense urban runoff (SEMENSATTO & ASAMI, 2017). Consequently, the water quality varies spatially and seasonally throughout the reservoir. The region closest to the catchment for supply presents better quality, which is the consequence of the natural depuration of the body of water, whereas the regions with higher population density and where tributaries and transposition that reach the reservoir present higher concentrations of pollutants (SÃO PAULO, 2011; SEMENSATTO & ASAMI, 2017).

2.2. DATA SOURCE AND CONCEPTUAL PREMISES

We used the land use and vegetation cover data elaborated by Andrade et al. (2015) for the Water Quality Assessment of Guarapiranga Reservoir (Aquased Project). This database was chosen because it presents

a temporal and spatial resolution compatible with our study, besides being used by Brito et al. (2018) in the valuation of ecosystem services, which in turn served here as the reference for the local ecosystem services valuation. Andrade et al. (2015) analyzed territorial changes of the watershed by mapping land use and cover types for the years 1986, 1996, 2010, at the regional scale 1:100,000, using an automatic classification of Landsat® images. For a more detailed analysis, they also used multispectral images Ikonos® (05/28/2012), on the scale of 1:10,000 for urban regions and 1:20,000 for other areas.

This study is based on the following conceptual assumptions regarding the analysis of results:

- The valuation of ecosystem services can be overestimated or underestimated because it is virtually impossible to describe all valuable ecosystem relationships and functions adequately;
- The rate of future changes in land use and cover was calculated considering the same trend will continue over the years prospected, based on the rate of loss of vegetation cover observed from 1986 to 2010 by Andrade et al. (2015);
- In the quantification of arboreal vegetation cover in the riparian zones we did not consider the differences among the types of vegetation, their successional stage, as well as their variation in terms of ecological functions;
- The estimation of the valuation of ecosystem services in riparian zones considered only the vegetation cover area (fields, forests, and reforestation);
- The regression model used in inferences considered only the variable “area of vegetation cover” and did not consider the effect of other factors, such as a change in population growth rate, implementation/extinction of management programs, or change in legislation;
- The water treatment technologies employed, and the public policies related to environmental conservation were considered constant over the years.

2.3. HYPOTHETICAL SCENARIOS

SCENARIO I: RIPARIAN ZONES WITH VEGETATION COVER FULLY RECOVERED

We delimited the waterbodies’ RPAs using the cartographic base of the Hydrography of the São Paulo Metropolitan Region and Baixada Santista (IGC/SP), at the scale of 1:25,000. Due to the lack of data, it is important to mention that the tributary springs were not considered in this study. Using ArcGIS 10.5 software (ESRI)® the RPAs were delimited according to the definitions of the Federal Law 12.651/2012 (buffer between 30-50 m depending on the river width) and the margin of the Guarapiranga Reservoir according to the São Paulo State Law 12.233/2006 and State Decree 51.686/2007 (50 m measured in horizontal projection from the contour line corresponding to the maximum level of the reservoir of 737 m in altitude, which equals to 171.2 hm3 stored.

This scenario presupposes full compliance with the corresponding environmental legislation. It indicates that the whole RPAs are covered by vegetation and there is no other type of current use. From this, it was possible to compare the situation of land use and cover (updated map from 2012) with the hypothetical scenario of legal compliance to estimate the value of ecosystem services that are lost in the real scenario and that could be gained in case of full recovery.

The vegetation cover forming riparian zones on the margins of the watercourse, such as forests, mosaics of vegetation and naturally flooded areas, play a critical role in protecting water resources by maintaining water quality in good conditions and by supplying and replenishing groundwater, such as aquatic sheets and aquifers (GONZÁLEZ et al., 2017). Deforestation debilitates virtually all ecosystem services. Thus, preservation of these areas is fundamental for the regulation of both the hydrological cycle and the biogeochemical cycles (SWEENEY et al., 2004; TAMBOSI et al., 2015).

The RPAs map was then superimposed over the map of land use and vegetation cover from 2012 elaborated by Andrade et al. (2015) to identify the type of land use present in riparian zones. This made it possible to define the arboreal cover deficit in the riparian zone observing the compliance with the legislation (Equation 1). Although the vegetation cover with exotic species (reforestation) is not in compliance with the current legislation for RPAs, we included this type of cover since the ecosystem functions and services for water regulation are somewhat similar to native forests (BROCKERHOFF et al., 2013; FERRAZ et al., 2013). Moreover, the presence of old commercial planting with the regeneration of native vegetation in the understory is a common structure for the reservoirs of SPMR (ROMERO et al., 2018). Even so, we cannot ignore concerns about the potential effects of forestry activities on water quality or the economic implications of limiting some chemical substances reaching lakes and streams (ERIKSSON et al., 2011).

$$ACD_{RB(YEAR)} = TA_{RB} - AC_{RB(YEAR)} \qquad (1)$$

$ACD_{RB(YEAR)}$: Arboreal Cover Deficit in the riparian zone in a given year

TA_{RB}: Total Area of the riparian zone

$AC_{RB(YEAR)}$: Arboreal Cover of the riparian zone in a given year

Scenario II: Keep Losing Vegetation Cover in the Riparian Zones until 2030

The year 2030 was chosen because it is the target year for meeting the Sustainable Development Goals (SDGs) of the 2030 Agenda established by the United Nations (UN), which includes the protection and restoration of ecosystems related to water quality, especially SDGs 6.3 and 15.1, which respectively state "By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally", and "By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains, and drylands, in line with obligations under international agreements" (UNITED NATIONS, 2015). Moreover, it is equivalent to at least five federal government mandates in Brazil, which would be, in principle, enough time for the consolidation and execution of a public policy of environmental resources conservation necessary to meet the UN agenda.

We projected the vegetation cover in 2030, based on the rate of loss of vegetation in the watershed previously observed between 1986, 1996 and 2010. For that, we fitted a logarithmic curve between the years and the area of the vegetation cover computed by Andrade et al. (2015). Although we did not consider the increase of built-up areas, it is directly related to the reduction of the vegetation cover areas (BRITO et al., 2018).

2.4 VALUATING ECOSYSTEM SERVICES

We transferred the value of the ecosystem services calculated by Brito et al. (2018) to estimate the value of the ecosystem services related to water quality regulation provided by the vegetation

cover identified in the watershed. This technique is widely used in the field of economic valuation of environmental resources when data is absent and it is acceptable when it is done between sites that present physical similarities and of the same valuation specificities (TROY & WILSON, 2006).

Brito et al. (2018) evaluated the ecosystem service of water quality in the Guarapiranga watershed through the Avoided Costs Method, which estimates the value of the use of natural resources that would be incurred in substitute goods in order not to alter the productivity since these services represent the production of a good that is not observable in the market. The estimate of the ecosystem service value was calculated utilizing the expenses needed to mitigate environmental degradation, namely the treatment of raw water for public supply. The authors estimated the value of the perfect substitute based on the data of average chemicals dosage utilized to treat raw water in the years of 1996 and 2010 obtained in consultation with the Brazilian National Sanitation Information System (SNIS), as well as expenditure on these chemicals.

The results obtained by Brito et al. (2018) showed that the loss of vegetation cover has a direct and negative correlation with the average dosage of reagents used in the treatment of raw water. The authors estimated the economic value of environmental resources for the ecosystem service of the water supply of the Guarapiranga reservoir for the years 1996 and 2010 at USD 927,536.25 and USD 6,624,543.78, respectively. Thus, the monetary value of the loss of vegetation cover is at least the value of the costs incurred in maintaining water quality (water treatment costs), and therefore the increase in the cost of treatment can be considered as a substitute for the evaluation of ecosystem services of good quality water supply. Using this approach and data, we rated the Value of the Ecosystem Service (VES) for the hypothetical scenarios by inferring the value of the increase in water treatment costs (WTCIha) to treat 1,000 m³ of raw water for each hectare of vegetation cover suppressed (Equation 2).

$$WTCI_{ha} = \frac{RCT_{2010} - RCT_{1996}}{VC_{1996} - VC_{2010}} \qquad (2)$$

$WTCI_{ha}$: Water Treatment Cost Increase for each hectare of vegetation suppressed (USD/ha)

RCT_{year}: Relative Cost of Treatment of raw water (1,000 m3) in a given year (USD)

VC_{year}: Vegetation cover in a given year (ha)

The VES was calculated through the monetary expenditure data with chemicals used to treat water and the area of vegetal cover for the period from 1996 to 2010. Based on this value and the vegetation cover inferred using the logarithmic model (fields, forests, and reforestation), it was possible to assess the relative cost in 2030 (RCT2030) (Equation 3) and the VES for the year 2030 (Equation 4).

$$RCT_{2030} = WTCI_{ha} \cdot (VC_{2030} - VC_{1996}) \qquad (3)$$

$$VES_{2030} = WP_{2030} \cdot RTC_{2030} \qquad (4)$$

VES_{year}: Value of the Ecosystem Service in a given year (USD)

WP_{year}: Water Production for public supply in a given year (1,000 m3)

Having established this estimate and the inference of the vegetation cover in 2030, we estimated the value associated with the loss of ecosystem services. We applied the same rationale by using the same value resulting from Equation 2 to calculate the VES of the deficit area of vegetation cover in the RPA. The reference currency was the US dollar to maintain compatibility with the data of Brito et al. (2018) and to allow comparability with other studies.

3 RESULTS AND DISCUSSION

3.1 SCENARIO I: FULL RECOVERY OF THE VEGETATION COVER IN RIPARIAN ZONES

The Guarapiranga watershed has 17,307.91 ha legally protected as RPAs (watercourses + reservoir), which is equivalent to 28% of the total area; 97% of RPAs are located at watercourse riparian zones (Table 1). In the present scenario (2012), the vegetation cover of RPAs represented equal rates to watercourses and reservoir, 77.4% and 75.2%, respectively. The difference was for arboreal cover (forest and reforestation), with 66.5% in the watercourses and 39.0% in the reservoir.

Moreover, the RPA of the reservoir proportionally concentrates more anthropized areas such as roads, residential areas, commerce and services, and other urban installations, than the RPAs of the watercourses in the entire watershed (Table 1, Figure 2). These differences indicate that the reservoir management did not have efficient control of the occupation and use of margins. Furthermore, they suggest that the legal definitions and the general guidelines of best practices of management to ensure better water quality is not being met.

The proportion of arboreal vegetation at 66.5% is a result of susceptibility of the RPAs to the historical process of the progressive anthropization of the watershed (ARAÚJO, 2017; FONTANA et al., 2014) represented by settlements (legal and illegal) and the construction of holiday clubs, marinas, restaurants, commerce and services linked to water sports (east) and small farms (west). As expected, the arboreal cover in the watercourses was concentrated mainly in areas of higher elevations in the western and southern regions of the watershed (Figure 2). On the other hand, the areas to the east and northwest of the reservoir, which present a higher population density (SÃO PAULO, 2011), are those with the lowest presence of arboreal cover. Although low-productivity or abandoned grasslands (here referred to “fields”) do not induce water degradation (that is one reason we included them in the vegetation cover), the forest cover should always be stimulated as a priority in riparian zones because of its strong and positive correlation with water quality (MELLO et al., 2018).

Table 1 | Land use and land cover in the RPAs of the Guarapiranga watershed (SP, Brazil) in 2012.

Land use and land cover	*Riparian Preservation Areas (RPAs)*			
	Watercourses (ha)	*%*	*Reservoir (ha)*	*%*
FIELDS	1,845.21	10.9	156.71	36.2
CULTIVATED LANDS	250.40	1.5	0.28	0.1
URBAN GREEN SPACES	44.45	0.3	-	-
UNBUILT LOTS	11.47	0.1	-	-
FORESTS	10,241.18	60.7	158.81	36.7
REFORESTATION	980.23	5.8	10.16	2.3
HOUSES/COMMERCE/SERVICES/OTHER URBAN INSTALLATIONS	3,422.49	20.3	104.31	24.1
ROADS	61.54	0.4	2.57	0.6
EXPOSED SOILS	17.88	0.1	0.19	0.04
TOTAL	**16,874.88**	**100**	**433.03**	**100**

Source: Own elaboration by treating data published by Andrade et al. (2015).

