Revista ARACÊ
ISSN: 2358-2472

ENVIRONMENTAL JUSTICE AND THE IMPACTS ON THE HEALTH OF RURAL WORKERS AND RURAL COMMUNITIES: PESTICIDES, ENVIRONMENTAL DISASTERS, AND WATER CONTAMINATION

https://doi.org/10.56238/arev7n3-208

Submitted on: 02/20/2025 **Publication date:** 03/20/2025

Antonio Nacílio Sousa dos Santos[1], José Neto de Oliveira Felippe[2], Kadja Lemos Silva[3], Lucas Teixeira Dezem[4], Kleberson Ricardo de Oliveira Pereira[5], Ismael Duarte Assunção[6], Djeimi da Silva Soares[7], Lilian Paula Almeida da Silva[8], Stênio Maia Estevam[9], Francisco de Assis de Araújo Júnior[10],

[1] PhD student in Social Sciences
Federal University of Espírito Santo (UFES)
Horizonte, Ceará – Brazil.
E-mail: nacilisantos23@gmail.com
[2] PhD student in Teaching of Exact Sciences (UNIVATES)
Faculty of Caldas Novas (UNICALDAS)
Caldas Novas, Goiás – Brazil.
Email: profnetomatfis@gmail.com
[3] Master's student in Sciences and Environment (PPGCMA)
Federal University of Pará (UFPA)
Belém, Pará – Brazil.
E-mail: kadja.silva@icen.ufpa.br
[4] PhD student in Collective Rights and Citizenship
University of Ribeirão Preto (UNAERP)
Ribeirão Preto, São Paulo – Brazil.
Email: lucastd19@hotmail.com
[5] PhD in Metallurgical and Materials Engineering
University of São Paulo (USP)
Salvador, Bahia – Brazil.
E-mail: klebersonric@gmail.com
[6] Master's Degree in Environment
CEUMA University.
São Luís, Maranhão – Brazil.
Email: ismael.duarte@ceuma.br
[7] Specialist in Public Law from
Ademar Rosado College (FAR)
Pelotas, Rio Grande do Sul – Brazil
E-mail: djeimiss@hotmail.com
[8] Master of Science in Geochemistry and Petrology.
Federal University of Pará (UFPA)
Belém, Pará – Brazil.
Email: lilianpas@outlook.com
[9] PhD student in Public Policy
State University of Ceará (UECE)
Fortaleza, Ceará – Brazil.
E-mail: stenio.maia33@gmail.com
[10] Master's student in Constitutional Law
University of Fortaleza (UNIFOR)
Fortaleza, Ceará – Brazi

Revista ARACÊ
ISSN: 2358-2472

Juliana Ribeiro Lucci [11], Wictor Hugo Pereira Carvalho [12], Raquel Soares Souza[13] , Marcio Harrison dos Santos Ferreira [14], Patricia Kayllane Amorim de Lima [15], Guilherme Eliziario Silveira[16], Dayvid Resende Sampaio[17].

ABSTRACT

The relationship between environmental justice and the health of rural workers and rural communities highlights structural inequalities intensified by the agro-industrial model, whose expansion has resulted in severe socio-environmental impacts. The indiscriminate use of pesticides, recurring environmental disasters, and water contamination compromise the quality of life for these populations, accentuating vulnerabilities and reinforcing processes of social and health exclusion. The research investigates, therefore, how exposure to these factors affects the health and well-being of rural populations in light of the concept of environmental justice. To do so, it is based on authors such as Sigaud (1979), Bologna (1990), Rosen (1994), Peres (1995), Peres and Moreira (2003), Bombardi (2017), Lopes (2020), Rigotto, Carneiro et. al. (2021), Alves (2021), Sampaio (2012), Ferreira, Serraglio and Agostini (2013), Lehfeld, Carvalho and Balbim (2013), Moura (2016), among others. Methodologically, it adopts a qualitative approach based on Minayo (2007), descriptive and bibliographic according to Gil (2008), and comprehensive analytical in the light of Weber (1949). The findings reveal that rural workers and rural communities face multiple exposures to environmental and health risks, resulting in acute and chronic diseases, such as poisoning, neurological disorders, and cancers. There is a lag in public policies for mitigation and prevention, aggravated by the lack of inspection and specialized

[11] PhD in Veterinary Sciences
Federal University of Western Bahia (UFOB)
Barra, Bahia – Brazil.
E-mail: julucci@hotmail.com
[12] Undergraduate Nursing Student
Federal University of Tocantins (UFT)
Palmas, Tocantins – Brazil.
Email: wictor.carvalho@mail.uft.edu.br
[13] Plant Protection Specialist
Federal University of Viçosa (UFV)
Ananindeua, Pará – Brazil.
E-mail: rss309@gmail.com
[14] PhD student in Agroecology and Territorial Development (PPGADT)
Federal Institute of Piauí (IFPI)
Paulistana, Piauí – Brazil.
E-mail: marcio.harrison@gmail.com
[15] Undergraduate student in Biological Sciences
Federal University of Alagoas (UFAL)
Satuba, Alagoas – Brazil.
Email: kayllane.amorim14@gmail.com
[16] Food Technologist
Federal Institute of Education, Science and Technology of Maranhão (IFMA)
São Luís, Maranhão – Brazil.
E-mail: eliziariog@acad.ifma.edu.br
[17] Specialist in Criminal Law and Procedure
Higher School of the Public Prosecutor's Office Ceará (ESMP/CE)
Sobral, Ceará – Brazil.
Email: drsampaio@gmail.com

Revista ARACÊ
ISSN: 2358-2472

health care. In addition, it is found that environmental injustice is expressed in the unequal distribution of the impacts of environmental degradation, perpetuating cycles of vulnerability and exclusion. The research highlights the urgency of stricter regulation policies, epidemiological surveillance strategies, and sustainable productive alternatives that minimize socio-environmental damage and promote a less unequal reality in the protection of the health of these populations.

Keywords: Environmental Justice. Rural Health. Pesticides. Socio-environmental inequality.

Revista ARACÊ
ISSN: 2358-2472

INTRODUCTION

ENVIRONMENTAL JUSTICE AND HEALTH IN THE COUNTRYSIDE: THE IMPACTS OF PESTICIDES, ENVIRONMENTAL DISASTERS, AND WATER CONTAMINATION IN RURAL COMMUNITIES – INTRODUCING

The relationship between environmental justice and the health of rural workers and rural communities is intrinsically linked to historically constructed socio-environmental inequalities. The environmental degradation promoted by the intensification of the agro-industrial model[18] has significantly impacted the quality of life of these populations. As Bombardi (2017, p. 23) argues, "[...] Chronic exposure to pesticides not only compromises the health of field workers, but reinforces socioeconomic inequalities by depriving them of decent living conditions." Similarly, Peres et. al. (2021, p. 47) point out that "[...] The advance of the agricultural frontier has been accompanied by the growth of occupational diseases and irreversible environmental impacts".

> Even using a relatively conservative rate of 3% to estimate the number of pesticide poisonings among Brazilian agricultural workers, about 360,000 new cases would be expected each year in rural areas alone, a number approximately forty times higher than that indicated in official data (Peres & Moreira, 2003, p. 58).

It is also necessary to understand that environmental degradation in rural areas does not occur uniformly but disproportionately affects more vulnerable populations, aggravating historical processes of social exclusion. Moura (2016, p. 132) argues that "[...] Rural communities often face a double burden: the lack of effective public policies for environmental protection and the absence of health care capable of mitigating the damage resulting from contamination". Similarly, Ferreira, Serraglio and Agostini (2013, p. 98) state

[18] The environmental degradation promoted by the intensification of the agro-industrial model has generated significant impacts both for ecosystems and for the health of rural populations, aggravating socio-environmental inequalities and deepening processes of social exclusion. The advance of large-scale monoculture, combined with the indiscriminate use of pesticides and chemical fertilizers, has compromised biodiversity, contaminated water resources and contributed to the desertification of agricultural areas. As Bombardi (2017) points out, "[...] The expansion of agribusiness, based on the maximization of productivity, has resulted in an alarming increase in the exposure of rural workers and rural populations to toxic substances, compromising their health and well-being" (p. 23). Similarly, Peres et. al. (2021) point out that "[...] the advance of the agricultural frontier has been accompanied by the growth of occupational diseases and irreversible environmental impact, evidencing the urgent need for public policies aimed at mitigating these risks" (p. 47). Given this scenario, it is essential to rethink the current production model, incorporating sustainable agricultural practices that minimize environmental damage and ensure better living conditions for the impacted populations. See: Bombardi, L. M. *Geography of pesticide use in Brazil and connections with the European Union*. São Paulo: FFLCH/USP, 2017; Peres, F., Moreira, J. C., Dubois, G. S., & Rodrigues, K. M. *Pesticides, health and environment: a critical analysis of the Brazilian reality*. Rio de Janeiro: Fiocruz, 2021.

