RGSA – Revista de Gestão Social e Ambiental
ISSN: 1981-982X
Submission date: 8/20/2025
Acceptance date: 10/17/2025
DOI: https://doi.org/10.24857/rgsa.v19n11-051
Organization: Interinstitutional Scientific Committee
Chief Editor: Ana Carolina Messias de Souza Ferreira da Costa
Assessment: Double Blind Review pelo SEER/OJS

WILDFIRES IN THE GOIANO CERRADO BETWEEN 2019 AND 2024: ADVANCES, STAGNATIONS, AND SETBACKS IN PUBLIC GOVERNANCE

Marina Pires Barbosa [1]
Giovana Alves Gomes [2]
Luciana Ramos Jordão [3]
Lauren Scalco Lautenschlager [4]
Thiago Henrique Costa Silva [5]

ABSTRACT

Objective: This study aims to investigate the relationship between wildfires in the Goiano Cerrado and the environmental public policies implemented between 2019 and 2024, to understand the factors that condition the reduction—or intensification—of fire outbreaks in the state.

Theoretical Framework: The research is grounded in concepts from political ecology and socio-environmental law, highlighting the works of Marés (2003), Porto-Gonçalves (2015), Benjamin (2007), and authors who analyze the Cerrado as a space of tension between conservation and agricultural expansion (Scariot, Sousa-Silva & Felfili, 2005; Santos & Faria, 2020).

Method: The study adopts a deductive and qualitative approach, structured in three stages: (a) a literature review of ten scientific articles on wildfires in the Goiano Cerrado; (b) a documentary analysis of federal and state legislation, such as Laws No. 12.651/2012 and No. 22.978/2024; and (c) an analysis of secondary data obtained from INPE, Mapbiomas, and SEMAD. Data analysis followed Gil's (2008) three steps: reduction, display, and verification.

Results and Discussion: The results indicate that, although Goiás' environmental policies have contributed to reducing wildfires in certain periods, limitations persist due to climate variability, agricultural frontier expansion, and weak institutional enforcement. The correlation between the adopted measures and the recorded fire outbreaks reveals partial but discontinuous progress.

Research Implications: The findings underscore the need for integrated, continuous, and territorially adapted public policies capable of aligning economic development and environmental conservation. They also highlight the importance of strengthening state structures for prevention, monitoring, and accountability regarding environmental crimes.

Originality/Value: This research contributes to the debate on environmental governance in the Cerrado by providing a recent empirical analysis (2019–2024) of the effectiveness of fire control policies in Goiás, combining legal, ecological, and technical perspectives.

Keywords: Environmental Conservation, Wildfires, Goiás Territory, Cerrado, Environmental Policies.

[1] Mestranda em História pela Universidade Estadual de Goiás, Caldas Novas, Goiás, Brazil.
E-mail: marinadanniele02@hotmail.com, Orcid: https://orcid.org/0009-0006-1689-547X
[2] Mestranda em História pela Universidade Estadual de Goiás, Morrinhas, Goiás, Brazil.
E-mail: giovana.gomes@aluno.ueg.br, Orcid: https://orcid.org/0009-0000-3182-078X
[3] Pós-doutoranda em Direito Agrário, Universidade Estadual de Goiás, Goiânia, Goiás, Brazil.
E-mail: luciana.jordao@ueg.br, Orcid: https://orcid.org/0000-0002-2594-3887
[4] Doutora em Direito pelo Centro Universitário de Brasília, Goiânia, Goiás, Brazil.
E-mail: lauren@ueg.br, Orcid: https://orcid.org/0000-0003-0681-3865
[5] Doutor em Agronegócio pela Universidade Federal de Goiás Caldas Novas, Goiás, Brazil.
E-mail: thiagocostasilva@ueg.br, Orcid: https://orcid.org/0000-0002-2916-6587

AS QUEIMADAS NO CERRADO GOIANO ENTRE 2019 E 2024: AVANÇOS, ESTAGNAÇÕES E RETROCESSOS DO PODER PÚBLICO

RESUMO

Objetivo: O objetivo deste estudo é investigar a relação entre as queimadas no Cerrado goiano e as políticas públicas ambientais implementadas entre 2019 e 2024, com o intuito de compreender os fatores que condicionam a redução — ou intensificação — dos focos de incêndio no estado.

Referencial Teórico: Fundamenta-se em referenciais da ecologia política e do direito socioambiental, com destaque para Marés (2003), Porto-Gonçalves (2015), Benjamin (2007) e autores que analisam o Cerrado enquanto espaço de disputa entre conservação e expansão agropecuária (Scariot; Sousa-Silva; Felfili, 2005; Santos; Faria, 2020).