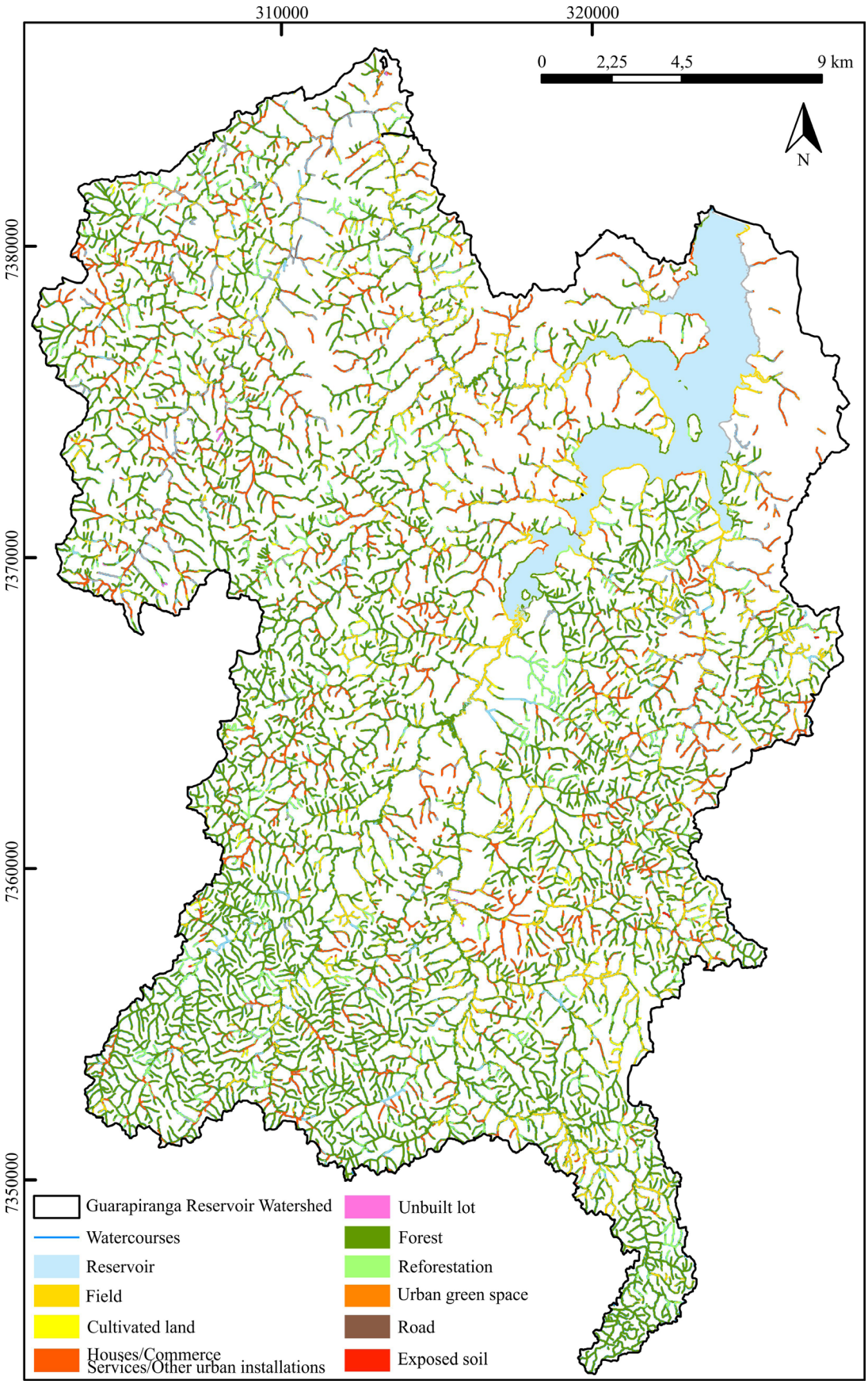

Figure 2 | Land use and cover of the RPAs of the Guarapiranga watershed (SP, Brazil) in 2012.

Source: Own elaboration by extracting and treating data published by Andrade et al. (2015) and the cartographic base of the Hydrography of the São Paulo Metropolitan Region and Baixada Santista (IGC/SP).

Under the theoretical hypothesis of full compliance with environmental legislation (Federal Law 12651/2012 and State Law 12233/2006), in which the entire riparian zones should be covered with forests (arboreal vegetation considering the study's purposes), and applying Equation 1, it would be necessary to reforest 5,917.5 ha (Table 2). Applying reference data from Antoniazzi et al. (2016), the cost (only material and manpower) to reforest this area may vary from USD 1,571,392.00 (active natural regeneration) to USD 14,545,037.00 (planting native trees), considering non-economic use of the planted area in Atlantic Forest (São Paulo State, Brazil) using native seedling.

Nonetheless, the real costs require study of specific characteristics of the area that were not addressed here, such as physical characteristics of the landscape, phytosociological data, and analysis of possible expropriations of real estate and removals, which was not in the scope of this analysis. Despite the undoubted importance (ecological and economic) of the restoration of arboreal cover in riparian zones, the historical and current land use of riparian zones does not show signs of changes in this sense.

There is a heterogeneous distribution of land uses of riparian zones throughout the area, resulting from the advance of large urbanization axes with the replacement of vegetation cover by built-up areas (ANDRADE et al., 2015; IKEMATSU, 2014). This process was stimulated by both public and private projects of settlements with various social profiles including irregular occupations of more remote areas and less value from the real estate perspective (ARAÚJO, 2017).

Table 2 | Arboreal cover (forest and reforestation) of the riparian zones of Guarapiranga watershed (SP, Brazil) in the present situation (2012), in the scenario of full legal compliance and the deficit of compliance in 2012

Type of the RPA	*Present situation (2012)*		*Full legal compliance*		*Deficit of legal compliance in 2012*	
	Area (ha)	*%*	*Area (ha)*	*%*	*Area (ha)*	*%*
WATERCOURSES	11,221.4	66.5	16,874.9	100	-5,653.5	33.5
RESERVOIR	169.0	39.0	433.0	100	-264	61.0
TOTAL RPAS	11,390.4	65.8	17307.9	100	5,917.5	34.2

Source: Own elaboration by treating data published by Andrade et al. (2015).

3.2. SCENARIO II: VEGETATION COVER IN 2030

The logarithmic curve was traced to obtain its regression model and infer the vegetation cover in the whole watershed in 2030, considering the rate of regional loss inferred from data reported by Andrade et al. (2015) (Figure 3). The logarithmic model is the most appropriate conceptually because the substitution of vegetation cover by other types of use must occur until near an asymptotic minimum limit. The forecast is that by 2030 the area of vegetation cover (51,390 ha) is reduced by 6,220 ha, which represents a reduction of 10.8% having the year 1986 as the initial reference (Table 3). Riparian deforestation impacts negatively on many types of ecosystem services, such as preventing pollutants from entering water bodies and amortizing nonpoint and point source pollutants (CHASE et al., 2016; SWEENEY et al., 2004).

Thus, deforestation has the potential to affect other ecosystems and respective services by reverbing negative impacts through diverse links, which may increase the externalities to users of water supply. We know that water quality may decrease with riparian deforestation because it promotes disturbances in hydrological and physical aspects of water bodies (e.g., sediment transport, water velocity, channel roughness), increases transference of some pollutants to water bodies by leaching and superficial runoff (riparian vegetation plays a filtering role), and induces changes in biological aquatic activities linked to aquatic chemical transformations (BROGNA et al., 2017; FIQUEPRON et al., 2013; MELLO et al., 2018; SWEENEY et al., 2004).

If deforestation keeps the recent pace through the next years in the watershed, the SDGs 6.3 and 15.1 will never be accomplished. Although 10% of vegetation loss over two decades does not appear overly impressive, this scenario can be worse considering recent political tendencies. The main Brazilian law that regulates RPAs (Federal Law 12.651/2012 – Forest Code) has changed in the last years, becoming more flexible and allowing anthropic uses in consequence of changes in technical terms that define protected areas; creation of the consolidated area concept in rural landscapes (uses before 2008); and the reinforcement of public utility and social interest in urban areas (ISSII et al., 2019; SPAROVEK et al., 2011).

These are important changes that may weaken conservation efforts and the possible gains in ecosystem services (ALARCON et al., 2015), which may represent an extra obstacle to recover the riparian zones and restore their ecological functions. Another important challenge facing riparian zones is that some modifications in legislation can create contradictory guidance with non-specific laws applicable to those zones (GONZÁLEZ et al., 2017), such as the State Decrees that forbid the construction of sanitation infrastructure in RPAs with irregular settlements.

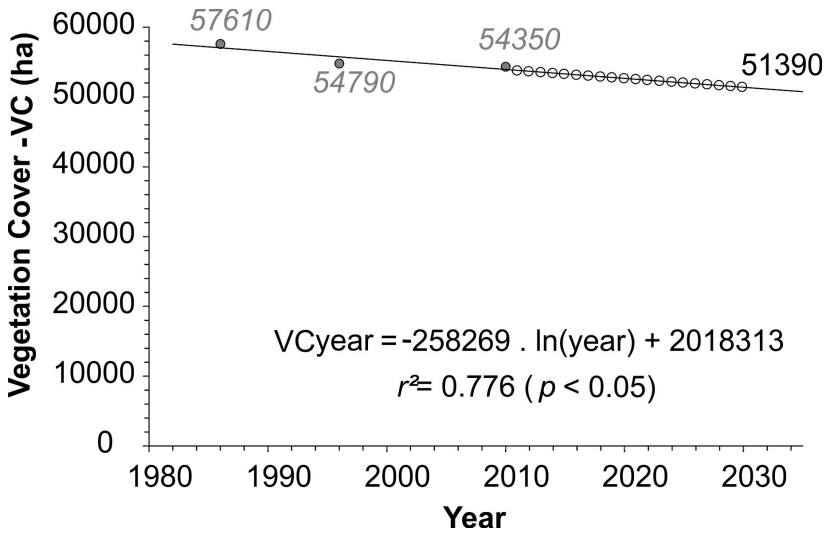

Figure 3 | Scatterplot with the logarithmic curve and respective model used to infer the vegetation cover throughout the years at the Guarapiranga watershed (SP, Brazil). The values in grey were observed by Andrade et al. (2015) and the white circles were computed from the logarithmic regression model.

Source: Own elaboration by treating data published by Andrade et al. (2015).

Table 3 | Estimates of vegetation cover loss in the Guarapiranga watershed (SP, Brazil) throughout the years. The values between 2011 and 2030 were inferred from the logarithmic model (Figure 3).

Year	*Vegetation cover area (ha)*	*Vegetation cover lost since 1986 (accumulated %)*	*Accumulated area of vegetation cover lost since 1986 (ha)*
1986	57.610	-	-
1996	54.790	4,89	-2.820
2010	54.350	5,66	-3.260
2011	53.819	6,58	-3.791
2012	53.691	6,80	-3.919
2013	53.562	7,03	-4.048
2014	53.434	7,25	-4.176
2015	53.306	7,47	-4.304
2016	53.178	7,69	-4.432
2017	53.050	7,92	-4.560
2018	52.921	8,14	-4.689

Year	Vegetation cover area (ha)	Vegetation cover lost since 1986 (accumulated %)	Accumulated area of vegetation cover lost since 1986 (ha)
2019	52.794	8,36	-4.816
2020	52.666	8,58	-4.944
2021	52.538	8,80	-5.072
2022	52.410	9,03	-5.200
2023	52.282	9,25	-5.328
2024	52.155	9,47	-5.455
2025	52.027	9,69	-5.583
2026	51.900	9,91	-5.710
2027	51.772	10,13	-5.838
2028	51.645	10,35	-5.965
2029	51.518	10,58	-6.092
2030	51.390	10,80	-6.220

Source: Own elaboration.

