

Pesticides in the Cerrado (Brazilian savanna): Popular surveillance as a monitoring strategy in vulnerable territories

Agrotóxicos no Cerrado: vigilância popular como estratégia de monitoramento em territórios vulnerabilizados

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ABSTRACT Pesticide contamination in Cerrado (Brazilian savanna) communities has intensified due to the agribusiness production model, compromising both human health and the environment health. This study aimed to describe the participatory methodological strategies used to monitor environmental contamination and human exposure to pesticides in seven Brazilian states within the Cerrado biome. It is a participatory action research conducted in Bahia, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Piauí, and Tocantins, involving water sampling and participatory mapping conducted by community leaders and social movements between 2022 and 2023. To support field activities, formative workshops were held, including training of field teams, the development and implementation of protocols, sample collection, and participatory territorial mapping. A total of 187 water samples were collected and six participatory mapping workshops were conducted. Participatory surveillance revealed socio-environmental problems, strengthened community autonomy, and fostered political mobilization, contributing to the formal denunciation and recognition of the crime of ecocide in the Cerrado by the Permanent Peoples' Tribunal. By integrating scientific and traditional knowledge, participatory approaches enable the development of context-specific solutions and prove to be more effective than conventional surveillance strategies.

KEYWORDS Pesticides. Community participation. Cerrado. Health surveillance. Environmental health.

RESUMO A contaminação por agrotóxicos em comunidades do Cerrado tem se intensificado devido ao modelo de produção do agronegócio, comprometendo a saúde humana e o meio ambiente. Objetivou-se descrever as estratégias metodológicas participativas utilizadas para monitorar a contaminação ambiental e a exposição humana a agrotóxicos no Cerrado em sete estados brasileiros. Trata-se de uma pesquisa-ação realizada nos estados da Bahia, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Piauí e Tocantins, com coleta de amostras de água e mapeamento participativo conduzidos por lideranças comunitárias e movimentos sociais entre 2022 e 2023. Para o desenvolvimento das atividades, foram realizadas oficinas formativas, que incluíram treinamento das equipes de campo, elaboração e aplicação de protocolos, coleta de amostras e mapeamento territorial participativo. Foram coletadas 187 amostras de água e realizadas 6 oficinas de mapeamento. A vigilância participativa revelou problemas socioambientais, fortaleceu a autonomia das comunidades e promoveu a articulação política, sendo capaz de subsidiar a denúncia e o reconhecimento do crime de ecocídio no Cerrado pelo Tribunal Permanente dos Povos. Ao integrar saberes científicos e tradicionais, as abordagens participativas permitem a construção de soluções que respeitem as realidades e necessidades dos territórios, sendo, nesse contexto, mais eficazes que estratégias de vigilância convencionais.

PALAVRAS-CHAVE Agrotóxicos. Participação comunitária. Cerrado. Vigilância em saúde. Saúde ambiental.

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Introduction

The Cerrado is Brazil's oldest and second-largest biome. It is the most biodiverse savanna in the world and plays a crucial role in water security by feeding the main South American river basins¹. Its plateaus and deep roots ensure groundwater recharge that sustains ecosystems such as the Pantanal and the floodplains of the Araguaia River. It is also home to a diversity of people whose ways of life are built on a wide range of traditional knowledge and practices².

Agribusiness is rooted in the Brazilian historical latifundia structure. It operates through the concentration of land and wealth and promotes a model centered on monoculture, intensive pesticide use, labor exploitation, and the criminalization of social movements. This model generates violence, environmental devastation, and socioenvironmental injustice, constituting a form of expropriation of peoples and denial of nature's goods³.

In the agribusiness expansion, the Cerrado is treated as a 'sacrifice zone' for Brazilian development. In order to secure this model's profitability, its people and nature are continuously plundered⁴. In this sense, land concentration in the region has led to the expropriation of lands occupied by the many peoples who inhabit these localities². The ongoing process in the Cerrado may constitute what the Permanent Peoples' Tribunal (PPT) defines as *ecocide*, understood as:

[...] serious damage to, destruction of, or loss of one or more ecosystems within a given territory, whether due to human or other causes, whose impact causes a severe reduction in the environmental benefits enjoyed by the inhabitants of that territory⁵.

To confront this predatory model, which generates injustice, deterritorialization, rights violations, and illness, it is essential to develop actions of Popular Health Surveillance within popular movements as a form of resistance. This type of surveillance is grounded in dialogue, listening, alterity, and respect for the knowledge of peoples and territories, proposing paths that coordinate knowledge, health promotion, and the defense of life⁶.

