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Mirror without reflections: social and environmental conflicts and vulnerabilities in a sugarcane producing region

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Abstract *This study aims to analyze the socio -environmental and health effects of sugarcane crops in a county in the Zona da Mata of the state of Pernambuco, Brazil. A collective mapping was carried out with use of social cartography. The issues investigated were plotted on maps, whose final versions were elaborated by means of the ArcGIS 10.2 software. The study was carried out in the district of Tejucupapo, located in the municipality of Goiana, selected due to its proximity to the sugarcane fields. In the environment there was an increase in deforestation, mangrove degradation, silting of rivers, reduction of fish and contamination of water and other crops by pesticides and sewage. For health, respiratory problems were pointed out by sugarcane burning, pesticide poisoning and the precariousness of the governmental health care. In the socio-cultural dimension, conflicts related to land use and occupation were identified, with loss, expropriation and destruction of historical objects and symbols of the community, reflecting the loss of cultural identity. The problems related to sugarcane production severely affect human health and destroy the territory both in its environmental aspects and the very identity construction of the community, threatening traditional livelihoods.*

Key words *Sugarcane, Health vulnerability, Environmental impacts, Pesticides*

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Introduction

Sugarcane cultivation dates back to colonial Brazil and marks one of the oldest forms of economic, cultural, social and symbolic appropriation and use of the territory[1]. In the 1970s, with the oil crisis, there was an increase in productivity in the sugar-alcohol sector mediated by State subsidies, which led to the expansion of the sugarcane agroindustry in the country, with expansion of the cultivation areas[2].

Currently, sugarcane has significant commercial relevance, with production in more than 70 countries, Brazil being the largest world producer. Although a 2.6% increase in sugar production in the 2019/2020 harvest was recorded in the country, contrasting with the decrease in world production, a reduction in the 2020/2021 harvest is expected due to the COVID-19 pandemic. Although the initial estimates point to an expected 0.4% reduction in the area destined to produce this crop when compared to the previous season, in the Northeast region there is an expectation of growth in the area harvested in the order of 2%. In Pernambuco, sugarcane continues to be the main crop in terms of planted area and the highest production value in reais, with planting concentrated in the Zona da Mata[3].

Sugarcane cultivation in Brazil takes place at the expense of social, health and environmental issues. Sugarcane advances over protected areas and native vegetation, driving deforestation[2]. The use of pesticides and chemical fertilizers in crops causes water, soil and air contamination, in addition to affecting animals and other plant species, contaminating other crops[4,5]. There can be siltation of rivers as a result of soil erosion. Atmospheric pollution caused by the burning of sugarcane reduces animal biodiversity due to loss of habitats or to death of species that use sugarcane for nesting or feeding. Plant biodiversity is also threatened in areas adjacent to sugarcane fields burned due to accidental fires[6,7].

As for health and life conditions, there is the formation of large estates and income concentration; precariousness of work; serious and fatal work accidents; threat to food and nutrition sovereignty; poisoning from exposure to pesticides; as well as respiratory, circulatory, and other harms to human health. There is also risk of losing the traditional ways of life. These issues are added to the socio-environmental vulnerabilities already existing in the territories, such as precarious housing and sanitary conditions, worsening the general health situation[7-10].

Considering these issues, this study aimed at identifying the socio-environmental and health impacts arising from the sugarcane monoculture in the municipality of Goiana, considered one of the largest producers of this crop in the Zona da Mata of Pernambuco.

Methodology

This is a cross-sectional study, with methodological triangulation for data collection and analysis.

The research was carried out in the municipality of Goiana, located in the Zona da Mata region, chosen for being one of the largest sugarcane producers in Pernambuco, with a planted area of 550,000 ha in 2018. Crossing of the points referring to burning with the urban clusters was carried out, seeking to identify densely populated areas located amidst sugarcane plantations.