3.3. VALUE OF THE ECOSYSTEM SERVICE

According to Brito et al. (2018), Sabesp produced 357,462,595 m3 of treated water for public supply in the Guarapiranga System in 1996 and spent USD 927,536.25 on chemicals for water treatment. Thus, the estimated relative cost was USD 2.5948 per 1,000 m3 of treated water. In 2010, Sabesp produced 411,175,012 m3 of treated water, which represented an increase of 15% compared to 1996. However, a total expenditure with chemicals in 2010 reached USD 6,624,543.78, resulting in the relative cost of USD 16.1113 per 1,000 m3 of treated water. Although the production of the system increased by 15%, the relative cost of treatment increased dramatically by around 621%. This amount represents one of the dimensions of loss of value of ecosystem services in the watershed due to the replacement of vegetation cover (ecosystem service provider) by built-up areas (demand for ecosystem service), as explained by Brito et al. (2018).

Mello et al. (2018) reported a similar situation in other areas in Brazil (Sapuraí River watershed, State of São Paulo), where they found a significant and positive correlation between the forest cover and water quality and a significant and negative correlation between the urban cover and water quality. They reported that forest cover correlates strongly and positively with dissolved oxygen and correlates negatively with total phosphorous (TP), total nitrogen (TN) and fecal coliforms (FC). Indeed, these last three variables and the eutrophication process have increased throughout the last decades at Guarapiranga watershed as deforestation took place (FONTANA et al., 2014; SEMENSATTO & ASAMI, 2017).

Concerning the total expenditure with chemicals for water treatment between 1996 and 2010, there was a nominal increase of USD 13.5165 per 1,000 m3 of treated water, and during this period the RPA vegetation cover was reduced by 440 ha, from 54,790 to 54,350 ha (Table 3). Thus, the result of the application of Equation 2 is that the $WCTI_{ha}$ is equal to 0.030718 USD/ha per 1,000 m3 of treated water. As we mentioned earlier (item 3.2), maintaining a similar rate of land use and changes in land cover, by 2030 vegetation cover will be 51,390 ha, which represents a reduction of 2,960 ha since 2010 (Figure 3, Table 3). Therefore, based on this change and the assumptions of this work, the RCT_{2030} may reach USD 90,917 per 1,000 m3 of treated water. If the level of water production (*WP*) recorded between 2009 and 2013 is maintained, the reservoir may produce around 420,000 m3 in 2030. Thus, with the loss of vegetation and its respective ecosystem services the $WTCI_{ha}$, the total estimated cost of water treatment for public supply for the year 2030 will be USD 38,185,319.75, which here is recognized as equivalent to the *VES* (Table 4). When compared to 2010 costs, this will mean an increase of USD 31,560,775.97 or approximately 576% in expenses with chemicals. If we

observe the inferred annual increase in the treatment cost compared to that spent in 2010, by 2030 USD 318,343,202.12 of VES would have been lost for 18 years.

It is an estimate of the loss of ecosystem services provided by the vegetation cover with the probable consequent externality to users of the public supply. At the same time, it also represents an estimate of the amount of investment in the water treatment system needed to replace the service provided by vegetation cover and amortize their respective loss over time, if the objective is to maintain the values of 2010. It should be noted that this scenario considers only the water quality maintenance service estimated for direct use, following the estimate of Brito et al. (2018). It does not consider the possible level of degradation of water quality in terms of impeding all the multiple uses and of restrictions in availability for public supply due to sanitary standards.

Table 4 | Inference of the VES estimated for the water quality maintenance by vegetation cover in the Guarapiranga Reservoir watershed (SP, Brazil).

Year	*Water Production (1,000 m3)*	*Relative Cost of Treatment – RCT (USD/1,000 m3)*	*VES (USD/year)*	*Increment of the Cost of Treatment from 2010 (USD)*	*Accumulated Increment of the Cost of Treatment from 2010 (USD)*
1996	357,463	2,595	927.536	-	-
2010	411,175	16,110	6.624.543,78	-	-
2011	420,000	16,313	6.851.563,98	227.020,20	-
2012	420,000	20,257	8.508.075,58	1.883.531,80	2.110.552,00
2013	420,000	24,199	10.163.764,06	3.539.220,28	5.649.772,28
2014	420,000	28,140	11.818.630,24	5.194.086,46	10.843.858,74
2015	420,000	32,078	13.472.674,95	6.848.131,17	17.691.989,92
2016	420,000	36,014	15.125.899,00	8.501.355,22	26.193.345,14
2017	420,000	39,948	16.778.303,20	10.153.759,42	36.347.104,56
2018	420,000	43,881	18.429.888,37	11.805.344,59	48.152.449,14
2019	420,000	47,811	20.080.655,30	13.456.111,52	61.608.560,67
2020	420,000	51,740	21.730.604,83	15.106.061,05	76.714.621,72
2021	420,000	55,666	23.379.737,75	16.755.193,97	93.469.815,69
2022	420,000	59,591	25.028.054,88	18.403.511,10	111.873.326,79
2023	420,000	63,513	26.675.557,01	20.051.013,23	131.924.340,02
2024	420,000	67,434	28.322.244,96	21.697.701,18	153.622.041,20
2025	420,000	71,353	29.968.119,53	23.343.575,75	176.965.616,95
2026	420,000	75,269	31.613.181,53	24.988.637,75	201.954.254,70
2027	420,000	79,184	33.257.431,74	26.632.887,96	228.587.142,66
2028	420,000	83,097	34.900.870,99	28.276.327,21	256.863.469,87
2029	420,000	87,008	36.543.500,06	29.918.956,28	286.782.426,15
2030	420,000	90,917	38.185.319,75	31.560.775,97	318.343.202,12

Source: Own elaboration.

Taking into account the scenario of legal compliance for this study, where the riparian zones would be completely recovered by arboreal vegetation, it is observed that the recovery of 5,917.5 ha (Table 2) using the same logic for the projections by 2030 would represent theoretical savings of USD 181,774 per 1,000 m³ of treated water (5,917.5 ha x USD 0.030718). Although this value gained in the ecosystem services (cost-of-treatment savings) would initially express a hypothetical cost below zero for water treatment, it is more appropriate to infer that the cost involved with reagents would potentially regress to the levels spent in 1996.

Our results point out that the value that would be generated in terms of ecosystem services if the vegetation cover deficit in riparian zones was eliminated would be higher than the amount spent for the water treatment. Fiquepron et al. (2013) estimated that an increase of 1% of forest cover would decrease by €0.0034/m3 (USD 0.0038/m3) of invoiced drinking water. If we compare their results with our estimates, an increase of 1% of vegetation cover at the Guarapiranga watershed would decrease treatment cost by €0.015/m3 (USD 0.0168/m3) which represents a more significant economic impact on water users. Certainly, it is necessary to consider that there are many other factors associated with the relationship between vegetation cover and water quality (BROGNA et al., 2017), especially in a complex watershed such as the Guarapiranga reservoir.

Furthermore, the installation of sanitation infrastructure for sewage collection and treatment, for example, should have an impact on the cost of water treatment as significant as the recovery of the vegetation cover. Despite these influences, in general, afforestation may produce many more benefits and improve other ecosystem services not included in our analysis (BROGNA et al., 2017). Buffin-Bélanger et al. (2015), for instance, predicted that riparian zones ecosystem services could reach CDN$ 958/ha/year (USD 691/ha/year) in Canadian watersheds by avoiding costs related to flood protection and improving wetlands ecosystem services.

3.4. LIMITS OF THE INFERENCES

Although the results showed an estimate of the value for the ecosystem services provided by the vegetation for water quality regulation, it is necessary to keep in mind that the methodology applied has some limitations. First, the projection of areas of vegetation cover for the future trend scenario in 2030 considered only the “vegetation cover area” as a variable. Other variables could influence changes in water quality, such as population growth, changes in current legislation, implementation of sanitation facilities or other measures that can reduce the input of organic matter and substances that alter water quality, as we have discussed above.

Furthermore, the practice of transferring values generally results in errors in the estimates due to the inherent differences among ecosystems and the lack of information. For this study, this was not a limitation, considering that the values transferred are specific for the studied site since both studies were carried out in the Guarapiranga watershed.

Variations in estimated values should be viewed with caution. The initial implicit idea is that variations in the values of ecosystem services reflect changes in their physical flows. However, the dynamics of ecosystem functions are not linear and require an in-depth knowledge of the relationships between ecosystem components to figure them out. Finally, considering the period proposed in the scenarios and that the scenario estimates are based on the variable “vegetation coverage area”, values of the ecosystem services coefficients cannot be considered static either, since the variation in the quantity of ecosystem services provided may change its monetary value due to interaction between demand and supply.

4 CONCLUSIONS

This work presents an example of the valuation of ecosystem services and projected scenarios due to the loss of vegetation cover in the Guarapiranga Reservoir watershed. This study was performed to demonstrate the importance of this methodological tool and to predict potential impacts for the public supply to subsidize environmental public policies. The results showed a negative impact on the value of the ecosystem service of water quality regulation, and therefore on the possible increase of externalities (e.g. water cost for users) with the loss of these services provided by the vegetation cover.

The conjectures derived from the projected scenarios presented here indicate that society faces two options concerning the Guarapiranga Reservoir: (i) to recover water sources and to conserve vegetation cover that protects water resources, thus saving financial resources due to ecosystem services provided by these natural areas, or (ii) to maintain the rate of land use and change in land cover, leading to progressive degradation of water resources and the need for larger financial contributions to maintain the quality of water in the SPMR. In the latter case, the support capacity of the watershed in terms of degradation must be considered, as once it reaches this level, the resources will become unavailable. Moreover, it will be impossible to accomplish SGDs 6.3 and 15.1.

Our results show that from simple data, such as historical land use and cover, we can infer the impact of change in land cover on water quality and calculate the financial damage in terms of water treatment costs. This projection analysis is quite simple and predicts the future without considering other socio-political-economic influences, and has the strength of simplicity and replicability of the model. The intention of this study is not to provide robust economic analysis, but to allow a simple prediction of the trend of future environmental changes (in water quality) to make this applicable in decision making on planning and management of water resources.

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Development of natural and innovative material for application as thermal insulation in buildings

Desenvolvimento de material natural e inovador para aplicação como isolamento térmico em edificações

Rodrigo Spinelli[a]

Dantara Lerin[b]

Glauco L. S. Spohr[c]

Alana Francischett Pitol[d]

Pedro Henrique Dall Agnol Pasquali[e]

Claus Haetinger[f]

Faustino P. Cambeiro[g]

Odorico Konrad[h]

[a]*Universidade do Vale do Taquari, Univates, Lajeado, RS, Brasil.*
E-mail: rspinelli@univates.br

[b]*Universidade do Vale do Taquari, Univates, Lajeado, RS, Brasil.*
E-mail: dantara.lerin@gmail.com

[c]*Universidade do Vale do Taquari Univates, Lajeado, RS, Brasil.*
E-mail: gsantos@universo.univates.br

[d]*Universidade do Vale do Taquari, Univates, Lajeado, RS, Brasil.*
E-mail: alana.pitol@universo.univates.br

[e]*Universidade do Vale do Taquari, Univates, Lajeado, RS, Brasil.*
E-mail: pedro.pasquali@universo.univates.br

[f]*Universidade do Vale do Taquari – UNIVATES. Lajeado/RS, Brasil.*
E-mail: chaet@univates.br

[g]*Universidade de Vigo, Vigo, Espanha.*
E-mail: faustinopc@gmail.com

[h]*Universidade do Vale do Taquari, Univates, Lajeado, RS, Brasil.*
E-mail: okonrad@univates.br

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ABSTRACT

The advent of new technologies related to thermal insulation systems in civil construction helps buildings become more efficient, reducing their consumption of electric energy through air conditioning, and providing thermal comfort to users. The research aims to develop a facade cladding board for buildings, with thermal insulation starting from the vacuum, and corn cob. Facade coatings with mortar finish were developed, filling them with developed materials. Three prototypes were executed in the masonry of ceramic blocks, with dimensions of 60x60x64,0 cm. The Field Logger 512K (Lite) and PT100 sensors were used for data collection of external and internal temperature of the prototypes. Solar radiation data were collected by the university weather station, model Davis-6450. It is worth noting the average internal temperature reduction in Prototype 2 and 3, compared to 1 (without isolation), which was 2.74 ° C and 8.05 ° C.