Against this backdrop, this article describes the popular and participatory methodological strategies used to monitor environmental contamination and human exposure to pesticides in the Cerrado across seven Brazilian states. These actions were built in dialogue with territories and social movements, based on participatory methodologies and popular surveillance.

Material and methods

This action research addressed human health in a transdisciplinary, participatory, and equitable manner, involving a broad view of health problems⁷ and mobilizing stakeholders to take control over their reality⁸. This methodological perspective enables more comprehensive studies and participatory interventions aimed at solving socioenvironmental problems by recognizing the interaction among different ecosystem components and highlighting the promotion of human health⁹.

This article details the participatory methodological stages used to analyze contamination of surface and groundwater by pesticides; to develop a participatory diagnosis of socioenvironmental vulnerabilities in vulnerable territories; and to identify contexts of socioenvironmental vulnerability related to pesticide exposure in seven Cerrado states, in the territories described in *table 1*.

Table 1. Territories where participatory methodologies were used for participatory diagnosis of vulnerabilities

Community/Municipality/State	Participatory Mapping	Water collection
Community Geraizeira, Formosa do Rio Preto/BA	Y	Y
Settlement Leonir Orback, Santa Helena/GO	Y	Y
Territory: Cocalinho, Parnarama/MA	Y	Y
Settlement Eldorado II, Sidrolândia/MS	Y	Y
Settlement Reforma Agrária Roseli Nunes – Mirassol D'Oeste/MT	Y	N
Community Cumbaru, Nossa Senhora do Livramento/MT	N	Y
Community Barra da Lagoa, Santa Filomena/PI	Y	Y
Territory: Serra do Centro, Campos Lindos/TO	N	Y

Source: Prepared by the authors.

The territories were defined based on indications from movements and organizations linked to the protection and defense of human and territorial rights and that operated in and/or knew the vulnerabilities and conflicts in the municipalities included in the study: the National Campaign in Defense of the Cerrado, the Pastoral Land Commission (CPT), the 10envolvimento initiative, and the Federation of Social and Educational Assistance Organizations (FASE). For inclusion, territories had to be located within the Cerrado region and include rural, forest, and waterside populations threatened by the advance of agribusiness.

The following stages were organized for the field activities: definition and training of field teams; definition of sampling points; preparation and distribution of research protocols; preparation and shipment of sampling materials; shipment of samples by the field teams for analysis; participatory mapping; feedback of results to affected communities; and strategies for mobilization and political articulation. Fieldwork, in which the activities involving community and social movement participation were concentrated, was divided into two major activities: water sampling and participatory mapping.

Water sampling was divided into two cycles to broaden the possibility of detecting different pesticide Active Ingredients (AIs) used

at different cultivation stages. The first cycle occurred from February to March 2022, close to the soybean harvest, the main monoculture in the territories studied. The second cycle occurred from November 2022 to February 2023, during soybean planting. Participatory mapping occurred from February 2022 to February 2023. From the communities, formally established or informal community leaders were included. From the social movements, members active in participating communities were included, considering prior articulation and ties to the territory.

During water sampling, community leaders actively participated in activities related to sample collection, definition of water collection points, and preparation of samples for shipment and toxicological analysis, together with members of the social movements. In the participatory mapping, the communities actively participated in activities representing the territory and the health and environmental problems associated with agribusiness, while movement members acted as facilitators, coordinating mapping activities whenever they had prior experience with the methodology. In cases where no such member had experience, a researcher from a research institution involved in the project traveled to the field.

The number of participants varied by activity performed. In water collection, there were differences by territory and collection cycle.

In the first cycle, samples were collected in five states: Bahia (BA), Goiás (GO), Maranhão (MA), Piauí (PI), and Tocantins (TO). In the second, Mato Grosso (MT) and Mato Grosso do Sul (MS) were added, totaling seven states. On average, two members of the movements/entities from each state traveled by land to the territory in each cycle, joining, on average, two community leaders to conduct the collections, totaling 24 participants from movements/entities and 24 community leaders. Six participatory mapping workshops were held in all, involving 20 community members in each territory, totaling 120 people. From the entities/movements, there were, on average, two participants per territory, totaling 12 participants. Inclusion criteria for community members were residence in the selected territories, age over 18, any gender, and availability and interest in participating in the study. Representatives of the movements were included based on indications from the entities. Water sampling and mapping actions were developed according to the availability of the field team in each state, which explains why not all procedures were conducted in all territories.