Identification of the fires was carried out by consulting the database on fires of the National Institute for Space Research (*Instituto Nacional de Pesquisas Espaciais*, INPE), available at http://www.inpe.br/queimadas/bdqueimadas. Data from the day and night periods were used, from 2007 to 2019. The data, in shapefile format, were imported into the ArcGIS 10.2 software, where point density estimation was performed using the Kernel method[11]. Subsequently, the communities located in the areas closest to the hot spots were identified, through the IBGE population agglomeration data, resulting in the selection of Tejucupapo (Figure 1).

The primary data were collected between July and November 2019, using social cartography as a strategy for the participation of those involved in the investigated problem, giving prominence to the community and legitimizing collective knowledge and ways of being[12].

Initially, exploratory visits were made to identify and mobilize the leaderships in the territory. Fortnightly meetings were scheduled, held at the headquarters of the "*Heroínas de Tejucupapo*" Association, in the community itself, on days and times previously defined by the participants. Residents of the district, over 18 years of age, of both genders, and linked or not to sugarcane cultivation were included.

The meetings were conducted based on the following guiding question: *Which are the conflict situations and impacts related to sugarcane cultivation for health and the environment?* The problems were mapped by the community on base maps, on an A3 sheet of paper, using felt-tip pens

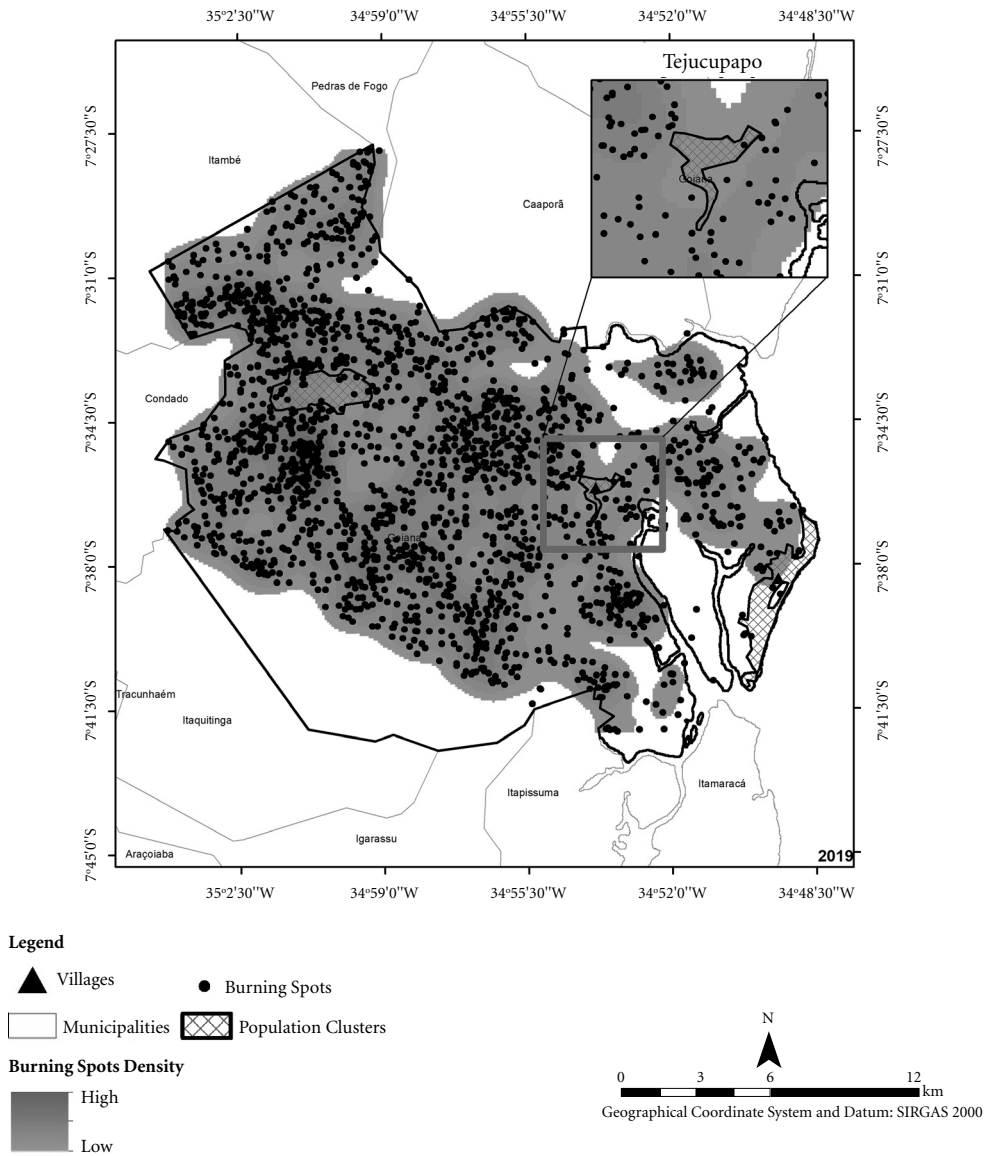

Figure 1. Distribution of the hot spots in the city of Goiana, Pernambuco, from 2007 to 2019.

Source: Authors, based on the Queimadas Project database (INPE), 2020.

and colored pencils. During the mapping, it was also sought to retrieve the memories and identities threatened by the expansion of sugarcane in the territory. The participants were divided into three groups, and each group elaborated a map. Each group activity lasted approximately 60 minutes, and was followed by the presentation of the mapped elements in a conversation circle.

A field visit was carried out, guided by the cartography participants, in order to locate the main problems identified by the community. The meetings were photographed, and the audios recorded and later transcribed, with the participants' written consent being obtained.

The content of the transcriptions was organized in thematic categories, with the subsequent conduction of Discourse Analysis (DA)[13]. The systematization and analysis of the issues which emerged in the conversations took place from Kvale's Condensation of Meanings (1996)[14],