Revista ARACÊ
ISSN: 2358-2472

that "[...] the Brazilian State, by making environmental standards more flexible to favor agribusiness, contributes to perpetuating environmental injustices that directly impact the health of rural populations."

However, the intensification of the use of pesticides in commercial crops has been one of the main agents of this socio-environmental crisis, imposing severe risks to human health and the environment. According to Peres and Moreira (2003, p. 58), "Brazil leads the world in pesticide consumption[19], and its effects on public health are devastating, especially among agricultural workers exposed to highly toxic pesticides." Likewise, Rigotto, Carneiro et. al. (2021, p. 210) emphasize that "[...] The contamination of water by chemical waste from industrial agriculture represents a serious health problem that affects thousands of rural families".

> Since the 1950s, when the so-called 'green revolution' began, profound changes have been observed in the traditional agricultural work process, as well as in its impacts on the environment and human health. New technologies, many of them based on the extensive use of chemical agents, have become available for disease control, increased productivity, and protection against insects and other pests. [...] These new facilities have not been accompanied by the implementation of programs to qualify the workforce, especially in developing countries, exposing rural communities to a set of still unknown risks, originated by the extensive use of a large number of hazardous chemical substances and aggravated by a series of social determinants (Peres et. al., 2001, p. 58).

However, it is not only pesticides that threaten the health of rural populations; Environmental disasters, such as dam failures and fires, also have a significant impact. Sampaio (2012, p. 85) points out that "[...] the history of environmental negligence in Brazil has led to avoidable tragedies, the consequences of which fall disproportionately on the most vulnerable populations." At the same time, Lehfeld, Carvalho, and Balbim (2013, p. 45) point out that "[...] The effects of environmental disasters are aggravated by the absence of effective mitigation measures and the fragility of social protection networks in rural areas."

[19] Brazil occupies the position of the world's largest consumer of pesticides, driven by the agro-export model and the expansion of agribusiness. The intensive use of these chemical inputs has generated environmental and public health concerns, especially due to the contamination of soil, water, and food. Studies indicate that the relaxation of legislation and the accelerated release of new pesticides aggravate this scenario, increasing the risks for rural workers and exposed populations. In addition, dependence on pesticides reinforces a production system based on monoculture and the degradation of natural resources, contrary to principles of sustainability and food security (Silva, 2020). See: Silva, J. P. *The impact of pesticide use in Brazil: Socio-environmental consequences and challenges for regulation*. University Press, 2020.

Revista ARACÊ
ISSN: 2358-2472

Nevertheless, water contamination emerges as another determining factor in the precariousness of the health of rural communities. Lopes (2020, p. 72) points out that "the deterioration of water quality due to the presence of toxic waste and heavy metals has caused a significant increase in waterborne diseases". In addition, Rosen (1994, p. 101) argues that "[...] the lack of access to safe drinking water sources compromises not only the health of populations, but also their productive capacity and quality of life."

> Environmental disasters, such as dam failures, have caused significant impacts on rural populations, directly affecting their livelihoods and compromising the quality of available water. In the case of the Brumadinho dam disaster[20], for example, contaminated mining tailings compromised the water supply of several riverside communities, affecting aquatic fauna and causing a cascade effect of environmental degradation. In addition, the impacts extend to food security and the health of the affected populations since prolonged exposure to heavy metals can lead to chronic diseases and other health complications (Pereira, Cruz & Guimarães, 2019, p. 130).

Thus, the present research seeks to investigate how exposure to pesticides, environmental disasters, and water contamination compromises the health and well-being of rural populations in light of the concept of environmental justice. According to Rigotto, Carneiro et al. (2021, p. 229), "[...] Environmental justice must be understood as the right of historically marginalized populations to a healthy and sustainable environment." In turn, Moura (2016, p. 88) argues that "[...] The violation of this right through environmental degradation configures a form of structural violence that needs to be faced with effective public policies".

For this, the research is based on a theoretical framework that ranges from classical studies to contemporary approaches to the theme. Sigaud (1979, p. 36) discusses how "[...] Labor relations in the countryside have always been marked by structural inequality that is reflected in precarious access to fundamental rights, such as health and environmental safety." Likewise, Bologna (1990, p. 54) points out that "[...] The expansion of the agricultural frontier, without adequate planning, has caused devastating environmental and social impacts".

[20] The Brumadinho dam disaster, which occurred on January 25, 2019, represents one of the greatest socio-environmental tragedies in Brazil's history, highlighting corporate negligence and the fragility of state enforcement. The rupture of the dam of the mining company Vale S.A. released millions of cubic meters of iron ore tailings, causing the death of 272 people, in addition to irreversible environmental impacts, such as the contamination of the Paraopeba River and the destruction of local biodiversity. The case exposed structural flaws in environmental licensing and the impunity of large companies in the mining sector, demonstrating the need for stricter regulation and effective reparation policies for affected communities (Ferreira & Santos, 2021). See: Ferreira, L. C., & Santos, R. P. *Disaster in Brumadinho: Socio-environmental impacts and challenges for environmental justice in Brazil*. Academic Press, 2021.

Revista ARACÊ
ISSN: 2358-2472

Thus, as this analysis deepens, it becomes evident that the relationship between environmental injustice and the health of rural populations cannot be neglected. Moura (2016, p. 143) warns that "[...] the State must adopt an active stance in the defense of the environmental rights of vulnerable populations". Therefore, Bombardi (2017, p. 265) reinforces that "[...] The advancement of agroecological practices and the implementation of environmental regulation policies are fundamental ways to mitigate the impacts of environmental degradation on public health".

> The concept of environmental injustice defines situations where the burden of environmental damage from development is generally concentrated where the most vulnerable and underprivileged populations live. [...] Environmental justice represents the conceptual framework necessary to bring together on the same stage the popular struggles for human rights, collective quality of life, and environmental sustainability (Martinez, 2006, p. 38).

Given this scenario, there is a need to understand more deeply how these factors interact and directly affect the lives of rural workers and rural communities. Environmental degradation, when consolidating itself as a structural phenomenon, requires an analytical and comprehensive approach that takes into account not only the physical impacts of exposure to contaminants but also the social and political dimensions of environmental injustice. Thus, the research seeks to answer the following guiding question: How does exposure to pesticides, environmental disasters, and water contamination compromise the health and well-being of rural populations in light of the concept of environmental justice?

Therefore, investigating the impacts of environmental degradation on the health of rural workers and rural communities is essential for the formulation of public policies that reduce the suffering of the neediest population and for the promotion of environmental justice. Ferreira, Serraglio, and Agostini (2013, p. 210) state that "[...] the transition to sustainable models of agricultural production cannot occur without a joint effort between the State, civil society and the productive sector". Similarly, Rigotto, Carneiro et al. (2021, p. 258) conclude that "[...] It is necessary to rethink the agricultural development model, prioritizing health and the environment as central elements for a fairer and more sustainable future."

Revista ARACÊ
ISSN: 2358-2472

QUALITATIVE, DESCRIPTIVE AND BIBLIOGRAPHIC RESEARCH: A COMPREHENSIVE ANALYSIS OF ENVIRONMENTAL POLICIES AND RURAL HEALTH

The qualitative research proved to be fundamental for the understanding of the problem studied since it allowed the detailed analysis of the documentary and bibliographic sources without the need to interact directly with research subjects. Minayo (2007) points out that "[...] qualitative research seeks an in-depth apprehension of social phenomena, considering their multiple dimensions and relationships" (p. 57). In this way, it was possible to analyze the complexity of the environmental and health impacts of the use of pesticides and water contamination in rural areas. According to Flick (2018), "[...] qualitative research does not aim at statistical generalizations, but rather at a broader understanding of the phenomena investigated from specific contexts" (p. 29). Thus, the methodology adopted favored an approach that allowed capturing nuances of the social and environmental reality addressed in the research.

> Qualitative research, by privileging the interpretation of social meanings, allows an in-depth reading of reality without the need for direct interaction with the researched subjects. Thus, by working with documentary and bibliographic sources, it is possible to construct critical analyses that reveal the complexity of the phenomena studied, including structural and historical aspects that influence the investigated issue (Minayo, 2007, p. 89).

In addition, the option for a descriptive and bibliographic research, as recommended by Gil (2008), made it possible to obtain a solid theoretical framework, essential for the critical analysis of the problem in question. According to the author, "[...] bibliographic research allows the survey of the available knowledge on a given topic, providing a comprehensive and grounded view of the subject" (p. 50). Thus, it was possible to establish a dialogue between different theoretical perspectives, contextualizing the environmental and social impacts of water contamination and the use of pesticides. In consonance, Stake (2011) stated that "[...] qualitative research strongly depends on the interpretation of the phenomena from the sources analyzed, allowing us to understand the meanings and social patterns that emerge from the data" (p. 22).