The Research Ethics Committee of the Instituto Aggeu Magalhães approved the project under Certificate of Presentation for Ethical Review (CAAE) N°53414421.3.0000.5190 and Opinion N°5.174.726, complying with the ethical principles for human research established by National Health Council Resolution N° 510 of April 7, 2016¹⁰.

Results and discussion

Background to the process: Listening to the voices of the territory

The participatory activities were developed as part of a project that followed a trajectory distinct from usual academic practice: rather than the researcher deciding what to study, it

was the territory that approached the academy, in 2021, demanding investigation of a problem affecting several communities in the North, Northeast, Midwest, and Southeast, namely, the contamination of water and the exposure of populations to pesticides used by large monocultures in the Cerrado. As background, in 2019, the National Campaign in Defense of the Cerrado, an articulation composed of more than 60 movements and social organizations, submitted to the PPT a petition signed by more than 100 entities requesting a Special Session to judge the crime of ecocide against the Cerrado and the genocide of its peoples¹¹.

The PPT is an international opinion tribunal, and one of its functions is to make explicit and determine the existence, seriousness, and responsibility for violations committed against peoples and territories, as well as the measures of justice and reparation required⁵. The PPT may be convened by governments, governmental bodies, groups, or movements that represent community interests, whether nationally or internationally. The final accusation submitted to the PPT argues that the devastation denounced, 'because of its systematic character in time and space', constitutes the 'crime of Ecocide'¹¹.

In November 2019, the Tribunal's Pre-Hearing endorsed 15 cases to compose the accusation. According to the petition, the escalated ecocide in the Cerrado would lead to the extinction of the biome and of the material basis of the sociobiodiversity of Indigenous peoples, quilombola, and traditional communities of the Cerrado as culturally differentiated peoples, thus representing their genocide¹¹.

Pesticide use in the Cerrado has been systematically contaminating waters in different locations, often in regions close to large monocultures, as attested by studies conducted in monoculture regions in Mato Grosso do Sul¹²⁻¹⁴, in Mato Grosso, in two of the most important monoculture-producing municipalities^{15,16}, and in rivers of the Pantanal basin¹⁷.

In addition, the use of pesticides as a tool to expel communities from their territories

has also been denounced, as shown by cases recorded in Mato Grosso^{18,19} and Maranhão²⁰. According to the 2024 Conflicts in the Countryside Report by the CPT, 27 occurrences of pesticide contamination were recorded in Cerrado territories in 2024, 20 of them in Maranhão alone. This use has been described as a new element of violence in the countryside, depicting the deliberate contamination of wells and springs, community food-production areas, and the poisoning of families in order to expel them from their territories. This use in conflicts has been identified particularly in Indigenous Territories (ITs) and quilombola territories²¹.

With regard to Indigenous peoples, several studies have revealed water contamination in the Cerrado: in Mato Grosso alone, different studies point to contamination of surface water, groundwater, or rainwater in Indigenous Territories such as the Wawi IT²²; the Marãiwatsédé IT, territory of the Xavante people²³; and the Xingu Indigenous Park²⁴. In Mato Grosso do Sul, in Jaguapiru village of the Guarani and Kaiowá peoples, located in the Dourados Indigenous Territory, the largest urban Indigenous Territory in Brazil, active ingredients were detected in the river that crosses the territory and supplies reservoirs in the second most populous city in the state¹². Water contamination in Indigenous Territories has also been reported in other regions, such as in the Turé-Mariquita IT in the Amazon region of Pará²⁵. In almost all of these studies, active ingredients banned either in the European Union or even in Brazil were identified^{12,22,24,25}.

Against this background, the PPT accepted the petition, which created a new challenge: to systematize evidence to support the case before the Tribunal. A partnership was therefore established between the Oswaldo Cruz Foundation (FIOCRUZ) and the CPT, the civil

society organization representing the affected groups, to develop a research project. The study was thus conceived with a distinctive feature: the involvement of affected territories and social movements from the outset. Such an unusual initiative could only be designed from the standpoint of an emancipatory, citizen-oriented science that incorporated participatory processes from the beginning. The project was therefore planned on the basis of action research and participatory surveillance, in which the protagonism of affected territories was the central concern⁹. The project's premise is also consistent with one of the fundamental political-methodological premises of the National Campaign in Defense of the Cerrado itself, namely the 'dialogue of traditional and scientific knowledge', according to the organization¹¹.