Keywords: Civil construction. Thermal insulation. Corncob. Vacuum. Thermal comfort.

RESUMO

O advento de novas tecnologias relacionadas a sistemas de isolamento térmico na construção civil auxilia para que edificações se tornem mais eficientes, diminuindo seu consumo de energia elétrica por meio de climatização artificial, e proporcionando conforto térmico aos usuários. A pesquisa, tem como objetivo o desenvolvimento de uma placa de revestimento de fachada para edificações, com isolamento térmico partindo do vácuo, e do sabugo de milho. Foram desenvolvidos revestimentos de fachada com acabamento em argamassa, preenchendo-as com materiais desenvolvidos. Foram executados três protótipos em alvenaria de blocos cerâmicos, com dimensões de 60x60x64,0 cm. Na coleta de dados de temperatura externa e temperatura interna dos protótipos foi utilizado o equipamento Field Logger 512K (Lite), e sensores PT100. Dados de radiação solar foram coletados pela estação meteorológica da universidade, modelo Davis-6450. Destaca-se a redução média da temperatura interna nos Protótipos 2 e 3, em comparação ao 1 (sem isolamento), que foi de 2,74°C e 8,05°C.

Palavras-Chave: Construção civil. Isolamento térmico. Sabugo de milho. Vácuo. Conforto térmico.

1 INTRODUCTION

Civil construction grew by 18% from 2000 to 2015, about one-third of the total end-use of global energy, equivalent to one-sixth of the direct end-use CO2 emissions, with buildings accounting for the largest share of energy consumption and greenhouse gas emissions. The main factors that influence this growth in energy consumption are mainly the exponential growth of the population, which increases the demand for residential buildings and associated services. It becomes important to invest in renewable energy, social policies to mobilize society to reduce carbon emissions, and as the main objective, implement research and development programs in energy efficiency in buildings, focus on building systems, making strategic decision and dissemination, show opportunities to improve energy efficiency is the goal in the future construction market. It is extremely important to analyze the impacts of the construction envelope in energy consumption and study the materials of the facades, and this aspect should not be underestimated (GALLO and ROMANO, 17)

It is important to invest in innovation using advanced options, as the focus in the future construction market, being a necessary approach to improve the energy efficiency of building components (GALLO, 2014)

Technological advances in materials and systems of building automation have been drawing parallels between adaptive facades and the intelligent response of human behavior and our skin to environmental stimuli, increasingly viable to regulate the flow of energy through the thermal insulation of buildings, providing reduced energy consumption and occupant comfort (WIGGINTON and HARRIS, 2002), (ASCHEHOUG and ANDRESEN, 2008).

Given the changes in climatic patterns and the need for comfort and energy of occupants of buildings, static façades cannot provide consistent climate control without the use of some type of artificial climatic system, enabling the implementation of dynamic controls for facades, such as light control diurnal in the materiality, adaptable windows, etc. proposing energy savings and improved comfort of the built environment, being applied alone or in combination under a variety of climatic conditions (LEE et al., 2002; PERINO, 2008).

Currently, related to technological innovations, designers have software that provides information on each material used and helps improve the issues related to costs and losses. Thus, it can be said that well-designed projects are more relevant for optimization and rationalization in construction, with more precision and reduction of uncertainties compared to conventional construction (ARO and AMORIM, 2004).

Given the above, it can be said that the introduction of materials, techniques and technological equipment is related to the improvement of civil construction, leading to the better construction quality and reduction of the amount of waste produced. This is one of the great impasses faced by the companies on this branch. It is important to emphasize, according to Bianchi (2014), that the construction industry nowadays requests that issues related to sustainability and energy efficiency in buildings be considered and that the concern with the thermal insulation of buildings is a constructive technique directly related to this aspect.

There are several points related to the technological advancements, and that has been developing and modernizing products in recent years, in which an important system is three-dimensional printing. Porto (2016) describes that this technology has been used in several areas, such as medicine, aerospace, and the production of automotive parts. The author also points out that, as in these areas, the 3D printer can bring significant advances and benefits to civil construction, such as the reduction of labor and waste, providing greater quality and agility in construction time, as well as lower severity and decrease the worker's contact with risk situations.

In addition to the 3D printing system, the laser cutting technique is widely used in the industrial sector (INDAC, 17), having as main characteristics the high precision in the cut, manufacturing flexibility, high production capacity with consequent reduction of costs, and possibilities of cuts in several formats (straight, curved and complex), thus minimizing waste of material.

For Martins and Barros (2005), innovation in the construction sector should be considered as a competitive strategy, becoming an important tool for companies to have competitive advantages, adding efficiency and agility in production activities, as well as providing greater profitability to the company and significant improvement in the final quality. In the context of the evolution of civil construction, one can also highlight the use of natural elements as thermal insulation material (ASDRUBALI et al., 2012; ASDRUBALI et al., 2015).

1.1 THERMAL PERFORMANCE STANDARDS

The strategy developed by the European Union to mitigate the negative effects of climate change, mentions that by the year 2020 new buildings must be energy efficient, close to zero, consuming the same amount of energy as it can generate. It is up to each member state to develop the best method to achieve the objectives, and the climatic adaptation of buildings is a fundamental factor, following

the guidelines of the European Parliament's Directive 2010/31 / EU on Energy Performance of Buildings (2010), determining that building materials should be used rationally and buildings should be energy efficient to minimize the emission of greenhouse gases (CAMBEIRO et al., 2016).

In Brazil according to data from the Energy Research Company, the Residential (29%), Commercial (19%), and Industrial (36%) sectors are responsible for 84% of current energy consumption, considered high (EPE, 2016). In a report prepared by EPE (2016), which presents "Brazil's Commitment to Combating Climate Change: Energy Production and Use", it identifies that for energy consumption there are three important challenges to be achieved: 1) energy efficiency for the reduction of the energy consumption of buildings and emissions of greenhouse gases (GHG); 2) expansion of energy self-production, to meet growing consumption and distributed generation; and 3) to meet annual energy consumption growth of 3% between 2014 and 2030 (disregarding self-production and including gains related to energy efficiency) (EPE, 2016).

NBR 15220 (2003), standardizes the techniques and parameters for the best thermal performance of buildings, is divided into five parts. The first part consists of tables that establish definitions, symbols, and units referring to the thermal performance of buildings. The second part presents the equations and typical values necessary for the development of the calculations of the thermal properties of building materials, such as solar factor, thermal delay, capacity, and thermal transmittance (U).

In its third part, the standard (ABNT, 2003) presents guidelines of the Brazilian Bioclimatic Zoning, in addition to a set of constructive strategies, which aim to adapt the buildings according to parameters related to the eight bioclimatic zones, aiming at the thermal performance of the building. The fourth and fifth parts of the standard present procedures for determining the resistance and thermal conductivity (λ) of materials from the protected hot-plate and flow-meter methods.

NBR 15575 (2013), developed to standardize the performance of housing developments, in focusses on the establishment of minimum requirements to be reached for the execution of buildings. One of the requirements is the thermal comfort of the users, independent of the materials and the construction system used, based on the requirements of NBR 15220 (2003).

As previously mentioned, (ARO and AMORIM, 2004), the computational tools bring the possibility of developing more precise simulations, and for the development of this technique, NBR 15575 (2003) recommends the use of Energy Plus software.

1.2 THERMAL COMFORT X ENERGY EFFICIENCY

The definition of thermal comfort according to ASHRAE (LAMBERTS et al., 2004) is associated with man's sense of well-being and the thermal environment that surrounds it. It is important to emphasize that to have thermal comfort, it is necessary to balance the temperature between the heat generated by the body and the heat lost in the environment. NBR 15220 (2003) describes thermal comfort as the "psychophysiological satisfaction of an individual with the thermal conditions of the environment".

Corbella and Yannas (2003) and Lamberts et al. (2004) share the sensation of thermal comfort in human variables (physical activity and dress) and environmental variables (infrared radiation, solar radiation, temperature, movement, humidity, and air velocity). It is important to emphasize that variables such as sex, age, weight, activity performed in the place, among other variables also influence the sensation of the wellbeing of each person.

Related to projects of air conditioning systems, NBR 16401 (2008) establishes comfort parameters for the summer and winter periods, which characterize a sense of well-being for people (Table 1).

Table 1 | Thermal Comfort Parameters.

	Summer	*Winter*
TEMPERATURE (°C) / PERCENT RELATIVE HUMIDITY (%)	22,5°C to 25,5°C / 65%	21,0°C to 23,5°C / 60%
	23,0°C to 26,0°C / 35%	21,5°C to 24,0°C / 30%

Source: Authors.

1.3 THERMAL INSULATION MATERIALS

According to data from the Energy Research Company (17), the Residential (29%), Commercial (19%), and Industrial (36%) sectors accounted for 84% of current energy consumption, considered to be high consumption. In a second report (17), he emphasized that "Brazil's Commitment to Combating Climate Change: Energy Production and Use" identifies that for energy consumption there are three important challenges to be met: 1) energy efficiency to reduce the consumption of buildings and emissions of greenhouse gases (GHG); 2) expansion of energy self-production to meet growing consumption and distributed generation and 3) to meet annual energy consumption growth of 3% between 2014 and 2030 (disregarding self-production and including gains related to energy efficiency). Focusing on the first challenge, thermal insulation strategies are fundamental to serve it efficiently.

Dutra (2010) points out that the commercially used materials used for thermal insulation are: 1) Rock wool (or mineral wool), produced from liquefied rock, and with low thermal conductivity (λ = 0,035 / 0,040 W/m.K); 2) Glass wool, produced by hot glass expansion, and low thermal conductivity (λ = 0,04 / 0,055 W/m.K); 3) Polyurethane (PU), which has characteristics suitable for use in civil construction, and very low thermal conductivity (λ = 0,025 / 0,040 W/m.K); 4) Designed Polyurethane (λ = 0,016 /0,02 W/m.K); 5) Expanded Polyurethane (EPS), one of the most widely used materials for thermal insulation (λ = 0,035 /0,040 W/m.K); and 6) Extruded Polyurethane (XPS) (λ = 0,035 /0,040 W/m.K). The application of EPS in tests performed with External Thermal Insulation Composite System (ETICS) (SPINELLI et al., 2018), on the external face of the facade. Comparing prototypes with no application, and with ETICS application, a reduction of 81% in the thermal transmittance (U) and 68% of the energy consumption was achieved for the prototype with ETICS, considerably interfering in the design of air conditioners.

With the modernization of the construction systems, new technologies for thermal insulation appear. For example, the Basalt fiber blanket (MORETTI et al., 2016), in which the basalt fiber manufacturing process is like that of glass fibers, but with lower energy consumption and without additives. Basalt fibers have no toxic reaction with air or water or other chemicals, are non-flammable and explosion-proof. The tests developed with the material presented low indices of thermal conductivity. At a density of 165 kg / m³, the thermal conductivity value of 0.0312 W / m.K. Considering a density of 187 kg / m³, the thermal conductivity is equal to 0.0320 W / m.K.

In this paper, we present the results of a study on the thermal insulation components of materials such as glass fiber and vacuum laminated aluminum (Vacuum Insulation Panel - VIP), with a thermal conductivity index of λ = 0,030 W/m.K. In a study carried out in South Korea (BOAFOA et al., 2015), it highlights the efficiency of the panel with vacuum and fiberglass thermal insulation but emphasizes that the elements used as support for the installation of the material cause thermal bridges, causing heat transfer.