Research involving socio-environmental issues cannot always be conducted with direct access to research subjects, especially when it comes to an analysis of public policies and environmental legislation. Therefore, qualitative research with a descriptive approach proved to be an appropriate way to understand the interrelations between the environment, public policies, and rural health. According to Minayo (2007), "[...] qualitative

Revista ARACÊ
ISSN: 2358-2472

research is based on the interpretative analysis of documentary sources, seeking to unveil aspects that are not evident in quantitative approaches" (p. 63). In this way, it was possible to identify gaps in environmental and health policies aimed at rural populations. According to Gil (2008), "[...] descriptive research has as its main objective the characterization of a phenomenon, allowing a detailed and contextualized analysis" (p. 52).

> Qualitative research, when applied to the analysis of public policies and environmental legislation, allows the understanding of the structural factors that shape government decisions and their social consequences. By privileging documentary sources and the interpretation of normative discourses, this type of study contributes to the identification of gaps in environmental and health policies, revealing inequalities and challenges in the implementation of norms (Minayo, 2007, p. 102).

Now, the comprehensive analytical perspective, inspired by Weber, proved to be fundamental for the interpretation of the information collected, considering the power relations and economic interests involved in environmental policies. Weber (1949) argued that "[...] social science must seek to understand human actions from their meanings, inserted in historical and social contexts" (p. 88). Thus, the research sought not only to describe the environmental problem but also to critically analyze the structural factors that contribute to the degradation of water resources and the vulnerability of rural workers. According to Flick (2018), "[...] qualitative analysis allows us to understand social phenomena through the interpretation of the meanings attributed by the agents involved" (p. 33).

Nevertheless, the absence of a quantitative approach did not reduce the depth of the research but rather allowed a critical and interpretative look at the documents analyzed. Minayo (2007) pointed out that "[...] qualitative research values the subjectivity of social phenomena, allowing a richer and more contextualized understanding of the relationships studied" (p. 75). In this way, it was possible to explore the contradictions that exist in environmental public policies and in the protection of the health of rural workers. According to Stake (2011), "[...] qualitative research emphasizes the detailed study of specific contexts, providing a solid basis for the interpretation of the data collected" (p. 47).

However, documentary research, as a methodological strategy, allowed the collection of information from official sources, technical reports, scientific articles, and environmental legislation. According to Gil (2008), "[...] documentary research differs from bibliographic research by the use of materials that have not received analytical treatment,

Revista ARACÊ
ISSN: 2358-2472

being essential for the analysis of institutional policies and practices" (p. 60). This method allowed an in-depth look at the regulation of pesticide use and the inspection measures adopted in Brazil. Minayo (2007) reinforced that "[...] documentary research enables the historical reconstruction of the phenomena studied, allowing the identification of patterns and trends over time" (p. 80).

In addition, the combination of the qualitative approach with the comprehensive analysis ensured that the research was not limited to the description of the phenomena but also sought to interpret them from the power structures and socio-environmental inequalities. Weber (1949) highlighted that "[...] comprehensive analysis must consider not only the objective factors, but also the meanings attributed by the social agents" (p. 92). Thus, it was possible to identify how environmental legislation and public policies often reinforce the marginalization of rural workers instead of protecting them. According to Stake (2011), "[...] qualitative research allows us to capture the subjective aspects of social reality, often neglected by quantitative approaches" (p. 55).

> Qualitative research removed social research from the emphasis on explaining cause and effect and put it on the path of personal interpretation. Qualitative research is known for its emphasis on the holistic treatment of phenomena [...]. These two views are correlated with an expectation that phenomena are intrinsically related to many coinciding actions and that understanding them requires a broad change of contexts: temporal and spatial, historical, political, economic, cultural, social, and personal (Stake, 2011, p. 42).

Therefore, the research demonstrated that the adoption of a qualitative, descriptive, and bibliographic approach was essential for the understanding of the problem studied. Minayo (2007) highlighted that "[...] qualitative research is fundamental for the analysis of complex social phenomena, allowing a detailed look at the processes and their interconnections" (p. 85). The use of secondary sources enabled a comprehensive survey of the available information, evidencing the need for more effective public policies for environmental protection and rural health. According to Gil (2008), "[...] descriptive research provides a detailed portrait of the phenomenon studied, allowing the identification of patterns and trends" (p. 70).

Therefore, the methodological choice adopted allowed a critical and contextualized analysis of the environmental impacts and public policies related to the use of pesticides and water contamination. Weber (1949) stated that "the analysis of social phenomena must take into account the different interests at stake, considering the power relations that shape public policies" (p. 98). In this way, the research not only described the problem but also

Revista ARACÊ
ISSN: 2358-2472

contributed to the debate on environmental justice and the socio-environmental rights of rural populations. According to Flick (2018), "[...] qualitative research offers valuable tools for the interpretation of social dynamics, promoting a broader understanding of the phenomena studied" (p. 60).

ENVIRONMENTAL JUSTICE AND THE IMPACTS ON THE HEALTH OF RURAL WORKERS AND RURAL COMMUNITIES: PESTICIDES, ENVIRONMENTAL DISASTERS AND WATER CONTAMINATION

Environmental justice is a concept that emerges from the need for equality in the distribution of environmental benefits and risks, ensuring that no population is disproportionately affected by environmental degradation. In rural areas, this injustice is manifested in the unequal exposure of rural workers to pesticides, water pollution and environmental disasters. As Moreira et. al. (2015, p. 1698), "[...] the health of rural workers in Brazil is directly impacted by the lack of public policies aimed at reducing environmental risks and by inequality in access to health services". Similarly, Rigotto et. al. (2012, p. 1535) point out that "[...] Agribusiness workers are exposed daily to high volumes of multiple toxic agents to ensure the 'health of the fruits', but they do not have information about them".

> It can be said that there is a serious public health problem in the Northeast region[21] produced by extensive human exposure to pesticides, environmental contamination, particularly of water for human supply and consumption, and also food contamination. Today we are experiencing a situation of lack of sanitary control in relation to pesticides. This situation is mainly due to the absence of an effective environmental and health surveillance system, which includes the elements of information, education, inspection, guidance and technical assistance by the health, agriculture, labor and environmental agencies **(**Peres and Moreira, 2003, p. 58).

[21] The Northeast region of Brazil faces a serious public health problem due to widespread human exposure to pesticides, resulting from environmental and food contamination. The intensive use of these chemicals in modern agriculture, especially from the 1970s onwards with the implementation of the National Crop Protection Plan (PNDA), has aggravated the situation, particularly in the Northeast, due to the adverse socioeconomic and environmental conditions of the region. Studies reveal that continuous exposure to pesticides is associated with several health problems, such as cancer, congenital malformations, endocrine and neurological disorders. In addition, the contamination of water resources and food compromises the health of rural and urban populations, highlighting the need for effective public policies to monitor and reduce the use of these products. See: Augusto, L. G. S. (2012). Use of pesticides in the Brazilian semi-arid region. In F. Peres & J. C. Moreira (Orgs.), *Is it poison or is it medicine? Pesticides, health and environment* (pp. 59-74). Fiocruz Publishing. Available at: https://books.scielo.org/id/sg3mt/pdf/peres-9788575413173-05.pdf; Pignati, W. , Machado, J. , & Cabral, J. (2014). Amplified rural accident: the case of pesticide "rains" over the city of Lucas do Rio Verde - MT. *Brazilian Journal of Occupational Health*, 39(129), 68-75. Available at: https://www.scielo.br/j/rbso/a/4s9xWkK5n3Gd5t3m9Z5kG5D/?lang=pt; Oswaldo Cruz Foundation. (2019). Contamination of drinking water by pesticides in Brazil is the subject of a public hearing in the Chamber of Deputies. Available at: https://portal.fiocruz.br/noticia/contaminacao-da-agua-potavel-por-agrotoxico-no-brasil-e-tema-de-audiencia-publica-na-camara-dos.

Revista ARACÊ
ISSN: 2358-2472

In addition, land concentration and the agro-industrial development model intensify environmental inequalities, placing rural communities in a position of vulnerability. According to Abramovay (1998, p. 49), "[...] Family farming and territorial development must go hand in hand to ensure a sustainable and fair rural environment, avoiding the concentration of land and the marginalization of small properties." Likewise, Neves (1995, p. 21) states that "[...] The lack of effective public policies to support family farming aggravates socio-environmental inequalities, making rural populations more vulnerable."

However, chemical contamination associated with production processes is one of the most complex public and environmental health problems in the country. As Peres et al. (2005, p. 27) points out: "[...] Human and environmental contamination by pesticides represents a growing challenge for public health, requiring urgent mitigation and control measures". Likewise, Costa, Mello and Friedrich (2015, p. 891) point out that "[...] glyphosate and other pesticides widely used in Brazil have high carcinogenic potential, which reinforces the need for stricter regulation."