Given the fundamental importance of ties to the territory, the participation of entities and social organizations already embedded in the communities and already familiar with the conflicts experienced with agribusiness was a key element in the development of the fieldwork. From there, it became possible to define the research problem, the real needs of the territory regarding what needed to be investigated, and the willingness of communities to engage in processes of transformation.

Community members were thus mobilized to take control over their own reality. Action research is a type of social research conceived and conducted in close association with an action or the resolution of a collective problem, in which researchers and participants who are representative of the situation under investigation are involved in a cooperative and participatory manner⁹. Following this theoretical-methodological framework, part of the objectives of the project was achieved based on these principles, which guided the fieldwork (*table 2*).

Table 2. Organization of field activities with participatory approaches and activity period

Activity	Period
Workshops on water sampling procedures in water sources	February and November/2022
Workshops on participatory mapping	January, February, and May/2022
Definition of water sampling points	February to March/2022
Development of field protocols – water sampling and participatory mapping	January/2022
Sending of sampling materials to field teams	January to February/2022 and October 2022 to January 2023
Sending of samples for analysis	February 2022 to February 2023
Conducting participatory mapping	February 2022 to February 2023
Feedback of results to affected communities, mobilization, and political coordination	Since July/2022

Source: Prepared by the authors.

Water surveillance and community engagement: Seeking answers to the problems identified by the territories

Once the territories and field teams had been defined, training sessions for water sampling were conducted by two researchers experienced in the techniques employed to standardize all procedures and avoid discrepancies in the sampling process. Training included biosafety aspects, presentation of the material used, procedures for georeferencing and collection according to source type, preservatives employed, identification, packaging, preservation, transport, and shipment of samples to the laboratory.

Detailed protocols were developed following the Ministry of Health guidelines^{26,27}, the National Water Agency – later replaced by Resolution N° 207/2024 – and the U.S. Environmental Protection Agency²⁸. The protocols contained checklists of materials, descriptions of all collection stages, and additional guidance on sample preservation and identification. At the end of the protocol, there was a field collection form to be printed and completed with the data for each collected sample for record-keeping purposes. Emergency contacts were also provided in case

of any complication or doubt during procedures. The protocols were printed and distributed to members of entities and movements who coordinated activities in their respective states and field sites in each territory.

The training sessions were held in the weeks preceding field deployment, reducing memory-related bias. All materials necessary to ensure proper biosafety, collection, conservation, storage, and transport conditions were previously sent to the headquarters of the research institutions or participating entities in each state, and all material was sorted and checked before traveling to the field using the checklist. These teams then traveled by land to the communities, where they met the participating leaders to conduct the collections. These procedures were often accompanied by several residents of the territories, who were already aware of the purpose of the investigation.

Collection points were defined after discussing criteria during the workshops, namely: the importance of the water source to the community; closer proximity to monoculture plantations; proximity to areas of aerial pesticide spraying; residential areas close to crops; locations accessible by road; and water not treated with chlorine. A model form was

prepared containing the detailed descriptive information needed for prior characterization of each collection point, including numbering, geolocation, address, place description, the source, the point itself, and the purposes for which the water was used.

Eight to nine collection points were defined in each community. Weather conditions were monitored during the 48 hours before collection to avoid sampling during or after rainfall, and all points in the same community were collected on the same day. Samples were shipped within at most 24 hours after collection. Collection usually occurred between Monday and Wednesday, never on the eve of holidays, in order to avoid laboratory receipt over weekends or on commemorative dates.

A total of 187 samples were collected (8 to 9 points per territory in each cycle, and 2 samples per sampling point in each cycle, one for paraquat and 2,4-D assessment and another for the remaining parameters), with only one loss due to breakage of the bottle during transport, which demonstrates the success of community involvement and organized civil society participation in the surveillance process.

Despite the limitations and difficulties involved in analyzing the presence of pesticide residues in water, at least one parameter was detected in all states and in both collection cycles, totaling 13 pesticide parameters identified: 2,4-D, atrazine, azoxystrobin, cyproconazole, difenoconazole, epoxiconazole, etofenprox, fipronil, glyphosate, metolachlor, picoxystrobin, pyraclostrobin, and trifloxystrobin²⁹.