With bias for the use of natural materials, according to ASDRUBALI et al. (2012) (2015) a material can be considered as a thermal insulator if its thermal conductivity index is less than 0.07 W / m.K, and highlights several compositions of natural materials (corn cob - λ = 0,057 W/m.K, straw - λ = 0,051 W/m.K, pine bark - λ = 0,069 W/m.K, pineapple leaf fiber - λ = 0,057 W/m.K, rice husk - λ = 0,0566 W/m.K, straw- λ = 0,067 W/m.K, etc.) with wide possibility of use as material of thermal insulation in buildings.

SPINELLI et al. (2019a) presents in its studies for determining the thermal conductivity of slabs based on natural materials and innovative indicators of 0,07 W/m.K, highlighting or corn cob (λ = 0,052 W/m.K), a soy straw (λ = 0,058 W/m.K), pine bark (λ = 0,061 W/m.K) and recycled slimstone (λ = 0,063 W/m.K). When applying pine bark in a prototype, SPINELLI et al. (2020) reduced a 62% reduction in the thermal transmission index (U), contributing to a 52% reduction in energy consumption when using an artificial air conditioning system.

In a simulation using the RTQ-C method to assess energy efficiency, the application of natural and innovative elements on the facade of an educational building (brick + plaster), SPINELLI et al. (2019b) presents the evolution of the classification from level D to level A, proving that the use of natural elements for thermal insulation helps in the energy efficiency of the building.

1.4 OBJECTIVE

The main objective of the research is to develop a study related to the temperature of thermal comfort and improvement of energy efficiency, developing a coating for thermal insulation of facades of buildings. The study was developed from the comparison between three prototypes: Prototype 1 - No coating application; Prototype 2 - Application of facade cladding insulated with Corncob; Prototype 3 - Application of facade cladding with vacuum insulation. The external temperature (Te), internal temperature (Ti), and solar radiation data were analyzed, comparing the heat gain inside the prototypes, and the efficiency of the materials applied for insulation. The corn husk was selected for the study, because Brazil, mainly the southern region, has a large corn crop, where the estimated 2016/17 harvest was 91.5 million tons (37.5% growth), with 29.9 million tons for the first harvest and 61.6 million tons for the second. The total area of maize should reach 17.1 million hectares (SPINELLI et al.,2018). The vacuum element was developed to expand studies from innovative materials (MARTINS and BARROS, 2005).

2 METHODOLOGY

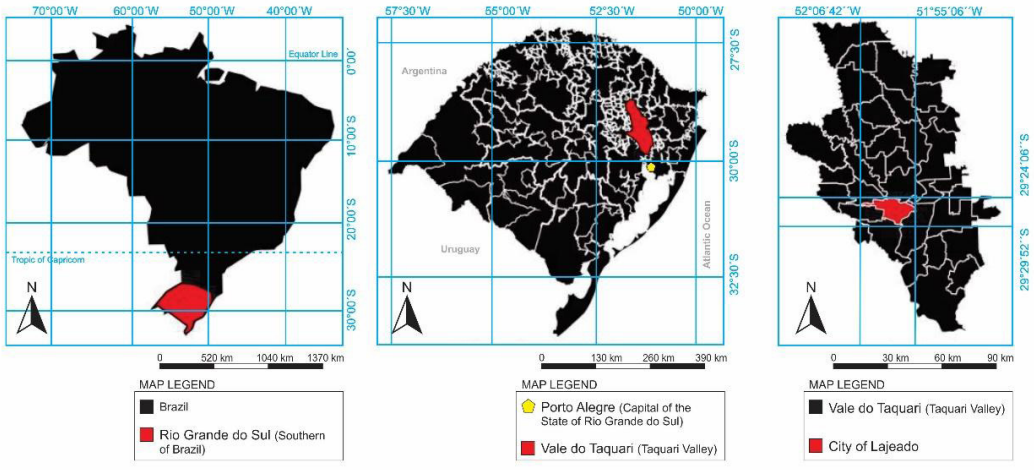


Figure 1 | Location of the State of Rio Grande do Sul in Brazil, Taquari valley in the state of Rio Grande do Sul, and the city of Lajeado in Taquari valley.

Source: Authors.

For the accomplishment of the study, the applied methodology (GIL,1999) is of exploratory research.

2.1 EXPERIMENT LOCATION

The city of Lajeado / RS-Brazil is in the Taquari Valley, 120 kilometers away from Porto Alegre, capital of the state of Rio Grande do Sul (Fig.1) (SPINELLI et al., 17). According to Spinelli et al. (17), in his study on bioclimatology, with the elaboration of the Bioclimatic Chart for the city of Lajeado / RS, data point out that there is a predominance of 45.26% days of the year when bioclimatic strategies are not necessary (Zone 1), due to the natural sensitivity of thermal comfort in buildings.

With 29.92% of the days, the zone of High Inertia / Passive solar heating (Zone 7) can be used, being able to use them separately or together, being thus this strategy used in the colder days. The Passive Solar Heating (Zone 8) strategy points to 10.24% for use of a natural heating resource, taking advantage of solar radiation heating through the openings to achieve thermal comfort temperature inside the rooms.

In the winter period (SPINELLI et al., 17) with 0.47% to the Artificial Heating strategy can be disregarded due to the low percentage of probability of use. Presenting approximately 15% of the days/year, the strategies of Zones 2 (Natural Ventilation), 10 (Natural Ventilation / High Thermal Inertia) and 11 (Natural Ventilation / High Thermal Inertia / Evaporative Cooling) correspond to the summer climate. Considering the possibility of using Zone 7 for winter, added with Zones 10 and 11 for summer, the strategy of High Inertia presents the total percentage of 36.5% of days of the year of use, being able to be considered in the projects of buildings the application of thermal insulation in buildings.

2.2 PROTOTYPES

For the development of the study, three prototypes were executed, with dimensions of 60 x 60 cm and a height of 64 cm. For its base and cover were used reinforced concrete slabs, with dimensions of 80 x 80 cm and 5.0 cm of thickness. The masonry was executed with solid ceramic blocks 11.5 cm thick and accented with mortar, a material widely used in the study region. In the roof was applied polyurethane insulation metal (5.0 cm), to minimize the transfer of heat by the horizontal surface. In Prototype 1 no facade cladding was applied, Prototype 2 was coated with corncob insulation boards, and for Prototype 3 the facade cladding plates were made with acrylic and vacuum interior.

The coatings of Prototypes 2 and 3 were made with dimensions of 32 x 30 x 4.2 cm, and mortar finish. The corn cob applied to the plates used in Prototype 2, was crushed and inserted in a plastic container. In the end, the coating of the plates began to be finished, being first performed with a 1.0 cm thick layer in the mortar, and thus placing thermal insulation material. Subsequently, the second layer of mortar was applied, also with a thickness of 1.0 cm (Fig. 2).

For the development of the facade cladding applied in Prototype 3, acrylic boxes with dimensions of 28 x 26 x 2.2 cm were executed using laser cutting technology, and then bonded with high strength adhesive material (Super Bonder Power Flex Gel). Inside the plates, reinforcements were executed, also in acrylic, so that in the air removal did not deform the larger faces. On the side of the acrylic box, a 1.10 cm opening was made, in which a plastic sealing device was applied, where the air was removed (Fig. 3). After the gluing of the sealing device, three days were left to dry the glue. To test the plaque seal, they were submerged in a vessel with water and checked if any of them had infiltration, adjusting some parts. After the adjustments were made, the tests were again applied to the parts.

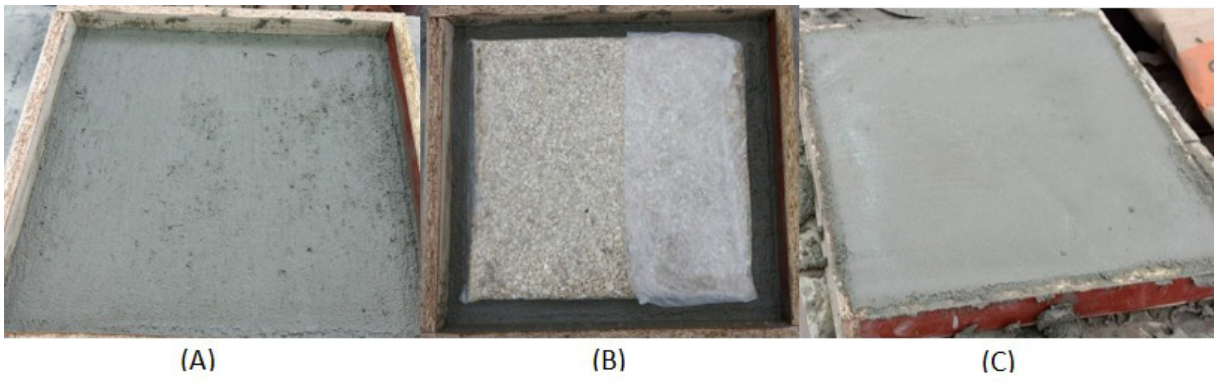


Figure 2 | Process of manufacturing the coating plates of Prototype 2. Execution of the first layer of mortar; Layer of corn cob; Application of the second layer of mortar.

Source: Authors.

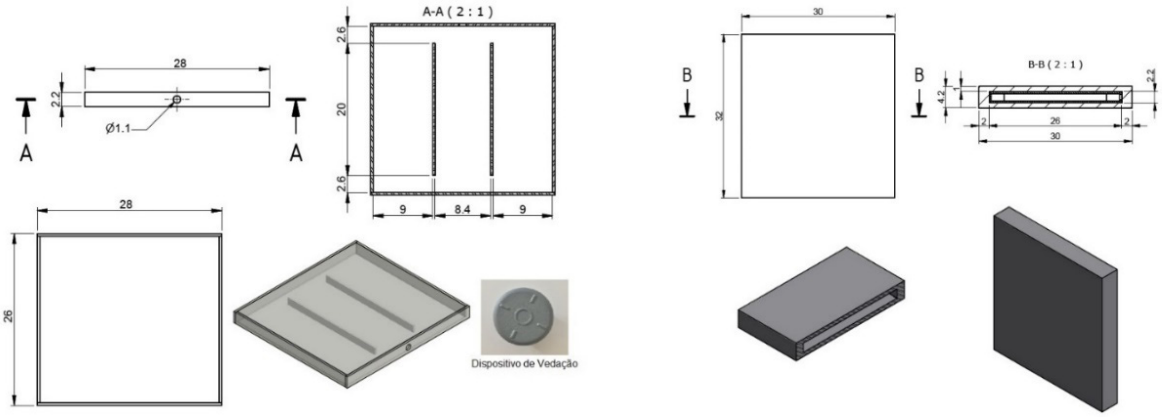


Figure 3 | Design of Vacuum Coating Plates.

Source: Authors.

When the sealing tests were completed, a 5 x 5 mm woven glass fiber cloth (Placlux) was applied to the acrylic boxes to allow better adhesion between the acrylic and the finishing mortar of the plates.

Removal of air from the interior of the plates was performed by the sealing device in which a needle was coupled to a manometer fitted to a pressure gauge connected to a compressor. With the removal of air, the internal pressure recorded in the box was -5.89 Psi, indicating the absence of air (vacuum). Finally, the coating of the plates began to be finished, being first performed with a 1.0 cm thick layer in the mortar, and thus positioning the acrylic box with the vacuum layer, wrapped with the glass fiber screen. Subsequently, the second layer of mortar was applied, also with a thickness of 1.0 cm (Figure 4).

After the construction of the Prototypes, the fixation of the plates in the facades of Prototypes 2 and 3 was carried out with the aid of metallic supports, and in the roof placed metal tile with thermal insulation of polyurethane (Figure 5).