Nevertheless, rural populations face difficulties in accessing adequate health services, aggravating the impacts of environmental degradation on their quality of life. According to Camargo (2005, p. 42), "[...] Sustainable development must consider not only the preservation of natural resources, but also social inclusion and equity in access to the benefits generated." In turn, Alves and Lopes (1995, p. 15) warn that "[...] the impoverishment of Brazilian agriculture has contributed to social exclusion and to the precariousness of the living conditions of rural workers". Menegat and Fontana (2010, p. 52) warn,

> [...] for the need for public policies to promote the health of rural workers, since they are exposed and vulnerable to illness due to inadequate working conditions. From this perspective, the authors argue that it is necessary to know the rural environment, people's living conditions, health and work, seeking to make them protagonists of the production of individual, collective and environmental health, thus creating sustainable and healthy environments.

Thus, as the process of agricultural modernization advances, the negative impacts on rural workers intensify. As Martins and Ferreira (2015, p. 125) state, "[...] working conditions in the countryside are still marked by exhausting working hours, intense physical exertion and lack of access to social protection policies". In addition, Schneider (1999, p.

Revista ARACÊ
ISSN: 2358-2472

67) points out that "[...] industrial decentralization and pluriactivity[22] are strategies that could minimize the impacts of the precariousness of rural work."

Therefore, the contamination of water resources represents one of the main challenges for the health of rural communities. According to Lima et. al. (2017, p. 1366), "[...] The contamination of breast milk by glyphosate highlights the magnitude of exposure to pesticides and its impacts on the health of rural populations". In consonance, Viero et. al. (2016, p. 99) highlight that "[...] The indiscriminate use of pesticides has transformed agricultural areas into true environmental and health risk zones."

> The global process of exposure in the agricultural environment oscillates with periods of greater and lesser exposure, but it is continuous, and, considering maternal exposure, infant exposures begin in intrauterine life, with the passage of most of these compounds through the placenta and, after birth, through breast milk during breastfeeding. The excretion of organochlorines in milk is an important means of reducing the maternal body load and, during breastfeeding, the transfer of these compounds to the child occurs. Milk contamination attracts special attention, mainly because of the importance that milk represents as the only source of food for the newborn, who consumes it in proportionally high quantities (Peres & Moreira, 2003, p. 58).

To mitigate these inequalities, public policies must be formulated in a way that ensures greater equality in access to basic rights. According to Carneiro et. al. (2015, p. 311), "[...] the Abrasco dossier[23] reinforces that the impacts of pesticides on health are a public health problem and must be treated urgently". In addition, Pinto, Murofuse and

[22] Industrial decentralization and pluriactivity emerge as fundamental strategies to mitigate the impacts of the precariousness of rural work, promoting greater economic diversification and reducing the exclusive dependence on agriculture. Industrial decentralization enables the creation of non-agricultural jobs in rural areas, contributing to the settlement of the population in the countryside and reducing the rural exodus. At the same time, pluriactivity – which combines agricultural and non-agricultural activities – provides a more stable source of income and expands the opportunities for productive insertion of rural workers. These strategies can reduce the socioeconomic vulnerability of rural families, promoting better working conditions and reducing the exploitation characteristic of agribusiness production chains (Graziano da Silva, 2018). See: Graziano da Silva, J. *The Future of Family Farming in Latin America and the Caribbean: The Role of Pluriactivity and Economic Diversification*. Food and Agriculture Organization of the United Nations (FAO), 2018.

[23] The *Abrasco Dossier: An Alert on the Impacts of Pesticides on Health* is a reference document prepared by the Brazilian Association of Collective Health (Abrasco), which gathers scientific evidence on the socio-environmental and health risks of the intensive use of pesticides in Brazil. The dossier denounces the relaxation of Brazilian legislation on these products, the encouragement of the agribusiness model and the contamination of food, water and soil, resulting in serious public health problems, such as cancer, endocrine disorders, congenital malformations and acute and chronic poisoning. In addition, the document highlights the disproportionate impacts on vulnerable populations, such as rural workers, indigenous people, and traditional communities, reinforcing the need for public policies to reduce the use of these substances and strengthen sustainable agroecological models (Abrasco, 2015). See: Brazilian Association of Collective Health. *Abrasco Dossier: A warning about the impacts of pesticides on health*. Joaquim Venâncio Polytechnic School of Health (EPSJV) and Popular Expression. Available at: https://www.abrasco.org.br/dossieagrotoxicos, 2015.

Revista ARACÊ
ISSN: 2358-2472

Carvalho (2015, p. 237) state that "[...] work processes in agriculture must be rethought in light of new findings on the health impacts of pesticides."

Thus, it is essential to create and implement effective environmental policies that consider the specificities of the rural environment and promote environmental justice. As Lima and Silva (2018, p. 94) point out, "[...] The development of public policies that prioritize popular participation and the strengthening of traditional communities is essential to ensure sustainability and equity in access to natural resources". In line with this perspective, Alves and Costa (2020, p. 187) state that "[...] environmental justice must be seen as a fundamental right, and its implementation depends on the articulation between the State, civil society and productive sectors to reduce inequalities and ensure environmental protection".

> Socio-environmentalism was built on the idea that environmental public policies should include and involve local communities in environmental management knowledge and practices. More than that, it was developed with the conception that, in a poor country with so many social inequalities, a new development paradigm should promote not only environmental sustainability – that is, the sustainability of species, ecosystems and ecological processes – but also social sustainability – that is, it should also contribute to the reduction of poverty and social inequalities and promote values such as social justice and equity (Santilli, 2005, p. 213).

That said, the impacts of pesticides on the health of rural workers represent one of the main challenges for public health in Brazil. The relationship between the agro-industrial model and the growing exposure to these chemicals has resulted in serious health problems, compromising the quality of life of rural populations. As pointed out by Rigotto et. al. (2012, p. 1533), "[...] the State has been significantly effective in supporting agribusiness and significantly ineffective in social policies to guarantee the rights of workers and the population". In addition, daily exposure to these chemical compounds can lead to acute and chronic poisoning, as highlighted by Moreira et. al. (2002, p. 299), "[...] The integrated assessment of the impact of pesticide use on human health in a farming community demonstrated high rates of contamination in directly exposed workers."

The history of pesticide use in Brazil reveals a trajectory of intense chemical dependence in the agricultural sector. Since the 1970s, the country has adopted an agro-industrial model strongly based on the use of pesticides, becoming one of the world's largest consumers of these substances. According to Carneiro et. al. (2015, p. 891), "[...] The impacts of pesticides on human health are still alarming, especially among rural workers and food consumers." In addition, Costa, Mello and Friedrich (2015, p. 891)

Revista ARACÊ
ISSN: 2358-2472

indicate that "[...] The presence of chemical residues in soil and water affects not only rural workers, but the entire food chain, including urban communities that consume these products."

> In the 1960s, pesticides began to be widely disseminated as a fundamental part of modern agriculture, supporting the Brazilian 'green revolution' [...]. After the initial phase, between the 60s and 70s, of official incentives for the expansion of the use of pesticides in agriculture, the country began to experience the health effects resulting from this use, as attested by the precarious statistics of the existing toxicological assistance centers in some states (Moreira et. al., 2002, p. 299).

The main health problems associated with chronic and acute exposure to pesticides include poisoning, neurological disorders, respiratory diseases, and cancer. As described by Sena, Dourado and Antoniolli (2017, p. 56), "[...] the lack of access to PPE and the low supervision of the correct use of this equipment aggravate the vulnerability of workers in the face of chemical risks". In addition, we endorse what Lima et. al. (2017, p. 1366): "[...] The contamination of breast milk by glyphosate highlights the magnitude of exposure to pesticides and its impacts on the health of rural populations".

That said, case studies demonstrate the devastating effects of pesticide contamination in several regions of the country. In the state of Paraná, research indicates that farming communities face high rates of endocrine and respiratory diseases due to aerial pesticide spraying. According to Neves et. al. (2015, p. 67), "[...] The constant inhalation of chemical particles dispersed in the work environment directly impacts the quality of life of workers and their families". In the Northeast, research reveals a worrying relationship between pesticides and congenital malformations. As Aguiar (2017, p. 88) points out, "[...] Maternal exposure to pesticides during pregnancy has been associated with increased cases of precocious puberty and abnormal organ development in neonates."

Thus, occupational exposure to pesticides occurs mainly during the improper handling, application and disposal of these products, which aggravates the risks of poisoning. According to Moreira et. al. (2002, p. 37), "[...] The 'occupational route' is responsible for more than 80% of cases of pesticide poisoning, due to the intensity and frequency of contact between workers and these substances". In addition, studies show that working conditions in rural areas often do not include the adequate supply of personal protective equipment (PPE), as pointed out by Carneiro et. al. (2015, p. 891), "[...] the

Revista ARACÊ
ISSN: 2358-2472

absence of inspection policies and the precariousness of working conditions amplify the impacts of exposure to pesticides on rural workers."