where the speeches were condensed in a framework constituted by the analysis categories and central themes identified. The data were tabulated in the Excel program.

The final map was prepared from the combination of digital mapping geotechnologies and data provided by the community, using the ArcGIS 10.2 software. For the analysis of deforestation, the territorial limits of the Acau-Goiana Extractive Reserve (Resex) were used as a reference, obtained from the website of the Chico Mendes Institute for Biodiversity Conservation (*Instituto Chico Mendes de Conservação da Biodiversidade*, ICMBio).

The research was approved by a committee of ethics in research involving human beings.

Results

The mapping carried out by the population revealed impacts on health and on the environment, as well as the existence of conflicts associated with sugarcane cultivation in the territory (Figure 2).

The impacts associated with sugarcane cultivation were organized into three central categories, detailed in Chart 1.

Territorial conflicts

Tejucupapo has been exploited for the production of sugar since the 16th century, and was the scene of armed conflicts at the time of the Dutch invasion, the most emblematic of them being the Battle of Tejucupapo. In the region, this story has the way and proper place to be told, being marked by orality, where the population proudly recalls their trajectory and reasserts their collective identity. Through a theatrical staging, the community recalls the trajectory of "*Heroínas de Tejucupapo*", dating from the 17th century, in which women led the expulsion of the Dutch invaders from the town using hot water, pepper and pieces of wood. However, the population disputes with the "landowners" the space for the event, since Monte das Trincheiras, the landmark of this important battle, identified by an obelisk, was fenced and privatized, demanding authorization from the owner to access the area.

According to the community, archaeological pieces and records found at the site were taken to the headquarters in Goiana and to museums in Recife. In this area, the ruins of what the population claims to have been the first church in the territory are also abandoned, the Santana Church (Figure 3a), as observed in the field visit.

Surrounding this historic site is the Acaú-Goiana Resex, where sugarcane advances over the territory (Figure 3b), marking new territorial conflicts that challenge the collective identity in the community.