Within the communities, the collection process generated expectations and a sense of the need to 'take care of the water'. There were also doubts regarding water contamination. Many were concerned about illnesses associated with pesticide contamination of water. There was also fear of job loss if contamination were reported. Another concern was the risks that community representatives and grassroots organization agents might face during or after

water collection if their involvement became known to large agribusiness enterprises located near the territories involved, especially in areas with a higher incidence of conflict. Despite the slowness of, or even lack of, state agencies in cases related to pesticide contamination^{18,19,22}, confirmation that waters are being contaminated – as communities and entities had already denounced – is information that does not serve the interests of local landowners.

This entire process raises reflections on 'what kind of surveillance to undertake' and helps clarify that 'health surveillance' in traditional terms, as advocated by regulatory agencies and national and international organizations and bodies, is important but insufficient to address contemporary socio-environmental problems crossed by complex macro-processes, for several reasons. One is the hollowing out of the state apparatus, which has escalated in recent years, including the removal of powers from the Ministry of Health and the Ministry of the Environment, among other measures that have relaxed pesticide regulation in the country and, consequently, surveillance actions³⁰. Another important issue is that traditional surveillance is grounded in hegemonic toxicology, whose conception, methodologies, and risk-assessment approach serve economic interests and the definition of safety settings far removed from reality, rather than health protection and the defense of life. In this regard, Brazilian female scholars have debated a critical toxicology with effective social participation as a strategy to reduce concealment or minimization of risks and hinder the manipulation of decision-making processes in order to serve market interests³¹. Another important limitation of the institutional environment of public services is that its structure still carries a normative conception of planning, with a specific contribution of hierarchized functions and responsibilities³², and with little or no real social involvement in decision-making processes.

Pignatti et al.³³ also offer a reflection from a critical standpoint and propose a 'surveillance

of development', pointing to the insufficient regulated-use standards for environmental resources, as well as the need for "processes of collective critique allied to a popular emancipatory project and the projection of other forms of territorial organization"³³⁽³⁵⁵⁾. The authors continue:

Health surveillance is devised as a transformative health praxis of ways of life in contact with modes of production and social reproduction, in which the surveillance of development is articulated with a process of integrated and participatory territorial-based health surveillance in which the popular-health-surveillance component stands out as the essence of a governance model, as a driver of actions beyond the health sector, integrating other sectors, but mainly social and popular movements. [...]

We define the surveillance of development as an apparatus of intersectoral and participatory social policy, producing a territorialization of displacement grounded in the transformation of the economic bases of the agribusiness production chain's accumulation model into a mode of production in life cycles [...]. It is the structural economic and social realization of a transposition of labor in its dimension of social reproduction, in which care is articulated with the mode of producing³³⁽³⁵⁵⁾.

The assumptions underlying this alternative form of surveillance are, therefore, anchored in critical Latin American approaches, placing the subjects of territories at the center, and discussing the social determination of health while considering gender, race, ethnicity, and class³⁴.

In Brazil, the concepts of 'participatory surveillance', 'popular surveillance', and 'territorial-based surveillance' have emerged – with some differences, whose discussion is beyond the scope of this article – but all share recognition of the knowledge and practices of populations in territories, especially traditional peoples, within surveillance practices.

They seek to overcome merely normative, authoritarian, and paternalistic health surveillance practices that disregard ancestral knowledge, practices, and territorial experience³⁵. We understand, however, that the actions undertaken within this study align with movements of popular health education grounded in the pedagogies of Paulo Freire, bringing into the Health field ideas centered on dialogue, problematization, and joint action between the population and the professionals involved³⁶.

Meneses et al.³⁵ emphasize that, because of the epistemological value and the political and social dimension of popular health surveillance, it is important to strengthen such initiatives "through the articulation of diverse knowledges and practices with production, health promotion, and care in the territories"³⁵⁽²⁵⁶²⁾.

In this study, fieldwork was facilitated by the territorial insertion and prior coordination of the participating institutions in the communities and by the population's knowledge of the territory. The results achieved reinforce that research on pesticides in agricultural areas requires an interdisciplinary and participatory approach, including the knowledge of those affected, given the complexity of the events involved³⁷.