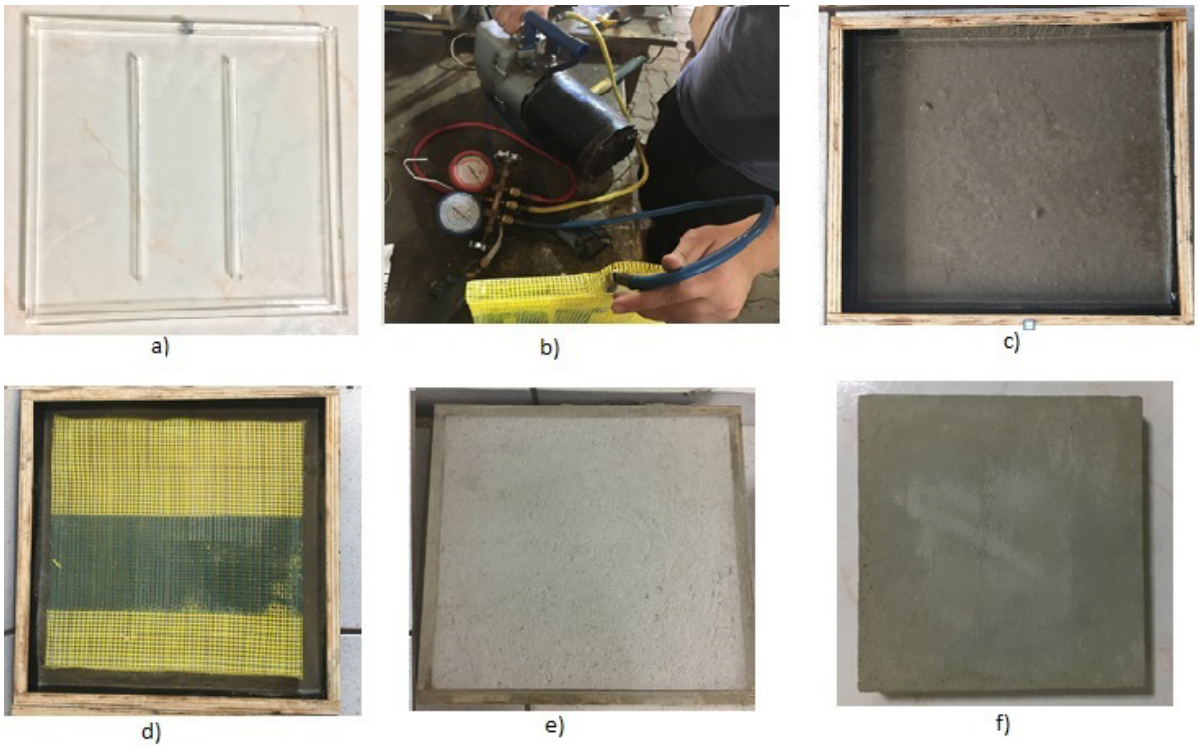


Figure 4 | Execution of the vacuum coating plate: a) Acrylic plate with laser cutting technology; b) Compressor and manometer for withdrawal of air - vacuum; c) First layer of mortar; d) Insertion of the acrylic box with vacuum layer wrapped with glass fiber cloth; e) Second layer of mortar; f) Final proposed element.

Source: Authors.

Figure 5 | Installation Facade Plates, and Finished Prototypes.

Source: Authors.

2.3. DATA COLLECT

To collect data related to the study, PT 100 (thermoresistor sensor) sensors connected to a datalogger (FieldLogger 512K) were used to store the data in the 15-minute interval, external (Te) and internal (Ti) of the Prototypes 1, 2 and 3. The stored data were transferred to a computer through a spreadsheet, and the days with significant external temperatures were analyzed, with intense heat recording. The study period corresponds to the months of October 17 to May 2018. Solar radiation, wind, and precipitation data were also collected from the University of Vale do Taquari - Univates, registered by the meteorological station Vantage Pro 2, of Davis brand, with sensor coupled model 6450.

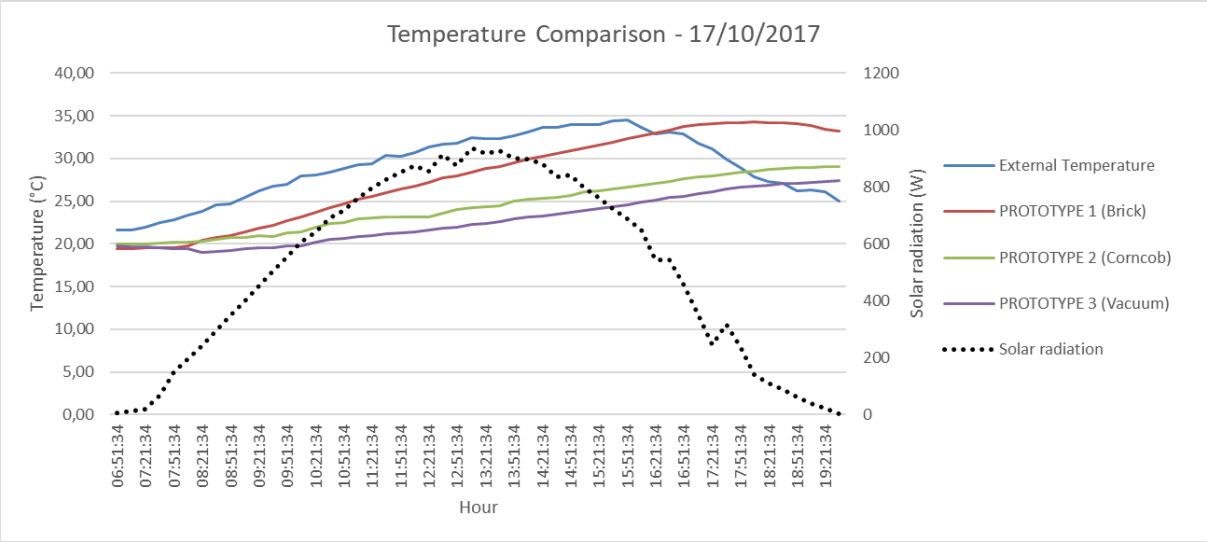
3 RESULTS

After the data were collected and sorted, we selected the days in which Te maximums and solar radiation levels for the periods were presented. These data were transposed in comparative graphs, together with the Ti of the Prototypes 1, 2 and 3, and verified the period necessary to reach the maximum Ti (thermal delay).

3.1. DATA ANALYSIS

The data arranged on October 17, 17, have the maximum temperature of 34.50 ° C, the prototype Ti recorded at the same time of 32.30 ° C, the Ti of Prototype 2 of 26.60 ° C, and Ti of Prototype 3 of 24.60 ° C, differences of 2.50 ° C, 7.9 ° C and 9.90 ° C in relation to Te. Maximum solar radiation was recorded at 938 W / m², occurring steadily and uniformly, with some recorded cloudiness. The maximum of Ti Prototypes 1 (34,30 ° C), 2 (29,00 ° C) and 3 (27,50 ° C) occurred, respectively, with 1:45 min, 3h15min, and 4h of A Teima of the day (Graph 2), and its consistency of temperature of 5.5 ° C (Prototype 2) and 7 ° C (Prototype 3) between the outer and inner maxims. The largest external temperature difference concerning Prototype 3, at 2:15 p.m., with Te = 33.60 ° C, solar energy of 882 W / m², and Ti = 23.30 C (difference of 10.30 C), maintaining the comfort temperature (ABNT, 2008).

Graphic 1 | Temperature Comparison 17/10/17.



Source: Authors.

Table 2 summarizes the relevant data collected for the first analysis phase. We highlight the Ti difference between Prototypes 1 and 2, with an average variation of 2.7ºC, not being so efficient if we buy prototypes 1 and 3. The difference of Ti between Prototypes registered a mean variation of 8.0ºC , differing on October 16, 17 with 4.8 ° C (Graph 3), and April 8 and 4, 2018, with 4.7 ° C, which presented a high solar radiation index, and absence of constant winds.

For these dates, cloudiness periods were recorded for the afternoon period, and a high percentage of relative air humidity, which may have helped to increase Ti. It is important to analyze the thermal delay for Prototypes 2 and 3, being always exceeding 2h and 3h, even in periods of high and constant solar radiation. It is important to point out that, for 10/16/17, the maximum Ti of Prototype 3 remained constant for a period of time up to 2h, that of Prototype 2 remained constant in the interval of 1h45min, while in Prototype 1, this time interval was reduced, of only 30min, causing in the rapid loss of heat.

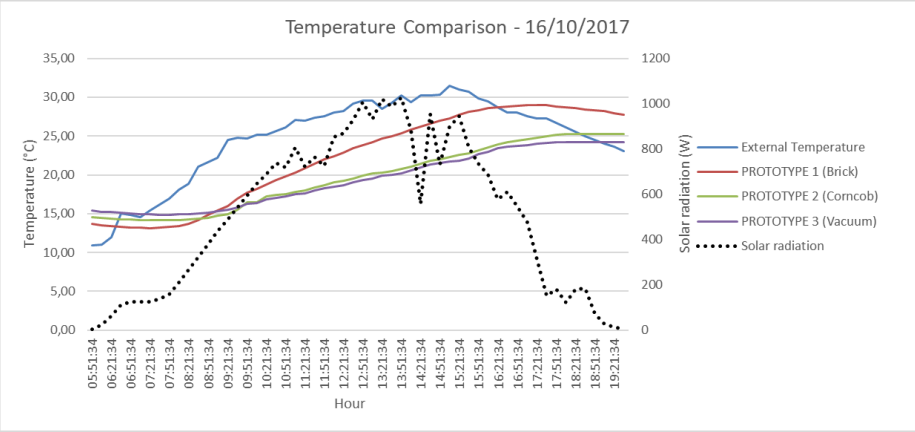
Table 2 | Data Analyzed First Step. Note: For solar radiation V (variable) and C (constant).