The residents' identity is marked by popular organization, resistance, and permanence in the territory. The narratives of the most recent conflicts include the expulsion of a pesticide factory that intended to settle in the region and the dispute for part of the territory with a family of mill owners, who claim ownership of lands where the community lives.

The recent installation of an industrial hub in the city intensifies the socio-territorial conflicts, potentiating real estate speculation and the increase in the number of condominiums in the region, with expulsion of families and an increase in land prices. The private appropriation of soil and biomes promotes plant suppression, prevents their collective uses and makes it difficult for the State to provide urban infrastructure, as the community reveals.

When this river thing starts to have an owner... The river is not supposed to have an owner. In the past, we even drank the water…

As a result of this process, an increase in violence in the territory was reported, expressed by the rupture of family and community ties as a result of migration, mental distress, drug use, physical violence and prostitution, among others. There were reports of drug trafficking and consumption in the community and the existence of extermination groups and murders of family members of the study participants.

Harms to the environment

The speeches pointed out serious problems such as lack of sanitation in the community. Irregularity was pointed out in the collection and treatment of domestic sewage, which is disposed of in a collection unit locally known as "*fossão*". The visit to the territory revealed that the sewer runs in the open, corroborating the participants' statements. According to a number of reports, the "*fossão*" was installed in a site previously occupied by a well that supplied water to the community. Open sewers cause discomfort due to the unpleasant odor, mischaracterization of the landscape, contamination of rivers, streams, and groundwater, and because of the proliferation of

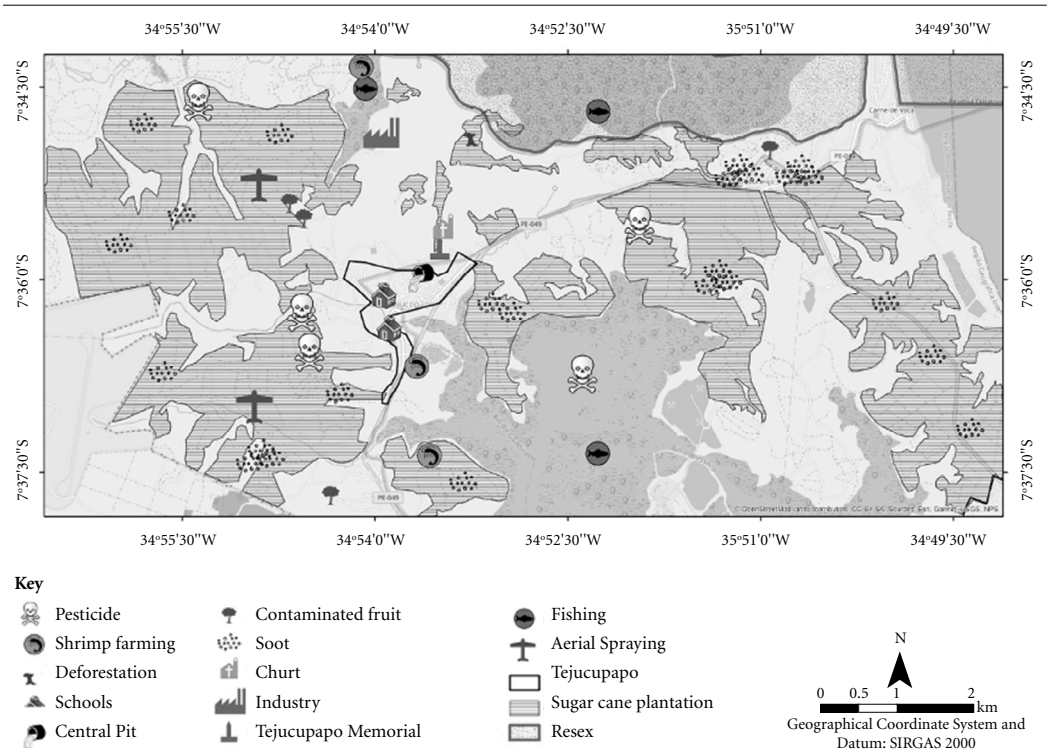

Figure 2. Tejucupapo's social cartography.