Participatory mapping: Hands that denounce and build paths in defense of the Cerrado

To conduct the participatory mapping, which aimed to analyze environmental contamination, exposure, and human illness, and strategies of resistance and confrontation, training was also conducted with the social movements active in the participating territories and communities. The workshops were facilitated by two researchers experienced in the techniques employed. They were organized in four stages: (a) Presentation and discussion of maps and participatory mapping methodologies; (b) Participatory mapping as

an organizational process for visibility and social mobilization; (c) Exposure to pesticides and harm to health and the environment, emphasizing emblematic Cerrado cases; and (d) Mapping vulnerabilities in threatened territories: how to organize fieldwork for mapping in affected territories.

Guidance was also provided on all stages before and after going to the field, such as prior coordination with leaders to mobilize participants, definition of date, time, and place, field diary organization, and all other steps needed to conduct the participatory mapping. Participants received a roadmap for the participatory mapping field activity, describing in detail all stages of the process according to the following moments: 1) Mobilization of local leaders; 2) Organization of material to be taken to the activity; 3) Participatory mapping; and 4) Post-field stages (digitization of maps, Informed Consent Form and Image and Testimony Authorization Form, storage and transcription of audio recordings, digitization of field diaries, storage of field photographs, and submission of files).

During the mapping process, harm associated with the agribusiness mode of production affecting Cerrado peoples was perceived by the groups in all of its dimensions, emphasizing environmental and health issues. Through the participatory approach, affected communities narrated and graphically represented these problems, diagnosing those most relevant and

most threatening to their ways of life. This approach brought together the efforts of researchers and social movements for engaged scientific production, with the protagonism of people from the affected territories.

Meetings were held in the communities themselves, at places, days, and times previously defined by participants. The meetings were conducted on the basis of two main guiding questions: ‘What damage does agribusiness cause to health?’ and ‘What damage does agribusiness cause to the environment?’. During the mapping process, efforts were also made to recover memories and identities threatened by the expansion of monocultures in the territories. Furthermore, transect walks were conducted in some communities, guided by participants in the mapping process, in order to deepen understanding of the territories and the problems affecting them. Based on the discussions, a more in-depth exploration was undertaken in each reality, highlighting the repercussions for the communities’ ways of life.

The mapping was conducted using simple and accessible materials, such as sheets of paper of various sizes (A1, A2, A3) and kraft paper, colored markers, and colored pencils. Each group activity lasted, on average, one half-day and was followed by a presentation of the mapped elements in a discussion circle. This field visit was guided by participants in the mapping process (*figure 1*).

Figure 1. Records of participatory mapping in the study territories



Source: Project collection.

The maps represented the realities of the communities and their modes and means of producing life autonomously, symbolizing a way of strengthening identities, recognizing rights and cultural practices, and affirming their life territories. The appropriation of mapping techniques by social groups historically excluded from decision-making about their territories enables the recognition of participants' popular, symbolic, and cultural knowledge, making socioenvironmental injustices inflicted on a given population and territory by hegemonic subjects or groups visible. Thus, this tool serves as an instrument for making socioenvironmental injustices visible and denouncing them³⁸.

Participatory mapping reveals conflicts existing at different dimensions and scales – territorial, environmental, and social – between communities and other groups (the State and economic sectors) seeking to dominate

traditional territories by virtue of the pressure and structural incidences of capital, such as agribusiness, and over common goods, to the detriment of health and environmental protection³⁹.

The maps highlighted risks of biodiversity loss and the emergence of a setting of food and nutritional insecurity, besides acute and chronic intoxications from pesticide exposure. On the other hand, agroecological practices emerged as elements that protect both the environment and health in the defense of territory and ways of life⁴⁰.

These findings align with the results of several studies conducted in states of the Cerrado region, which have detected environmental contamination, human exposure, and illness. There are reports and records of acute and chronic intoxications with severe effects, such as cancers and miscarriages. In the environment, there are reports of crop loss,

soil and water contamination, and exposure of animals^{13,15-17,19,23,37}.

Popular surveillance as an instrument of denunciation and resistance: Contributions to the Permanent Peoples' Tribunal and to territorial struggles

Partial results of the study were presented at the PPT Final Hearing to judge the crime of 'Ecocide against the Cerrado' and were delivered to the Jury of the Session in Defense of Cerrado Territories. Data from the first water collection cycle were incorporated into the accusation and supported the final ruling, which "accepts the arguments of the complaint and considers the human rights violations denounced to be proven in all cases indicated"⁵⁽⁷⁷⁾. The crime of ecocide is recognized, as the ruling declares:

Physical destruction refers to the group and is inseparable from the maintenance of its identity as such. If the group is compelled, by all means, to abandon its lands or is expelled, the continuity of its traditional ways of life and social reproduction becomes impossible, and the differentiated identity of the group – and therefore the group itself – is destroyed. That is the process of genocide currently underway, in direct connection with ecocide⁵⁽⁸¹⁾.