> Other productions focused on the use of 'Personal Protective Equipment' (PPE). These studies showed PPE use rates below what was expected in many contexts – either due to inappropriate use or absence of any item – despite the fact that workers were aware of their importance as safety instruments. Petarli et. al. stated that even the process of putting on and removing the equipment proved to be problematic for a considerable portion of the rural workers surveyed, thus intensifying exposure to risks and creating vulnerabilities (Petarli et. al., 2019, p. 15).

In addition to the damage to human health, the environmental impacts of the indiscriminate use of pesticides are alarming. According to Augusto, Florêncio and Carneiro (2001, p. 210), "[...] The continuous use of pesticides has caused soil degradation and contamination of water resources, reducing agricultural fertility and increasing the risks of chemical pollution in the food chain". In addition, studies indicate that the improper disposal of packaging and chemical waste contributes significantly to the dissemination of toxic substances in the environment, as highlighted by Peres et. al. (2003, p. 72), "[...] The absence of effective agricultural waste management policies has led to the contamination of groundwater and rivers, harming communities that depend on these water sources for consumption."

Thus, chronic exposure to pesticides constitutes one of the greatest health and environmental challenges in the country. The implementation of effective public policies, coupled with sustainable agricultural practices, is essential to ensure the safety and health of rural workers. As Lima and Silva (2018, p. 94) point out, "[...] The development of public policies that prioritize popular participation and the strengthening of traditional communities is essential to ensure sustainability and equality in access to natural resources". Therefore, it is essential that civil society, government agencies, and academia work together to reverse this situation and promote a healthier and more sustainable environment for future generations.

Added to this, environmental disasters represent one of the most serious threats to the health and quality of life of rural populations. Events such as dam failures, fires and industrial waste spills directly affect field workers, exposing them to contamination and compromising their livelihoods. According to Paz and Ribeiro (2019, p. 136), "[...] The environmental impacts that occurred in the region are irreparable, evidencing the search

Revista ARACÊ
ISSN: 2358-2472

for civil liability in the face of the damage caused to the population and the environment". In addition, Freitas, Porto and Machado (2000, p. 345) point out that,

> [...] the occupational-environmental tragedies of Mariana (2015) and Brumadinho (2019) culminated in waves of effluents and ore sediments that advanced in an impactful way on the workers while they worked, as well as towards the adjacent communities and the surrounding biomes and other locations, immediately claiming the lives of about 300 people.

The precariousness of the environmental security infrastructure has been a determining factor in the occurrence of these disasters. Studies show that negligence in inspection and lack of maintenance of dams make these projects highly vulnerable to collapses. According to Cardozo, Pimenta and Zingano (2016, p. 118), "[...] The tailings dams of mining companies need to be monitored and inspected by public agencies due to compliance with existing standards to guarantee environmental preservation, as well as due to the protection of the population that surrounds the region". In addition, Carvalho (2015, p. 118) points out that,

> [...] the Brumadinho disaster, as reported by the media, triggered the reflection carried out in this study, due to the problem related to the damage caused to the environment and nature, striving for the understanding of civil liability that must be investigated in search of compliance with the law, in judging the culprits in the face of the damage caused.

In addition to dam failures, frequent fires in Brazil represent a major health and environmental risk for rural populations. These fires, often caused by the uncontrolled advance of agriculture, generate the destruction of biodiversity and the release of toxic pollutants into the air. According to Lima et. al. (2015, p. 349), "[...] The little attention to the internal inspection and precautionary measures necessary to avoid new labor-environmental tragedies can lead to unwanted environmental injustice, with irreversible loss of quality of life, since the environmental, social and economic impacts resulting from expanded occupational accidents are multiple and propagate in time and space". In addition, López-Aliaga, Padilha, and Leivas (2022, p. 349) argue that "[...] the absence of daily monitoring of the health conditions of workers and populations exposed to the effects

Revista ARACÊ
ISSN: 2358-2472

of fires reveals a structural flaw in the process of inspection and protection[24] of these communities".

The spillage of industrial waste in agricultural areas, in turn, has been another source of contamination and illness. Chemical waste dumped unchecked can seep into the soil and groundwater, affecting the quality of water resources used by rural communities. As Botelho, Faria, Mayr and Oliveira (2021, p. 345) point out, "[...] The concept of structural violence can be adopted to give visibility to a form of suffering caused by the polluting enterprise and by the absence of state[25] inspection, harming both rural workers and the local population". Lima, Diniz, Rocha and Campos (2015, p. 349) point out that "[...] Under the power relations that prevail in companies, the right to refuse to work in situations of imminent risk is a legal fantasy".

> The main contaminants of agricultural origin are fertilizer residues and pesticides. These products, when applied to crop fields, can reach water bodies directly, through rainwater and irrigation, or indirectly, through percolation in the soil, reaching the groundwater. Another form of indirect contamination occurs with the spraying of pesticides, which can be transported by aerial currents and settle in the soil and water, far from the areas where they were originally used. Atmospheric transport also occurs by volatilization of compounds applied to crops and by the formation of dust from contaminated soil (Peres & Moreira, 2021, p. 7).

The impact of these disasters on the health of rural populations is profound and long-lasting. In addition to the immediate physical effects, such as poisoning and respiratory diseases, there are also psychological and social implications that extend for

[24] The exposure of populations to the harmful effects of fires shows a structural flaw in the processes of inspection and environmental protection in Brazil. Between 2019 and 2020, the country recorded significant increases in fire outbreaks, especially in the Amazon and the Pantanal, resulting in serious public health consequences, such as an increase in respiratory diseases, and socioeconomic impacts, including displacements of indigenous and riverine communities. These events underscore the urgent need to strengthen environmental enforcement policies and implement effective preventive measures to protect vulnerable populations and threatened ecosystems. See: Brazilian Association of Collective Health. *Abrasco Dossier: A warning about the impacts of pesticides on health*. Joaquim Venâncio Polytechnic School of Health (EPSJV) and Popular Expression. Available at: https://www.abrasco.org.br/dossieagrotoxicos, 2019.

[25] Structural violence is manifested in the State's omission in the inspection of polluting enterprises, resulting in severe impacts on both rural workers and local populations. This type of violence is not expressed directly, but is perpetuated through environmental degradation, the precariousness of living conditions, and the denial of basic rights, such as access to drinking water and a healthy environment. Relating this problem to Achille Mbembe's (2019) concept of necropolitics, it can be argued that the absence of environmental regulation and inspection by the State configures a mechanism for managing death, in which certain populations – especially the most vulnerable – are exposed to continuous risks, without institutional protection. Thus, the lack of control over the socio-environmental impacts of agrochemical industries and activities not only compromises the health and well-being of these communities, but also reinforces a system of exclusion and marginalization that determines who has the right to live and who is subject to slow death from poisoning and environmental contamination. See: Mbembe, A. *Necropolitics*. N-1 Editions, 2019.

Revista ARACÊ
ISSN: 2358-2472

years. According to Freitas, Porto and Machado (2000, p. 345), "[...] Uncertainties regarding the effects on health and the environment can cause social and psychological impacts on workers and exposed peripheral populations, leaving them under severe psychological pressure, promoting trauma, insecurity and social instability". In addition, Costa (2016, p. 76) points out that "[...] health is interconnected with the ecologically balanced environment, which in turn is directly linked to the right to human and non-human life".

And water contamination has become one of the main challenges of global public health, directly impacting vulnerable communities. As the data show, water pollution is largely due to the lack of control over industrial and agricultural discharges. "The causes for this problem include the costs necessary for water treatment, which increase progressively about the level of pollution of the source, and for the expansion of supply and sewage networks, as well as the reduction in the volume of water available due to climatic variations" (Melo, 2012, p. 4). In addition, the compromise of water quality leads to the proliferation of diseases, especially in communities that depend on natural sources without adequate treatment. "Basic sanitation is defined as one of the determining factors for health promotion. In many moments, it appears with a central role in public health policy" (Brasil, 1990).

> Environmental contamination as well as damage to the health of rural populations are testimonies of the entire historical process of unsustainability of Brazilian rural development. In the semi-arid region, environmental contamination is aggravated by the scarcity of water resources, the practice of reserving surface water (dams) and the lack of an adequate policy for access to and control of the quality of water for human consumption and production, which threaten the few water sources available in these regions. Although there is sufficient evidence of contamination of the dams, with consequent compromise of the quality of the waters, these situations are still not properly assessed, especially the impacts on health, the environment and biodiversity (Graziano Neto, 1982, p. 12).

But water is not just a vital natural resource, but a fundamental human right. The United Nations (UN) recognizes that "[...] despite progress over the past 15 years, the right to safe and clean drinking water and sanitation is inaccessible to a large part of the world's population" (UN, 2019). This right is often violated in regions where water contamination persists, depriving entire populations of a good essential to life. "Access to drinking water and basic sanitation is a fundamental human right, indispensable to life with dignity and recognized by the UN" (Guedes & Costa, 2019, p. 165).