Source: Authors.

Chart 1. Problems associated with sugarcane cultivation in the territory of Tejucupapo, Goiana - PE.

Categories	Central themes
Environment	Precarious environmental sanitation, with reduced quality of water supply and precarious sanitary sewage; Use of pesticides in sugarcane cultivation; Aerial spraying; Increased deforestation; Contamination of rivers and mangroves due to the use of pesticides, shrimp farming and domestic sewage; Siltation of rivers; Reduction in food and fish from the region
Health	Precariousness in health care for residents and workers in the territory; Absence of prevention, diagnosis, and care actions for pesticide poisoning cases; Illness in factory workers causing compulsory retirement due to disability; Acute poisoning in workers; Increased symptoms of asthma and tiredness in residents at the time of sugarcane burning; Lack of structure in the educational system and mobility
Conflicts	Land and power concentration; Land conflicts; Lack of historical recognition of Tejucupapo; Appropriation of historical landmarks in the region by landowners; Losses of historical objects of the territory; Losses in lifestyles and identity; Loss of access to public areas and environmental resources such as rivers and mangroves; Lack of public security; Increased prostitution, violence, and drug use

Source: Authors.

mosquitoes and other vectors, as shown by the community:

I have some complaints about this part, about the contempt we experience: basic sanitation, it's the sewers running out there in the open, it's sugarcane when it burns, *in my house it's not so dirty because it's covered with plastic, but the terrace is all black and* it's the complaint of many other people here also [...]. *And the other thing here that we* complained to the secretariat, and nothing was done is mosquitos. There is a massive mosquito pest in Tejucupapo (emphasis by us).

Loss of water quality is also caused by the excessive addition of chemical sanitizing products by the concessionaire, with reports of changes in physical-chemical and organoleptic properties, such as odor and color, causing doubts as to its potability. Sanitation precariousness was relegated to a feeling of abandonment, both by the City Hall and by the water and sewage supply company, where the residents' request for the adoption of resolute measures was never met.

The advance of deforestation due to the expansion of the sugarcane monoculture was mentioned by the participants, even in environmentally protected areas (Figure 3c), as is the case of the Acau-Goiana Resex, which suffers from the intensive use of pesticides and chemical fertilizers in the sugar-alcohol monoculture, in addition to the expansion of shrimp farming activities.

The concern with the use of pesticides and its relationship with environmental pollution marked the discourse, including aerial spraying. The use of glyphosate, popularly known as "forest bush", in sugarcane fields was highlighted, with apprehension about the consequences of the use of these substances for the health of the population and the environment, such as contamination of the soil, surface and underground waters, mangroves and subsistence crops existing in the territory:

I even live near a cane field there and there is a river. Every time the pesticide is applied, it completely leaks into the pod. Our river here is all in need of treatment, right?

The residents reported a reduction in the aquatic species previously found in abundance in the region, such as mussum, crab and guaiamum, which constituted an important source of income for fishermen, with emphasis on fish contamination by pesticides.

Regarding air pollution, a significant reduction in air quality was pointed out during the period of burning sugarcane straw and the sedimentation of particulate matter, which covers houses and places close to the sugarcane fields, causing environmental and health problems.

Harms to health

Social cartography revealed the existence of sugarcane burning during the harvest months,

Figure 3. Socio-territorial impacts related to sugarcane cultivation in the district of Tejucupapo, Goiana, Pernambuco.

Key: 3a (upper left): ruins of the Santana Church. 3b (upper right): sugarcane plantation located in Tejucupapo. 3c (lower left): deforested area and mangrove destroyed in the Resex for sugarcane expansion. 3d (lower right): intentional burning for sugarcane deleafing in Goiana.

Source: Authors, 2019.