			PROTOTYPE 1 (WITHOUT ISOLATION)			PROTÓTIPO 2 (CORN COB)			PROTÓTIPO 3 (VACUUM)		
DATE	Te (°C)	SOLAR RAD. MAX. (W/m²)	Ti (°C)	THERMAL DELAY (h)	Ti MAX. (°C)	Ti (°C)	THERMAL DELAY (h)	Ti MAX.(°C)	Ti (°C)	THERMAL DELAY (h)	Ti MAX. (°C)
04/10/17	32,40	979 – V	27,40	2h45min	31,30	22,60	3h30min	25,60	20,90	4h00min	24,60
05/10/17	34,30	873 – V	31,20	2h00min	33,90	26,30	3h00min	28,80	24,10	3h45min	27,50
16/10/17	31,50	1028 – V	27,30	1h45min	29,00	22,30	2h45min	25,30	21,70	2h30min	24,20
17/10/17	34,50	938 – C	32,30	1h45min	34,30	26,60	3h15min	29,00	24,60	4h00min	27,50
24/10/17	29,00	954 – C	26,50	2h15min	28,60	22,60	3h00min	25,40	19,20	3h15min	22,00
02/11/17	31,70	1000 – C	29,80	2h00min	31,80	26,80	2h45min	28,50	22,20	3h15min	24,50
20/11/17	31,60	1018 – C	28,10	2h00min	31,10	24,70	3h30min	28,20	18,00	3h45min	21,40
23/11/17	33,20	1023 – C	28,90	1h30min	30,60	25,60	2h15min	27,60	17,90	3h45min	20,50
24/11/17	33,90	999 – C	32,00	1h30min	33,40	28,70	1h30min	30,30	22,50	2h00min	24,10
02/12/17	34,20	1154 – C	32,00	2h00min	33,80	28,50	2h15min	31,00	22,20	2h45min	24,70
06/12/17	35,00	999 – C	31,90	2h45min	33,90	29,00	3h15min	31,50	22,50	4h15min	25,30
09/12/17	33,40	1037 – C	29,50	2h45min	31,70	27,40	2h15min	29,10	20,30	3h30min	22,40
10/12/17	36,90	1079 – V	33,40	2h45min	35,00	31,20	3h00min	33,20	23,90	3h00min	25,80
13/12/17	38,10	1062 – C	34,40	1h00min	35,60	30,60	2h30min	33,20	22,90	2h45min	25,70
14/12/17	36,40	953 - V	33,30	1h00min	34,00	31,40	1h15min	32,30	24,00	5h45min	27,20
15/12/17	35,70	1014 – C	34,40	2h30min	35,30	30,50	3h00min	32,90	24,80	4h00min	27,90
16/12/17	38,60	1127– V	34,60	4h00min	38,60	31,70	5h30min	35,90	26,60	5h15min	29,90
17/12/17	37,90	934 – V	33,80	15min	34,50	32,40	15min	33,10	26,60	15min	27,30
21/12/17	34,00	1170 – C	31,60	2h45min	33,30	29,20	3h00min	31,00	24,20	3h45min	26,90
22/12/17	36,80	1161 – V	35,00	2h30min	36,10	32,30	2h45min	33,80	27,70	4h15min	29,40
26/12/17	34,50	1039 – V	31,40	1h45min	33,30	27,80	2h45min	30,70	21,90	2h45min	25,10
27/12/17	36,80	1167 – V	35,70	2h00min	36,50	33,00	2h00min	33,90	26,10	3h30min	29,10
28/12/17	34,40	1006 – C	33,50	1h00min	34,10	31,00	2h15min	32,00	26,50	2h45min	27,90
29/12/17	34,30	1260 – V	31,70	45min	32,80	29,60	1h00min	30,70	25,20	2h00min	26,40
31/12/17	34,50	1175 – V	33,70	1h15min	34,80	31,20	1h45min	32,10	25,70	1h45min	26,80
01/01/18	32,60	1045 – V	31,00	2h15min	32,70	29,80	4h15min	31,60	24,90	3h45min	26,40
03/01/18	33,30	1197 – V	30,60	3h00min	32,10	28,90	2h15min	30,10	22,60	3h30min	23,70
04/01/18	35,20	1042 – C	33,00	2h15min	35,90	29,60	4h00min	32,10	23,90	4h15min	26,90
05/01/18	38,10	1086 – V	35,70	1h45min	37,20	32,80	2h00min	34,40	26,30	1h45min	27,90
08/01/18	31,20	1191 – V	31,00	1h30min	32,00	28,80	1h45min	29,80	23,50	2h00min	24,70
09/01/18	33,00	1029 – C	32,80	1h00min	33,40	30,20	1h30min	31,20	24,40	2h15min	26,00
08/02/18	36,60	997 – C	34,00	2h45min	37,60	30,80	3h45min	34,00	22,10	4h30min	25,40
09/02/18	36,90	1108 – V	33,50	4h15min	35,20	31,20	4h15min	33,50	22,50	4h15min	24,70
10/02/18	33,30	1086 – V	30,10	3h30min	32,90	28,40	4h00min	31,20	19,10	4h30min	22,70
16/02/18	33,70	1000 – C	31,04	1h45min	32,80	28,80	1h45min	30,30	19,70	2h15min	21,50
17/02/18	35,10	1028 – C	32,60	1h45min	34,70	29,10	2h30min	31,90	19,60	3h15min	22,70
18/02/18	35,50	1024 – C	33,90	2h15min	36,80	30,80	3h45min	33,70	22,10	4h30min	25,00
21/02/18	31,50	1099 – V	28,20	15min	28,50	26,50	30min	26,80	16,90	30min	17,10
25/02/18	32,80	979 – C	31,10	1h45min	32,40	28,80	2h15min	30,30	19,00	3h00min	20,40
26/02/18	31,90	1049 – C	29,90	2h00min	31,90	27,90	2h30min	29,80	18,10	4h30min	20,90

			PROTOTYPE 1 (WITHOUT ISOLATION)			PROTÓTIPO 2 (CORN COB)			PROTÓTIPO 3 (VACUUM)		
DATE	Te (°C)	SOLAR RAD. MAX. (W/m²)	Ti (°C)	THERMAL DELAY (h)	Ti MAX. (°C)	Ti (°C)	THERMAL DELAY (h)	Ti MAX.(°C)	Ti (°C)	THERMAL DELAY (h)	Ti MAX. (°C)
28/02/18	31,70	1045 – V	29,40	1h15min	30,90	27,50	3h30min	29,50	17,70	3h00min	19,70
01/03/18	33,80	1034 – V	32,00	1h00min	32,70	30,40	45min	31,00	20,00	1h15min	20,90
02/03/18	33,10	1052 – V	31,00	2h45min	32,90	29,10	2h45min	30,70	19,70	2h45min	21,00
03/03/18	30,90	789 – V	28,50	3h15min	31,10	27,30	3h30min	29,20	17,60	3h30min	19,30
04/03/18	31,40	930 – V	27,40	7h00min	32,20	26,20	7h30min	29,80	16,90	7h30min	19,80
05/03/18	35,40	996 – C	33,90	2h30min	36,10	31,20	2h45min	32,80	21,60	3h30min	23,40
06/03/18	32,40	1016 – V	30,90	1h30min	32,30	29,40	1h45min	30,50	19,70	1h45min	20,80
23/03/18	32,30	1044 – V	27,20	4h30min	30,00	24,00	6h00min	28,00	19,70	5h45min	23,20
24/03/18	32,70	516 – V	27,00	2h00min	29,20	26,20	2h45min	28,10	21,90	2h45min	23,60
29/03/18	31,10	1054 – V	27,70	3h00min	30,00	26,20	3h15min	28,20	21,30	3h30min	23,30
30/03/18	30,20	918 – V	27,70	2h15min	29,60	26,20	3h30min	28,00	22,20	3h15min	24,00
07/04/18	33,40	786 – V	31,70	3h45min	33,30	27,20	4h30min	29,70	25,60	4h45min	28,10
08/04/18	32,30	767 – C	31,00	1h15min	32,40	27,40	2h00min	29,50	25,80	3h15min	27,70
09/04/18	32,20	762 – C	31,30	2h15min	32,90	27,70	2h30min	29,70	26,00	3h45min	28,00
10/04/18	33,40	773 – V	32,10	2h00min	34,90	28,30	3h15min	30,80	26,40	3h30min	29,00
11/04/18	35,50	757 – C	33,90	2h30min	37,50	29,70	3h45min	32,90	27,90	3h30min	31,00
12/04/18	36,20	801 – C	34,70	2h15min	37,70	30,40	3h15min	33,10	28,50	3h45min	31,20
18/04/18	32,30	760 – C	29,90	3h15min	33,30	25,80	4h15min	29,40	23,60	4h15min	27,20
19/04/18	32,70	727 – C	31,40	2h45min	35,20	26,90	3h45min	30,20	25,20	4h15min	28,40
22/04/18	31,80	711 – C	28,70	4h00min	32,90	24,80	5h00min	28,60	22,60	5h00min	26,80
23/04/18	31,50	705 – V	29,30	45min	30,20	27,00	3h00min	28,50	24,90	2h45min	26,30
24/04/18	30,80	821 – V	28,30	2h00min	29,90	26,20	3h00min	28,20	24,20	2h45min	26,10
25/04/18	31,60	705 – V	28,70	2h00min	31,00	26,40	4h15min	29,10	24,60	4h30min	27,20
28/04/18	32,90	661 – C	31,20	2h30min	34,80	27,20	3h45min	30,40	25,00	3h30min	28,20
29/04/18	33,50	678 – C	31,50	2h15min	34,70	27,40	4h00min	30,90	25,50	3h45min	28,70
08/05/18	30,00	664 – C	28,20	2h45min	30,30	24,40	4h00min	27,10	22,30	3h30min	24,80
10/05/18	30,00	625 – V	28,10	2h00min	29,40	25,30	3h00min	27,20	21,70	3h15min	23,40

Source: Authors.

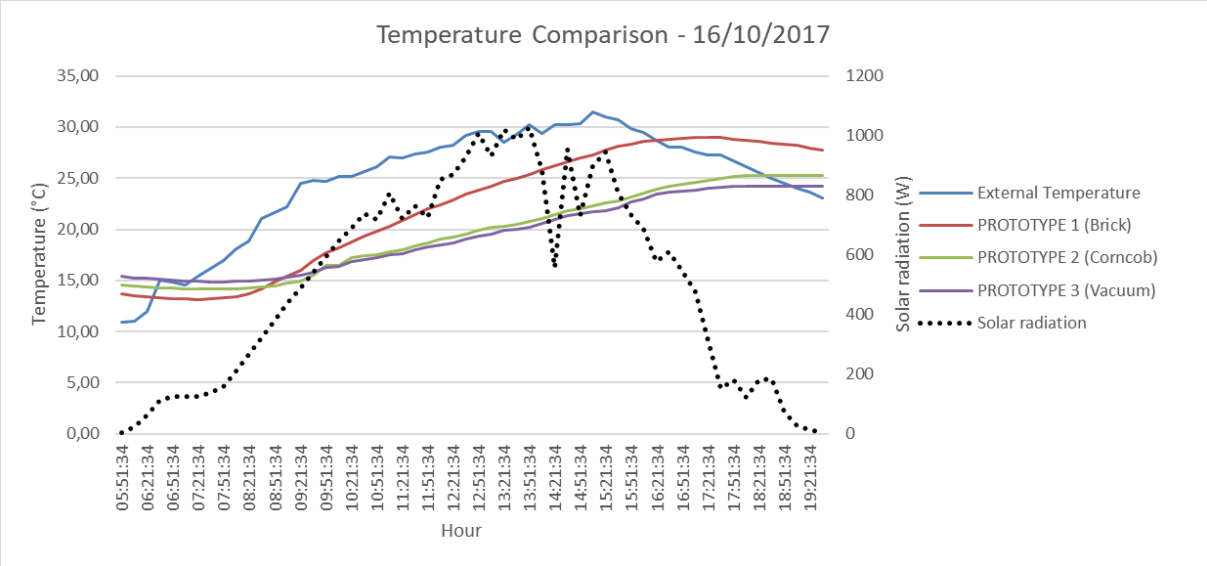
Graphic 2 | Temperature Comparison 16/10/17.



Source: Authors.

The date of 12/29/17 recorded the maximum solar radiation index during the experiment period with 1260 W / m², even with strong cloudiness, and reached the maximum of 34.30 ° C. The variation of Ti presents more intense for Prototypes 1 and 2, being for a long period of the day surpasses to 30 ° C, above the ideal temperature of comfort. In prototype 3 the Ti variation remains small, of 3.30 ° C, while Prototypes 1 and 2 had a Ti variation of 7.90 ° C and 3.90 ° C. It stands out the strong fall of the solar radiation and Te at the beginning of the afternoon, due to the occurrence of rain. It is evident the thermal insulation capacity applied in Prototypes 2 and 3, but Prototype 2 Ti is always superior to Prototype 3, due to the accumulated heat content of the previous day, and the higher density of the insulation material (Graph 4).

Graphic 3 | Temperature comparison 29/12/17.



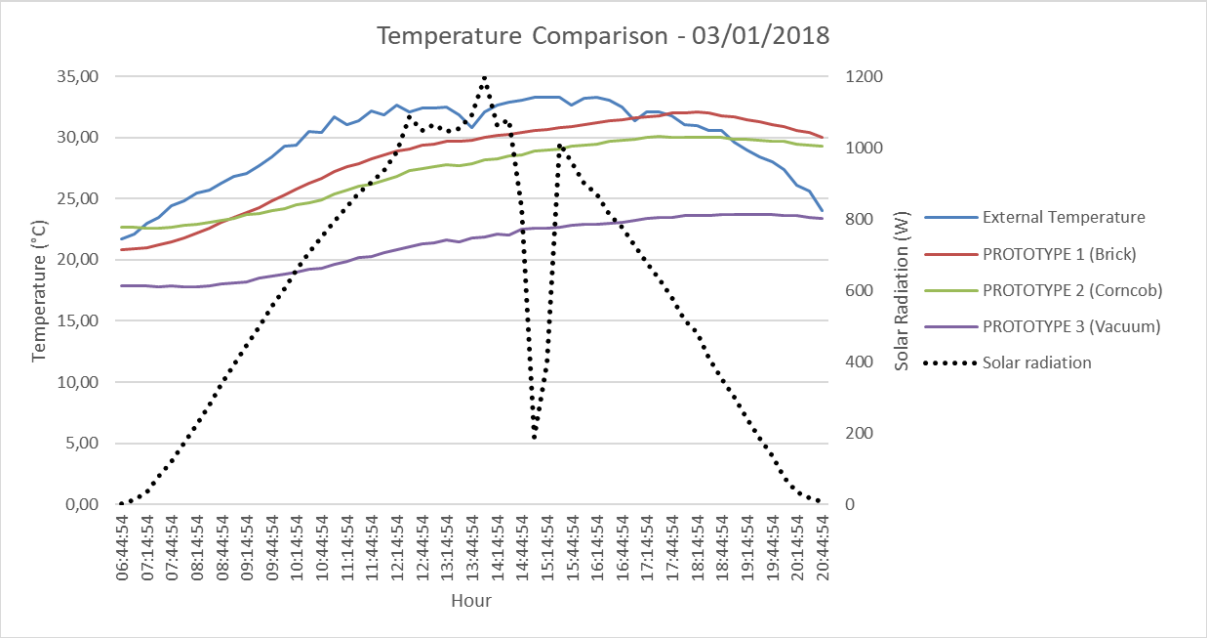
Source: Authors.