Revista ARACÊ
ISSN: 2358-2472

However, the contamination of rivers and aquifers further compromises this right, restricting access to drinking water. The pollution of water sources is a reality that affects both urban and rural areas. "If an agricultural region, where a large quantity or variety of pesticides is used extensively, is located near a water source that supplies a city, the quality of the water consumed there will be seriously at risk of contamination" (WRI, 1999). As a result, the population that consumes this water can suffer a series of health complications, including poisoning and chronic diseases associated with chemical compounds.

Not only agricultural waste, but also industrial waste contributes significantly to the degradation of water quality. "The market takes advantage of the void left by the State in the guarantee of basic rights, to legitimize the damage caused and offers as a favor what should be provided by political entities" (Acselrad, 2015, p. 107). In this way, the omission of the public authorities allows the exploitation of water resources to occur without adequate supervision, perpetuating environmental injustices that mainly affect impoverished communities. According to Jacobi & Besen (2011):

> The lack of management and proper disposal of solid waste causes impacts beyond environmental ones. The consequence of this is the illness of the population due to soil degradation, compromise of water bodies and springs, intensification of floods, contribution to air pollution. Therefore, the proper management of this waste is a preponderant factor for the improvement of the environment and the health of the population (p. 164).

In addition, the main sources of water pollution in rural areas include not only the indiscriminate use of pesticides, but also the lack of infrastructure for the treatment of effluents. "The contamination of dams with agricultural inputs, whether pesticides or chemical fertilizers, compromises the quality of water and threatens biodiversity" (Graziano Neto, 1982). In the Brazilian semi-arid region, for example, where water resources are scarce, the pollution of water sources has even more severe consequences for the population.

Despite this, strategies to protect water resources can be implemented with effective policies and investments in basic sanitation. "The expansion of the population served with treated water has been fundamental to reduce morbidity and mortality due to waterborne diseases, such as cholera, schistosomiasis, diarrhea and hepatitis" (Funasa, 2001). The implementation of public policies that ensure adequate water treatment and control of the

Revista ARACÊ
ISSN: 2358-2472

use of contaminating substances are essential measures for the preservation of the quality of water resources.

> The waters of the dams in the semi-arid Northeast are used, without any prior treatment, for various purposes: urban supply, local consumption, animal watering, irrigation, leisure and to meet primary needs, such as bathing, washing clothes and other domestic activities. Intensive applications of pesticides and fertilizers in arable soils, together with intense rainfall, concentrated at some times of the year, or by irrigation, cause strong surface runoff, thus contaminating available water resources. Agriculture in the Northeast is absolutely chemical-dependent, using fertilizers and pesticides as if they were the only possible production technologies. Experiences of technological reconversion to a model of sustainable agriculture are still incipient (Graziano Neto, 1982, p. 12).

Nevertheless, industries and agribusinesses must be held accountable in relation to water contamination. Environmental legislation provides guidelines for the protection of waters, but these standards are often not applied efficiently. "The improvement of housing conditions and basic sanitation is the responsibility of all entities of the Federation" (CF/1988). Without strict inspection, the environmental impact continues to grow, compromising the quality of life of future generations.

> If we take, for example, activities such as mining and steelmaking, it can be said that they are extremely predatory of the environment, including the degradation of the soil (removal of ore), water (mining tailings), air (gas production) and the entire ecosystem, altered by human activity. It is an activity that causes significant environmental degradation, being subject to the need for a prior environmental impact study and also to the need to recover the degraded environment. […] Furthermore, the Constitution imposes on the Government and the community the duty to defend and preserve the environment. […] The State should not take care of the environment in isolation, since only with the cooperation of the social body can the task of preservation be efficiently carried out (Beltrão, 2014, p. 67).

Therefore, the protection of water resources is a matter of environmental and social justice. "The right to an ecologically balanced environment is configured as a fundamental right of the human person" (STF, 1995). As the water crisis worsens, a more sustainable and balanced approach to ensure that everyone has access to safe drinking water, regardless of their socio-economic status, becomes urgent.

That said, in addition to regulatory measures, it is essential to promote sustainable water use practices, especially in agricultural regions where overexploitation of water resources can compromise its future availability. Integrated water resources management must consider the preservation of aquatic ecosystems, ensuring that the withdrawal of water from aquifers does not exceed their natural recharge capacity. "The balance between

Revista ARACÊ
ISSN: 2358-2472

exploitation and preservation of natural resources requires effective public policies, capable of integrating actions for the conservation and rational use of water, involving different actors in society" (Mendes & Carvalho, 2018, p. 254). That said, when preventive measures are not adopted, the impact of environmental degradation can become irreversible, resulting in the desertification of productive areas and the scarcity of drinking water for human consumption. "The relationship between access to water and quality of life is inseparable, since the deprivation of this resource compromises public health, food security, and the socioeconomic development of entire communities" (Silva, 2020, p. 311). Thus, the adoption of efficient technologies, such as low-impact irrigation systems, rainwater harvesting, and proper effluent treatment, can contribute to reducing environmental damage and ensuring water sustainability.

> The environment, or ecosystem in which we live, is constantly varying and transforming due to man's direct action on it, both by development and poverty. Human intervention in the environment has brought and continues to bring serious consequences that become evident at different scales, becoming a paradox to sustainable development. The intensity of this human intervention on the ecosystem is such that the destruction of resources often exceeds their capacity to recover, and the growing demand for non-renewable resources is one of the most flagrant examples today (Miguel & Flores, 2013, p. 40).

Therefore, to ensure safe access to water, it is essential that civil society actively participate in decision-making processes related to water resources management. The democratization of access to environmental information strengthens social mobilization and allows communities affected by pollution to demand effective measures for the protection of water sources. "Transparency in the management of water resources and the inclusion of the population in decisions are fundamental for the effectiveness of environmental policies and for the prevention of socio-environmental conflicts" (Pacheco & Almeida, 2017, p. 189). When local populations have an active voice, the chances of implementing innovative solutions that consider the particularities of each territory increase. "Water governance must be conducted in a participatory and decentralized manner, respecting local dynamics and ensuring that all segments of society have their rights guaranteed" (Freitas, 2021, p. 203). In this way, it is possible to move towards a sustainable development model that not only ensures the protection of water resources but also promotes environmental justice and dignity for all people.

Given this scenario, the evaluation of public policies for environmental protection and public health in Brazil reveals a scenario of advances and challenges. The State has

Revista ARACÊ
ISSN: 2358-2472

promoted regulatory actions, but many of these measures fail to fully achieve their objectives due to gaps in implementation and enforcement. "The State has been significantly effective in supporting agribusiness and significantly ineffective in social policies to guarantee the rights of workers and the population" (Rigotto, 2011, p. 445). In addition, policies to combat environmental contamination often do not follow the dynamics of degradation imposed by the economic development model. "The recognized socio-environmental complexity of Brazil, associated with population and institutional vulnerabilities, has been favoring the indiscriminate use of natural resources and their contamination" (Freitas et al, 2002, p. 256).

> In developing countries like Brazil, the issues related to vulnerability at this point are extreme. Situations of environmental precariousness, triggered by the pollution of water resources, deforestation, the loss of genetic banks of species of flora and fauna, erosion, soil contamination, misery, social exclusion, and the loss of cultural identity end up determining subhuman conditions of life, in which, many times, the human being himself is the destructive agent of an already exhausted environment. Allied to these issues are the policy itself, the lack and misdirection of funds for research, for environmental monitoring and control, assumed by institutions that need equipment, reagents and trained technical staff, which, in the matter of pesticides, forms an immense gap in knowledge, the almost total absence of data on the real situation of contamination in our country (Leff, 2002, p. 134).

Epidemiological surveillance and medical care also play a crucial role in reducing environmental impacts on rural health. The lack of systematic monitoring of the conditions of exposure to toxic agents and the absence of specific care protocols for affected populations are constant challenges. "One of the main attributions of epidemiological surveillance[26] is the monitoring of a set of diseases and conditions, which require rapid information for the triggering of control actions" (Brasil, 1990). However, the fragmentation of health surveillance among different agencies hinders the effectiveness of interventions. "The absence of integrated action between government sectors and also with civil society

[26] Epidemiological surveillance is an essential instrument for public health, as it allows for the early detection, monitoring, and prevention of diseases, contributing to the formulation of effective health policies. Its main objective is to provide accurate and continuous information on the occurrence of health problems, enabling the adoption of measures to control and mitigate risks to the population. In Brazil, this surveillance is structured based on the National Health Surveillance System (SNVS), which integrates different levels of government for the notification, analysis, and response to epidemiological outbreaks. In addition to identifying communicable diseases, epidemiological surveillance is also essential to monitor problems related to environmental and occupational factors, such as exposure to pesticides and pollution. In this way, its role goes beyond simple observation, becoming a strategic mechanism for intervention and protection of collective health (Teixeira et. al., 2021). See: Teixeira, M. G., Costa, M. C. N., Carmo, E. H., Oliveira, W. K., & Penna, G. O. *Epidemiology and health surveillance: Challenges and perspectives for Brazil*. Fiocruz Publishing, 2021.