The ruling states that the cases presented show the effects of the massive use of agrochemicals on the rights of Cerrado peoples; the losses to agrobiodiversity; the loss of agroecological practices; contamination of soil, air, and water by pesticides and their effects on the health of people and animals; limitations in access to water; destruction of crops; and the physical confinement of communities⁵.

The Jury's recognition of ecocide and condemnation of the accused also represents recognition of the responsibility of national and foreign states, together with companies and institutions – most notably agribusiness

interests – as major contributors to the destruction of the Cerrado in all its dimensions. It is therefore the materialization of necropolitical rationality, in which policies of death are engendered both by the absence of the State and by its action as a regulatory power over the maintenance of life and death⁴¹.

This action generally seeks to serve the interests of large capital holders, who systematically violate the rights of Indigenous peoples and traditional communities in order to meet their own interests, relaxing more protective environmental and health legislation, and even rolling back hard-won rights whenever these obstruct their profits in some way³⁰. A recent example of this *modus operandi* of the Brazilian State is the Senate's approval of Bill N° 2.159, known as the 'Devastation Bill', which relaxes environmental licensing in Brazil. Among its measures, the bill considers only Indigenous, quilombola, and traditional territories whose regularization has already been concluded for purposes of analyzing socioenvironmental impacts in the licensing of works and economic activities. By adopting no measure to protect populations in areas not yet fully recognized, the government further increases the vulnerability of people and traditional communities, many of whom are already immersed in situations of conflict⁴².

After the Final Hearing, a dossier was published systematizing all water-monitoring results²⁹, and several communication materials were produced and disseminated by the National Campaign in Defense of the Cerrado and the entities that compose its network, presenting data and testimonies from representatives of the study territories. These materials circulated through digital channels, social media, and the press.

At the national level, a public hearing was organized in the House of Representatives to present the results included in the dossier, together with members of the communities and movements involved⁴³. Other public hearings were organized at the state level for feedback on results and political advocacy. A

large meeting was held with representatives of all communities to present the research findings in full, debate strategies, and propose ways of using the data produced by the study in political agendas for territorial defense. In some communities, feedback on the results was provided to territorial subjects using participatory approaches, and this process is still ongoing.

Deep engagement with the issue was observed among community members, along with appropriation and understanding of the results and incorporation of the findings into their struggles and claims. This points to a political-pedagogical perspective of participatory mapping, allowing it to act as a tool that promotes collective recognition of the elements that threaten and those that protect territories, while also fostering mobilization and political articulation among social movements, research institutions, and communities. The set of actions developed is organized within the logic of popular surveillance, enabling.

[...] a better understanding of the possibilities for transforming reality from a perspective of struggle in defense of cultural values and healthy, solidaristic, and sustainable ways of life⁶.

Final considerations

The use of participatory approaches was a powerful strategy for confronting the socioenvironmental problems resulting from agribusiness in the Cerrado, since it identified vulnerabilities associated with this productive model.

Although difficulties exist, it is undeniable that not only listening to communities affected by these enterprises but also enabling processes in which territorial subjects play a leading role in surveillance actions has far greater potential and can become an important element in promoting the necessary strategies for change. The joint action of researchers, social movements, and communities strengthened local protagonism and made historic injustices visible, as understood from the perspective of those who experience these harms on a daily basis. By integrating scientific and traditional knowledge, participatory approaches favor the construction of solutions that respect the realities and needs of territories.

The recognition of ecocide and genocide in the Cerrado by an international tribunal reinforces the urgency of effective action. The results of this study indicate that environmental destruction and human-rights violations are reflections of agribusiness as a predatory development model that prioritizes profit over life.

Authorship contributions

Gurgel AM (0000-0002-5981-3597)* contributed to the conception, analysis, writing, revision, and approval of the final version of the manuscript. Alfaced BS (0009-0002-2877-0982)*, Costa AM (0000-0001-9498-7886)*, Morais LCLS (0009-0000-6492-7786)*, Moura FAG (0009-0007-8857-9764)*, Melo LC (0000-0002-5602-0831)*, and Almeida FS (0000-0002-4840-9118)* contributed to the analysis, writing, and revision of the manuscript. ■

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