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which generally lasts from August to February, the dry season of the year (Figure 3d). Smoke and particulate matter disperse over long distances, compromise air quality and affect the respiratory system, especially in the most vulnerable groups, such as children and older adults, who have symptomatic asthma and respiratory distress reported by the population. The consequences of the burning were mentioned mainly by the women who take care of the housework and cleaning the homes affected by the soot:

I worked at the medical center and spent a week using four oxygen balloons, apart from nebulization, it was adults, it was children, everyone was tired from the burns.

And all the houses here are affected, you see? It becomes black, black, from those things that fall.

As for exposure to pesticides, cases of acute poisoning were reported, including multiple cases of occupational poisoning, hearing loss in workers who handle pesticides; disability retirement and other problems. The participants reported difficulties in workers' health care, especially those who are directly exposed to pesticides in their routine work in the sugarcane fields.

Dizziness, poisoning. I was helped, I took a serum. There were 6 peers with me. Everything in just one day...

If you go to the SUS, you take a dipyrone, you don't take an X-ray, you don't do a blood test.

The difficulty in accessing adequate care was evident, and the workers themselves reported that there are no case investigations or surveillance actions to prevent recurrence. There is also a situation of food insecurity due to crop contamination by pesticides, threatening the health of the population.

The discourse reveals the low quality of health care, evidencing the difficulty in accessing services and appointments with professionals at different care levels. The precariousness of the health services was emphasized by the participants through reports regarding shortage of professionals, especially physicians, and lack of medications and ambulances in the territory. There is also lack of social facilities in the community, noting the nonexistence of public social assistance services and social/leisure facilities, with the reduced number of schools, in addition to the precariousness of public transportation.

Health is terrible. No need even to say so, you see? When it comes to health, there is no care, when it comes to care, we have no more help.

Discussion

Territorial conflicts and disputes and the materialization of violence in the territory

The conflicts, disputes over land and destruction of the biome for the expansion of sugarcane that were evidenced refer to historical processes of advance of the sugarcane monoculture, with appropriation of the territory mediated by violence. The atmosphere of fear, repression and lack of rights[15] shaped the relationship of the communities with the territory, revealing the perversity of the dynamics established by this activity over the centuries.

Although the demarcation of rural settlements and of the Extractivist Reserve in Goiana represented a victory in the dispute for land possession, the social relationships in Tejucupapo remain affected by conflicts regarding land for sugarcane production, and by industries and real estate companies that advance over the territory. A similar situation was observed in Colombia, where the spatial segmentation caused by sugarcane expansion has been instituted by territorial planning instruments, denying the communities' constitutional rights[16].

Dispossession of the physical space represents a situation of injustice, also observed in the deprivation of social and cultural rights, which evidences the symbolic dimension of the marginalization of access to the territory and its protection. The threat of looting is reinforced by the contemporary installation of large projects in Goiana, such as the automobile hub, which can affect traditional territoriality, these findings being similar to those found in a sugarcane producing region in Colombia[16].

In Tejucupapo, the substitution of sugarcane fields with industrial zones adds elements to the historic territorial disputes, since industries used formalities to classify the region as an urban expansion zone, generating real estate speculation. The persistence of disputes over land between the community and the "monoculture landowners" is updated in light of the State's interests, being evidenced in other communities with similar characteristics, such as Engenho Massangana, in the municipality of Cabo de Santo Agostinho, marked by the violence imposed by the installation of a port industrial complex[17]. In both communities, the eviction processes, territorial conflicts and permanence of the communities' ways

of living sometimes depend on the expansion of sugarcane plantations, and sometimes on industrial and urban expansion.

One of the consequences of this process is the increase in violence, expressed in economic, physical, moral, and symbolic ways, compromising human rights and dignity. Widespread violence in the Zona da Mata resulted in evictions from the territories, as well as in lasting conflicts, as observed in the 1980s, where 74.4% of the rural murders in Pernambuco took place in sugarcane monoculture areas [18,19].