It is evidenced the high-density index of the insulation material at the moment of heat loss of the internal environment, with a value of 4 ° C in Prototype 1, 2,20 ° C in Prototype 2 and 0,80 ° C in Prototype 3, for a period of 4 hours. Thus, the thermal insulation material with the vacuum layer stands out if compared to the material applied with the use of corn cob.

On 03/01/2018, it had the second-highest recorded solar radiation index, value of 1197 W / m², and Te variation of 14.20 ° C. Prototype 3 recorded maximum Ti of 23.70 ° C, remaining within the comfort temperature range, as presented in NBR 16401 (ABNT, 2008). For Prototypes 1 and 2, the maximum Ti was higher than 30.00 ° C.

The absence of insulation in Prototype 1, caused a Ti variation of 11.30 ° C, and the heat accumulated from the previous day in Prototype 2, the recorded Ti variation of 7.50 ° C (Graph 5), this due to high thermal transmittance (U) of the composition of the brick wall, because the moment the masonry cools, the internal temperature drop process accelerates, which does not occur with prototypes with insulation application. Even the experiment taking place in the summer period, it is now proven that the heat loss is slowed down for the winter period when the wall has thermal insulation elements in its composition.

Graphic 4 | Temperature comparison 03/01/2018.



Source: Authors.

3.2. DATA ANALYSIS - 48H PERIOD

Thus, it becomes important to analyze the behavior of the materiality of the Prototypes for a 48h interval, and thus to analyze the behavior regarding the accumulation/loss of heat between the diurnal and nocturnal periods. For this analysis, the days that presented high solar radiation rates, Te and Ti were selected.

In the period of 21 and 22 December 17 (Graph 6), the solar radiation index approaches 1200 W / m², highlighting the accumulation of atmospheric heat, with high Te indexes, mainly on day 22, higher than 35 W. To this day, the solar radiation was in constant elevation in the morning, contributing to the accumulation of heat. Graph 6 shows the constancy in the Ti difference of the prototypes, with loss of heat for the night, but more accelerated in Prototype 1, due to the absence of insulation. Prototype 2 showed a Ti index higher than 33.00 ° C, while in Ti prototype 3 Ti was recorded at 29.40 °

The variation of Te and Ti from day 21 to day 22, which remained constant, with a difference of maximum of 2.80 ° C for Te and Ti of Prototypes 1 and 2, and 2.50 ° C for Ti of Prototype 3. By maintaining a similar difference, and in a lower register, the accumulation of heat in the internal environment from one day to the other is not characterized.

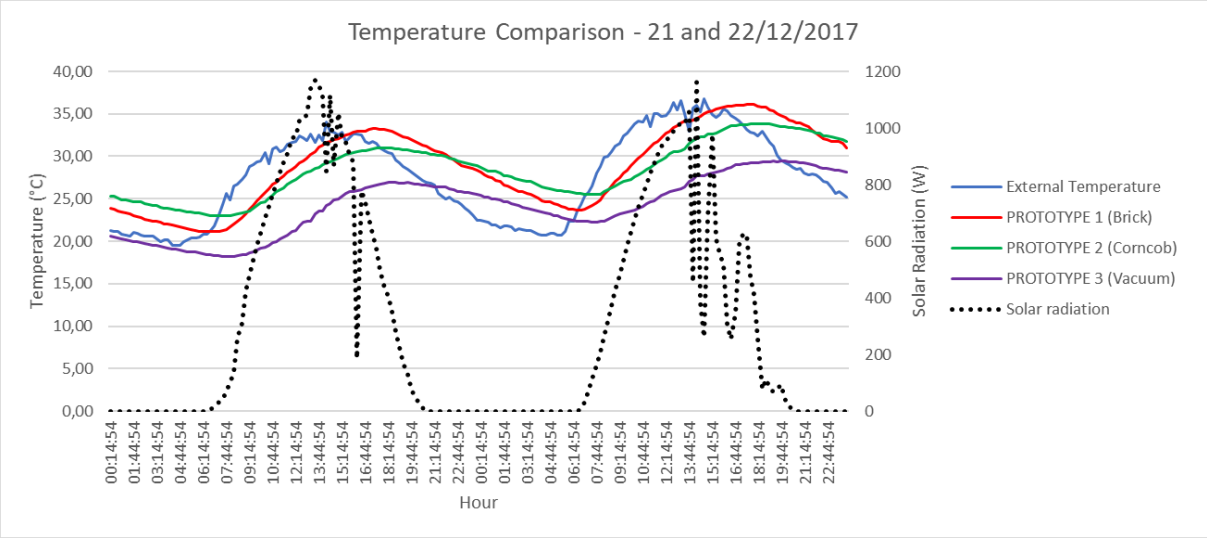
The data recorded for the days 16 and 17 of February of 2018 (Graph 7), stands out a small variation of the solar radiation index of overnight (28 W / m²), and a difference of 1.40 ° C to Te on the second day. The variation of Ti of Prototype 1, recorded at 1.90 ° C, and Prototype 2 of 1.60 ° C, higher than the variation of Te, can be considered here, and therefore the heat accumulation can be considered. For Prototype 3, the Ti variation recorded was 1.20 ° C, lower than the Te variation, thus not characterizing the accumulation of heat.

3.3. FEATURED PATHOLOGIES

Due to the prototypes being exposed to direct solar radiation, rain, wind, and constant temperature changes, there were cracks in the coating plates in vacuum insulation. Such pathology probably

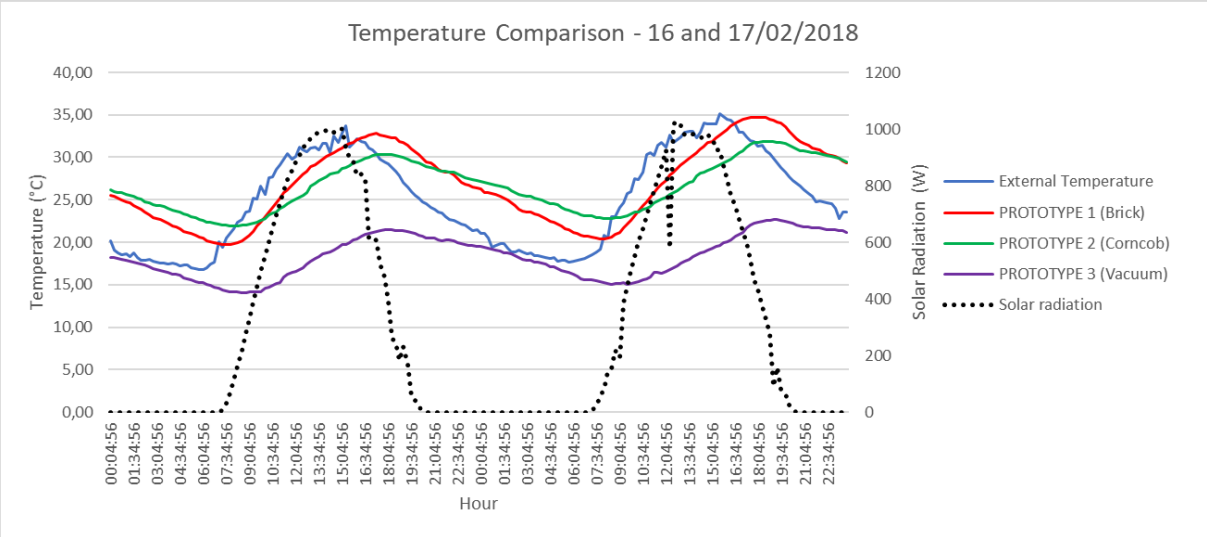
occurred due to the difference in thermal expansion of the materials, as well as the lack of adhesion between acrylic and mortar. The behavior of the fissures was collected periodically, and during the study period, there was no worsening of the pathologies, and there were no falls of mortar parts. It can be said that this behavior is related to the use of fiberglass mesh, improving the adhesion between materials. For the insulation coating plates based on a corncob, they did not present visible pathologies and should undergo in-depth analysis in this case, because the materials with different behavior to heat, dilating differently.

Graphic 5 | Temperature comparison 08 e 09/01/2018.



Source: Authors.

Graphic 6 | Temperature comparison 16 e 17/02/2018.



Source: Authors.

4 CONCLUSIONS

With the growing environmental concern, the importance of the use of constructive components that contribute to lower energy consumption and of fossil fuels in the manufacturing process, as highlighted by Dutra (2010), stands out.

Concluding the analysis of the presented data, it is verified that the data analyzed for Prototypes 2 and 3, in which the coating plates were fixed with the application of corncob and vacuum layer, registered a significant reduction of Ti when compared to Prototype 1 (uncoated) and Te. The reduction of Ti to Prototype 3 is more markedly emphasized. When the data of the 67 days recorded in Table 2 were analyzed, the mean value recorded for the maximum Ti difference between Prototypes 3 and 1 was 8, 05 ° C, while the mean difference for Prototypes 2 and 1 was 2.74 ° C.

It is important to emphasize that either Ti data presented according to the parameters established by NBR 16401-2 (2008) and by Givoni (apud LAMBERTS; DUTRA and PEREIRA, 2004), and it is necessary to deepen the study related to the percentage of relative humidity air.

For the data recorded concerning Prototype 2, it is worth mentioning that in previous studies, they already present information when the thermal conductivity of the billet bush applied for thermal insulation (λ = 0,057 W/m.K), (ASDRUBALI et al., 2015), being necessary the revision of the method of application of the material in constructions, considering that the index is considered ideal for its use, but did not present efficient in its application in the prototype.

It is also worth noting that the study is still under development, seeking to deepen the information related to the determination of the thermal conductivity of the plate with vacuum interior (following the Hot Plate and Cold Plate methods, according to NBR 15.220 (2003), so that consistent data can be used in the development of computational simulation for the energy efficiency of buildings.

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Amid the Covid-19 pandemic, Sustainability in Debate highlights, in its Editorial of this first edition of 2020, the polarization we are experiencing. In this Annus Horriblis, as has happened on other occasions, we are facing two poles that historically drive or slow the advance of human knowledge: imagination and dogmatic obscurantism or the scientific spirit vs. the delay. This edition contains 10 articles in the Varia section, which, with diversified and qualified research, broaden and enrich the debate on sustainability.

Nesta primeira edição de 2020, Sustentabilidade em Debate, em meio a pandemia do Covid-19, ressalta em seu Editorial a polarização que estamos vivendo. Em um Annus Horriblis, como já aconteceu em outras épocas, estamos frente a frente com dois polos que historicamente impulsionam ou freiam o avanço do conhecimento humano: a imaginação e o obscurantismo dogmático; ou o espírito científico vs. o atraso. A presente edição, contém 10 artigos na seção Varia, que, com pesquisas diversificadas e qualificadas, ampliam e enriquecem o debate sobre sustentabilidade.

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