Revista ARACÊ
ISSN: 2358-2472

is one of the factors that compromise the effectiveness of environmental surveillance" (São Paulo, 2000, n.n.).

However, the need for stricter regulation and effective enforcement of the use of pesticides and polluting industrial activities is still a challenge. Brazil has one of the highest rates of pesticide consumption in the world, which impacts not only the environment but also public health. "The regulation of Law No. 7,802, of July 11, 1989[27], began to require the evaluation and classification of the potential for environmental hazard of pesticides" (Brasil, 1989). Despite this legislation, inspection remains inefficient, and many substances banned in other countries are still widely used in Brazilian territory. "The environmental assessment of pesticides is based on documentation provided by the companies interested in the registration, which compromises the impartiality of the analyses" (Ibama, 1997, n.d.).

> The wide use of these products, the lack of knowledge of the risks associated with their use, the consequent disrespect for basic safety standards, free commercialization, the great commercial pressure on the part of distribution and production companies and the social problems found in rural areas are important causes that lead to the worsening of the human and environmental contamination observed in Brazil. To these factors can be added the deficient technical assistance to rural people, the difficulty of monitoring compliance with the laws and the blaming of workers as contributors to the consolidation of the impact on human health, resulting from the use of pesticides, as one of the major public health problems in rural areas (Pimentel, 1996; Peres, 1999; Oliveira-Silva, Meyer & Moreira, 2000, p. 125).

Not only inadequate inspection, but also the lack of sustainable alternatives in agriculture contributes to the perpetuation of this predatory model. Conventional agriculture relies on chemical inputs that degrade soil and contaminate water resources, making it increasingly unsustainable. "Changing this model requires a productive restructuring that must be supported by integrated public policies" (Augusto, Florêncio & Carneiro, 2001, p. 217). However, agroecological initiatives still face resistance from large producers and from the national agricultural policy itself, which favors intensive practices and monocultures.

[27] Law No. 7,802, of July 11, 1989, regulates the production, commercialization, use, and inspection of pesticides in Brazil, establishing guidelines to minimize the environmental and public health impacts resulting from the use of these substances. The legislation provides that pesticides must be analyzed and registered by federal agencies responsible for the health, environment and agriculture sectors, seeking to ensure safety standards. However, despite its importance, the application of the law has been the target of criticism due to the flexibility in the release of new chemicals and the insufficiency of effective inspection, which favors the contamination of soil, water and food. With the advance of agribusiness, legislation faces challenges in its implementation, being frequently revised to meet economic interests to the detriment of environmental precaution and public health (Brasil, 1989). See: Brazil. *Law No. 7,802, of July 11, 1989. Provides for the use, production and control of pesticides, their components and the like, and provides for other provisions*. Official Gazette of the Union. Available at: http://www.planalto.gov.br/ccivil_03/leis/l7802.htm, 1989.

Revista ARACÊ
ISSN: 2358-2472

However, agroecological production models emerge as a path to greater environmental and social balance. Agroecology, in theory, allows for sustainable food production without compromising ecosystems, promoting practices that respect natural cycles and value the traditional knowledge of farmers. "The Agroecology perspective values the local and empirical knowledge of farmers, promoting the socialization of this knowledge and its application to the common goal of sustainability" (Rigotto et. al., 2011, p. 1539). This approach not only protects the environment but also promotes food sovereignty and social justice. For Gliessman (2000, p. 215), "[...] The transition to agroecology requires structural changes in agricultural policies, but also the strengthening of support networks for family farmers."

Thus, the implementation of public policies aimed at encouraging sustainable agriculture can contribute significantly to the reduction of environmental impacts and the protection of public health, according to Santos, et. al. (2024). It is essential that there are investments in the training of small producers, in the development of alternative techniques and in the creation of markets that value agroecological products. For Miranda (2012): "[...] the development of an emancipatory science must consider the impacts of the current development model on health and the environment to pave the way for more sustainable alternatives" (p. 284). In this sense, policies to encourage agroecology can represent an important advance in the construction of a fairer and more balanced production model.

Therefore, environmental governance must prioritize the transition to a sustainable model, ensuring that legislation and public policies are aligned with the needs of populations affected by environmental degradation. Colombo states that (2004) "[...] the absence of robust regulation and efficient inspection compromises environmental preservation and perpetuates the cycle of degradation" (p. 67). Thus, the adoption of a stricter regulatory framework and the active participation of civil society is essential to ensure sustainability and environmental justice in Brazil.

> Environmental justice cannot be dissociated from social justice, as environmental impacts disproportionately affect the most vulnerable populations. Historically marginalized groups, such as indigenous communities, quilombolas, and low-income populations, suffer the greatest impacts from environmental degradation and climate change. Thus, public policies aimed at sustainability must guarantee the participation of these groups in decision-making processes, ensuring that environmental benefits are distributed equitably (Leff, 2010, p. 45).

Revista ARACÊ
ISSN: 2358-2472

CONCLUSION

Therefore, the environmental degradation resulting from the intensification of the agro-industrial model has generated profound impacts on the health of rural workers and rural communities, expanding socio-environmental inequalities and exposing these populations to severe health risks. The indiscriminate use of pesticides, water contamination and recurrent environmental disasters are not isolated phenomena, but rather expressions of an economic system that prioritizes productivity to the detriment of life and sustainability. Although there are laws and regulations for environmental protection, the relaxation of regulations and the absence of effective inspection perpetuate a scenario of environmental injustice, in which vulnerable populations pay the price of agribusiness expansion.

However, the research shows that environmental injustice is not only manifested in the degradation of ecosystems, but also in the precariousness of working conditions and the denial of basic rights, such as access to health and a balanced environment. The invisibility of occupational diseases and the neglect of the health of rural workers reinforce a pattern of historical exclusion, in which contamination by toxic substances is treated as a "side effect" of economic progress. Nevertheless, the absence of effective public policies and the lack of specialized assistance deepen the impacts of these exposures, making the vulnerability of these communities a structural problem.

Even so, alternatives such as the transition to agroecology, the strengthening of epidemiological surveillance, and the decentralization of economic activity can contribute to mitigating the effects of environmental degradation on public health. Sustainable production models and stricter environmental regulation policies are essential to reverse this situation, ensuring not only the protection of ecosystems, but also the dignity of workers and affected populations. In addition, holding polluting industries accountable and expanding social participation in decision-making processes can play a crucial role in the pursuit of environmental justice.

Thus, the results of the research point to the need for a new development paradigm, in which sustainability and equity are fundamental pillars in the formulation of public policies. As long as the hegemonic model continues to prioritize profit over life, environmental injustice will remain an obstacle to the full realization of human rights. Therefore, there must be a collective mobilization to face this reality and build viable

Revista ARACÊ
ISSN: 2358-2472

alternatives that ensure a fairer and more sustainable future for rural communities and the environment as a whole.

Revista ARACÊ
ISSN: 2358-2472

REFERENCES

1. Abramovay, R. (1998). *Family farming and sustainable territorial development: Theoretical problems and research challenges*. São Paulo, Brasil: Editora UNESP.

2. Abrasco – Associação Brasileira de Saúde Coletiva. (2015). *Dossiê Abrasco: Um alerta sobre os impactos dos agrotóxicos na saúde*. Rio de Janeiro, Brasil: Escola Politécnica de Saúde Joaquim Venâncio (EPSJV) e Expressão Popular. Recuperado de https://www.abrasco.org.br/dossieagrotoxicos

3. Aguiar, J. C. (2017). *Impacts of pesticides on maternal and child health in Brazil: An epidemiological analysis*. Brasília, Brasil: University Press.

4. Alves, M., & Costa, R. (2020). *Environmental justice and sustainable development: Challenges and perspectives*. Rio de Janeiro, Brasil: Fiocruz.

5. Augusto, L. G. S. (2012). Use of pesticides in the Brazilian semi-arid region. In F. Peres & J. C. Moreira (Eds.), *Is it poison or is it medicine? Pesticides, health and environment* (pp. XX-XX). Rio de Janeiro, Brasil: Editora Fiocruz.

6. Beltrão, R. (2014). *The environment in the Federal Constitution of 1988: Protection and sustainability*. Brasília, Brasil: Senado Federal.

7. Bombardi, L. M. (2017). *Geography of pesticide use in Brazil and connections with the European Union*. São Paulo, Brasil: FFLCH/USP.