The marking symbolic violence in the territory, where the advance of agribusiness marks several losses: of land, history, memory, culture, traditionality/ancestrality, of the way of relating to the land/water (fishing, shellfishing), of sovereignty and of food and nutrition security. These losses increase the territory's vulnerability, aggravating the already existing problems, creating, reinforcing, and legitimizing stigmas and constituting discrimination processes. Symbolic violence materializes in the rupture of family and community ties as a result of migration, mental distress, drug use, physical violence, murders and prostitution, among others. These findings are corroborated by other studies, as evidenced in the states of Goiás and São Paulo, where an increase was recorded in drug trafficking and conflicts and violence in sugar-alcohol areas[20,21].

Even with the violence and asymmetry of the power relations characteristic of these territories, it is possible to identify forms of resistance of these peoples, as observed in a study carried out with residents and workers of a sugarcane producing region in Alagoas[22].

As observed in other studies[22,23] and in this research, the different shared narratives reassert the power of life and its multiple forms of expression, marking the resistance strategies in the territory. Resistance strategies represent a unique way for the population to face the types of violence arising from established power relations, but not restricted to them. They are strong expressions of the desire to exist, resist and give new meaning to existences in the territory, or to maintain their ways of life, showing resistance in the face of situations that threaten life in the territory.

Harms to the environment

Sugarcane production and processing consumes large volumes of water[24], aggravating the irregular supply and low quality scenario seen in Tejucupapo. The prioritization of water supply for agribusiness to the detriment of the population corroborates the fact that more than 70% of the ground and surface water is consumed by agriculture, with a large part of this volume being wasted[25]. The problems related to water supply reflect the precariousness of sanitation in the municipality, where only 33.5% of the homes have adequate environmental sanitation, according to the 2010 Census. In traditional communities, the lack of basic sanitation structures is common, with poor sanitation and water supply[26-28]. Inadequate environmental sanitation can worsen the overall health situation, aggravating preexisting diseases and increasing susceptibility to other health problems.

Regarding the pesticides, sugarcane is one of the crops that most uses these substances in Brazil, consuming mainly the glyphosate, popularly known as "forest bush", and 2,4-D herbicides, which is in accordance with the participants' reports. Many of these pesticides have an environmental dynamic that is favorable to their accumulation, particularly in the soil and in surface and underground water, corroborating the participants' discourse, who pointed to the dragging of these agents to the rivers. A number of studies that evaluated water contamination by pesticides in sugarcane cultivation showed the presence of different active ingredients in rivers[4], as well as the high risk of contamination in groundwater and subsurface water tables by herbicides in all soil types studied, at depths of up to 10 meters[29]. 2,4-D has leaching potential and can contaminate groundwater, and glyphosate has a high transport potential associated with sediments[30].

Aerial spraying of pesticides represents one of the main problems caused by sugarcane cultivation, with harms reported in rural communities. The drift of pesticides contaminates soil, water, neighboring crops, forests and nearby residential areas, with a record of disasters in Brazil, with increased exposure and the occurrence of dozens of poisoning cases, particularly in children[31-33]. The emission of particulate matter and toxic substances during periods of cane burning also represents an important source of air pollution in sugarcane producing regions and can cause major fires [6,9].

The release of effluents from sugar mills into the rivers is also worrying, as it is estimated that the polluting potential of vinasse is nearly one hundred times greater than that of domestic sewage. Vinasse causes significant impacts on the

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environment, being considered highly harmful to animal and plant species, particularly to the microfauna and microflora of fresh waters, in addition to warding off marine species that reproduce in the coastal zone[34].

The appropriation of water sources by agribusiness has been pointed out as one of the main drivers of conflict over access to water in the Northeast[35], the role of the State in strengthening the logic of appropriation of the territory being highlighted, especially through incentives for the release of pesticides and weak monitoring of their harms[36].