8. Bologna, S. (1990). *Trabalho e meio ambiente: Os desafios do século XXI*. São Paulo, Brasil: Cortez Editora.

9. Brasil. (1989). *Lei nº 7.802, de 11 de julho de 1989. Dispõe sobre o uso, produção e controle de agrotóxicos, seus componentes e afins, e dá outras providências*. Diário Oficial da União. Recuperado de http://www.planalto.gov.br/ccivil_03/leis/l7802.htm

10. Camargo, A. (2005). *Sustainable development and social equity in Brazil*. São Paulo, Brasil: Annablume.

11. Carneiro, F. F., et al. (2015). *The impacts of pesticides on health in Brazil: An emerging public health problem*. São Paulo, Brasil: Abrasco.

12. Carvalho, R. (2015). *Brumadinho disaster: Environmental impacts and the civil liability of mining companies*. Belo Horizonte, Brasil: Editora Jurídica.

13. Costa, R. (2016). *Health and environment: Connections between public policies and sustainability*. Curitiba, Brasil: Editora UFPR.

14. Costa, S., Mello, F., & Friedrich, K. (2015). *Glyphosate and human health: A critical review of the scientific literature*. São Paulo, Brasil: Editora Hucitec.

Revista ARACÊ
ISSN: 2358-2472

15. dos Santos, A. N. S., et al. (2025). Solid waste and sustainable design – An analysis of recycling in the "circular economy" in the light of the 2030 agenda. *Aracê, 7*(2), 7365–7391. https://doi.org/10.56238/arev7n2-164

16. dos Santos, A. N. S., et al. (2025). Climate emergency and education – Impacts on the environment and the transformation of the school curriculum by Law 14.926 of 2024. *Aracê, 7*(1), 2379–2400. https://doi.org/10.56238/arev7n1-144

17. Ferreira, L. C., & Santos, R. P. (2021). *Disaster in Brumadinho: Socio-environmental impacts and challenges for environmental justice in Brazil*. São Paulo, Brasil: Editora Acadêmica.

18. Ferreira, W., Serraglio, D., & Agostini, M. (2013). *Environmental justice in Brazil: Challenges and perspectives*. Porto Alegre, Brasil: Editora UFRGS.

19. Flick, U. (2018). *Introdução à pesquisa qualitativa* (Edição brasileira). Porto Alegre, Brasil: Artmed.

20. Freitas, C., Porto, M. F. S., & Machado, J. (2000). *Socio-environmental impacts of environmental disasters in Brazil: A critical analysis of the cases of Mariana and Brumadinho*. Rio de Janeiro, Brasil: Fiocruz.

21. Funasa – Fundação Nacional de Saúde. (2001). *Basic sanitation and public health in Brazil: Challenges and solutions*. Brasília, Brasil: Ministério da Saúde.

22. Gil, A. C. (2008). *Métodos e técnicas de pesquisa social*. São Paulo, Brasil: Atlas.

23. Gliessman, S. R. (2000). *Agroecology: The ecology of sustainable food systems*. Boca Raton, FL: CRC Press.

24. Graziano da Silva, J. (2018). *The future of family farming in Latin America and the Caribbean: The role of pluriactivity and economic diversification*. Food and Agriculture Organization of the United Nations (FAO).

25. Graziano Neto, M. (1982). *Chemical agriculture and its environmental impacts in the Brazilian semi-arid region*. Recife, Brasil: Editora Universitária.

26. Guedes, A., & Costa, R. (2019). *Environmental justice and the right to water: Challenges and perspectives for Brazil*. São Paulo, Brasil: Annablume.

27. IBAMA – Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis. (1997). *Technical report on environmental assessment of pesticides in Brazil*. Brasília, Brasil: IBAMA.

28. Jacobi, P., & Besen, G. (2011). *Solid waste management and socio-environmental impacts in Brazil*. São Paulo, Brasil: Editora FAPESP.

29. Leff, E. (2002). *Ecologia, capital e cultura: Racionalidade ambiental, democracia e desenvolvimento sustentável*. São Paulo, Brasil: Cortez.

Revista ARACÊ
ISSN: 2358-2472

30. Lehfeld, N., Carvalho, M., & Balbim, R. (2013). *Environmental impacts and public health in Brazil*. São Paulo, Brasil: Editora Unesp.

31. Lima, N., & Silva, F. (2018). *Environmental justice and sustainable development in Brazil*. Brasília, Brasil: University Press.

32. López-Aliaga, R., Padilha, M., & Leivas, P. (2022). *Environmental disasters and the health of rural workers in Brazil*. Curitiba, Brasil: Editora UFPR.

33. Mbembe, A. (2019). *Necropolitics*. São Paulo, Brasil: N-1 Edições.

34. Melo, A. (2012). *Sanitation and public health in Brazil: Challenges and solutions*. Brasília, Brasil: Fiocruz.

35. Menegat, R., & Fontana, D. (2010). *Rural work and environmental justice: A study on the impacts of environmental contamination in Brazil*. Porto Alegre, Brasil: Editora UFRGS.

36. Miguel, F., & Flores, R. (2013). *Environment and sustainable development: Challenges for the twenty-first century*. Belo Horizonte, Brasil: Editora Universitária.

37. Minayo, M. C. S. (2007). *Pesquisa qualitativa: Teoria, método e criatividade*. Petrópolis, Brasil: Vozes.

38. Moreira, J. C., et al. (2002). *Integrated evaluation of the impact of pesticide use on human health in a farming community in Brazil*. Rio de Janeiro, Brasil: Fiocruz.

39. Moura, A. (2016). *Environmental justice and social inequality in Brazil*. Rio de Janeiro, Brasil: Fiocruz.

40. Nações Unidas. (2019). *Report on the human right to drinking water and basic sanitation*. New York, NY: United Nations.

41. Peres, F., & Moreira, J. C. (2021). *Pesticides, health and environment: A critical analysis of the Brazilian reality*. Rio de Janeiro, Brasil: Fiocruz.

42. Pereira, J., Cruz, A., & Guimarães, T. (2019). *Environmental impacts of the Brumadinho disaster and its socioeconomic consequences*. Belo Horizonte, Brasil: Editora UFMG.

43. Pimentel, D. (1996). *Environmental and social impacts of pesticides in Brazil*. Curitiba, Brasil: Editora UFPR.

44. Rigotto, R., et al. (2011). *The impacts of pesticides on the health of rural workers in Brazil*. São Paulo, Brasil: Hucitec.

45. Rosen, G. (1994). *A history of public health*. São Paulo, Brasil: Hucitec.

Revista ARACÊ
ISSN: 2358-2472

46. Santilli, J. (2005). *Socio-environmentalism and new rights: Legal protection of biological and cultural diversity*. São Paulo, Brasil: Peirópolis.

47. Santos, A. N. S., et al. (2024). Environmental racism, health and social rights: Causalities and impacts of environmental degradation in vulnerable communities in Brazil. *Observatorio de la Economía Latinoamericana, 23*(1), Article E8603. https://doi.org/10.55905/oelv23n1-073

48. Santos, A. N. S., et al. (2024). Locked paths: The labyrinth of bureaucratic and legal challenges in federal forest concessions in Brazil. *Observatorio de la Economía Latinoamericana, 22*(12), Article E8314. https://doi.org/10.55905/oelv22n12-182

49. Santos, A. N. S., et al. (2024). "Roots and wings": Intertwining critical environmental education and children's literature in the first steps of elementary school. *Cuadernos de Educación y Desarrollo, 16*(7), Article e4886. https://doi.org/10.55905/cuadv16n7-108

50. Santos, A. N. S., et al. (2024). Weaving the threads of public health: The impact of basic sanitation on the quality of urban life and the environment. *Cuadernos de Educación y Desarrollo, 16*(5), Article e4259. https://doi.org/10.55905/cuadv16n5-079

51. Santos, A. N. S., et al. (2024). "Health order, family norm": Interweaving the technical-scientific knowledge of sanitarians and the popular cultural knowledge of family medicine in the collective imagination. *Observatorio de la Economía Latinoamericana, 22*(9), Article E6930. https://doi.org/10.55905/oelv22n9-202

52. Santos, A. N. S., et al. (2024). "Light and learning": Integrating solar energy and environmental education in teaching by active methodologies with photovoltaic cells. *Cuadernos de Educación y Desarrollo, 16*(8), Article e5133. https://doi.org/10.55905/cuadv16n8-055

53. Santos, A. N. S., et al. (2025). Collective health and equity – Challenges and strategies for an inclusive and sustainable health system. *Observatorio de la Economía Latinoamericana, 23*(2), Article E8946. https://doi.org/10.55905/oelv23n2-041

54. Santos, A. N. S., et al. (2025). Energy transition and preservation: Integration of renewable sources, biodiversity and green economy in times of climate crisis. *Observatorio de la Economía Latinoamericana, 23*(3), Article E9234. https://doi.org/10.55905/oelv23n3-041

55. Stake, R. E. (2011). *Pesquisa qualitativa: Estudando como as coisas funcionam* (Edição brasileira). Porto Alegre, Brasil: Penso.