Regarding deforestation, a number of studies show that the sugar-alcohol agribusiness promotes suppression of the Atlantic Forest, including reserves[37,38], even in the face of the reduction in the cultivated area in the state[39]. Deforestation facilitates the erosive action of rain, transporting sediments and pesticides, and contaminating soil, rivers, and groundwater. Data reveal that between 63% and 75% of the global deforestation recorded between 2000 and 2012 occurred to promote the advancement of commercial agriculture[40]. Of this total, from 36% to 65% was illegal. Between 2005 and 2013 alone, the expansion of agricultural land, pastures and plantations for industrial purposes was responsible for 62% of the deforestation in the world, and 29% to 39% of the carbon emissions are associated with agricultural and forestry commodities outside producing countries[41].

The sugarcane monoculture in Tejucupapo has exerted a profound impact on fishing and extractive activities, which are considered the main sources of income for the community. The release of effluents from sugar mills has also been recorded in the Resex, causing the death of fish and other species of economic interest, such as crabs and shrimp[19,42].

Harms to health

The environmental impacts and territorial conflicts in the territory reflect in the deterioration of the population's health condition.

Considering the burning of sugarcane straw, different studies found a positive association between this practice and the emergence or worsening of cardiovascular and respiratory diseases, such as bronchitis, emphysema, and asthma, both in workers and in the population of areas neighboring the sugarcane fields. There is an increase in the demand for medical care from healthy individuals during the burning period, with an increased incidence of respiratory diseases, especially among children and older adults[7,9,10].

The reports of acute poisoning from exposure to pesticides are similar to those observed in other sugarcane producing regions, particularly among workers[8,43,44]. Significant changes in body balance, ototoxicity and sensorineural hearing loss have also been reported among exposed workers[45]. Some pesticides can also cause chronic problems like tumors and endocrine disorders, among others[5].

Exposure to pesticides and particulate matter from fires are associated with the occurrence of oxidative stress and accumulation of free radicals in the body, resulting in cytotoxicity and in the development of diseases[46].

The harms to health related to the sugarcane monoculture generate an important demand for assistance in the health services. However, in Tejucupapo a significant weakness was observed in the services offered by the State, increasing the population's vulnerabilities through the insufficiency of the SUS coverage. In Goiana, there is lack of public policies aimed at workers' health, insufficient financial resources for Primary Care, insufficient number of professionals and high turnover, making it difficult to establish a bond between the team and the community[47].

The precariousness in peasant territories is marked by greater difficulty in accessing the health services, insufficient sanitation, difficulties in public transportation and access to water, precarious housing and systematic closing of schools in rural areas. The neoliberal economic policy and its reproduction modes limit the role of the State, which makes it difficult for the rural population to access basic public services[26-28].

Final considerations

Sugarcane monoculture unveils several vulnerability processes that affect health and the environment, being associated with territorial conflicts related to land concentration, deterritorialization, and producing social inequalities and constant threats of eviction, depriving the population of their original ways of life and existence. The environment, devastated and contaminated, also generates economic harms, with loss of the main sources of income associated with shellfishing and artisan fishing.

The right to health has been denied in the Tejucupapo community, and the health services are not adequate to the demands generated by the

problems associated with sugarcane, revealing the insufficiency of the SUS coverage to meet the local needs.

The feelings of identity and belonging associated with territoriality are broken due to the territorial, social and cultural losses promoted by the sugarcane culture, decharacterizing the population's ways of life. The sugar-alcohol agribusiness produces "loss of the reflexes, in front of the mirror": the community in the territory does not recognize itself in it, "deforested, polluted, privatized and generator of illness and death".

Collaborations

AM Gurgel: collaborated with the following activities: study design, data collection, systematization and interpretation of data, critical review, writing and approval of the final version of the manuscript, agreeing to be responsible for all aspects of the work. Other authors: collaborated with the following activities: data collection, systematization and interpretation of data, critical review, writing and approval of the final version of the manuscript, agreeing to be responsible for all aspects of the work.

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