Método: A pesquisa adota abordagem dedutiva e qualitativa, estruturada em três etapas: (a) revisão bibliográfica de dez artigos científicos sobre queimadas no Cerrado goiano; (b) análise documental de legislações federais e estaduais, como as Leis nº 12.651/2012 e nº 22.978/2024; e (c) estudo de dados secundários provenientes do INPE, Mapbiomas e SEMAD. A análise seguiu as etapas de redução, exibição e verificação de Gil (2008).

Resultados e Discussão: Os resultados indicam que, embora as políticas ambientais goianas tenham contribuído para reduzir o número de queimadas em determinados períodos, persistem limitações relacionadas à variabilidade climática, ao avanço da fronteira agrícola e à fragilidade institucional da fiscalização. A correlação entre as medidas adotadas e os focos registrados demonstra avanços pontuais, mas ainda descontinuados.

Implicações da Pesquisa: O estudo evidencia a importância de políticas públicas integradas, contínuas e territorialmente adaptadas, capazes de alinhar desenvolvimento econômico e conservação ambiental. Ressalta, ainda, a necessidade de fortalecer a estrutura estatal de prevenção e responsabilização por crimes ambientais.

Originalidade/Valor: A pesquisa contribui para o debate sobre governança ambiental no Cerrado ao oferecer análise empírica recente (2019–2024) sobre a efetividade das políticas de controle do fogo em Goiás, articulando dados técnicos, jurídicos e ecológicos.

Palavras-chave: Conservação Ambiental, Incêndio Florestais, Território Goiano, Cerrado, Políticas Ambientais.

LAS QUEMADAS EN EL CERRADO GOIANO ENTRE 2019 Y 2024: AVANCES, ESTANCAMIENTOS Y RETROCESOS DEL PODER PÚBLICO

RESUMEN

Objetivo: Este estudio tiene como objetivo investigar la relación entre las quemas en el Cerrado goiano y las políticas públicas ambientales implementadas entre 2019 y 2024, con el fin de comprender los factores que condicionan la reducción —o intensificación— de los focos de incendio en el estado.

Marco Teórico: La investigación se fundamenta en los conceptos de la ecología política y del derecho socioambiental, destacando las contribuciones de Marés (2003), Porto-Gonçalves (2015), Benjamin (2007) y de autores que analizan el Cerrado como un espacio de tensión entre la conservación y la expansión agropecuaria (Scariot, Sousa-Silva y Felfili, 2005; Santos y Faria, 2020).

Método: El estudio adopta un enfoque deductivo y cualitativo, estructurado en tres etapas: (a) revisión bibliográfica de diez artículos científicos sobre las quemas en el Cerrado goiano; (b) análisis documental de la legislación federal y estatal, como las Leyes n.º 12.651/2012 y n.º 22.978/2024; y (c) análisis de datos secundarios obtenidos del INPE, Mapbiomas y SEMAD. El análisis de los datos siguió las tres etapas propuestas por Gil (2008): reducción, exposición y verificación.

Resultados y Discusión: Los resultados indican que, aunque las políticas ambientales del estado de Goiás han contribuido a reducir las quemas en determinados períodos, persisten limitaciones derivadas de la variabilidad

climática, de la expansión de la frontera agrícola y de la débil fiscalización institucional. La correlación entre las medidas adoptadas y los focos registrados revela avances parciales, pero discontinuos.

Implicaciones de la investigación: Los hallazgos destacan la necesidad de políticas públicas integradas, continuas y adaptadas territorialmente, capaces de conciliar el desarrollo económico con la conservación ambiental. Asimismo, se resalta la importancia de fortalecer las estructuras estatales de prevención, monitoreo y responsabilización por delitos ambientales
.

Originalidad/Valor: Esta investigación contribuye al debate sobre la gobernanza ambiental en el Cerrado al ofrecer un análisis empírico reciente (2019–2024) sobre la efectividad de las políticas de control del fuego en Goiás, articulando perspectivas jurídicas, ecológicas y técnicas.

Palabras clave: Conservación Ambiental, Incendios Forestales, Territorio Goiano, Cerrado, Políticas Ambientales.

1 INTRODUCTION

Land, as a common good, is an essential element for the existence of all living beings, as it provides the resources necessary for sustaining life (Marés, 2003). From it come food, shelter, and livelihood, which is why it is often regarded as the "granary that nourishes life." However, with the expansion of the capitalist system, land has increasingly been treated as a commodity — reduced to an economic asset oriented toward income generation. This exploitative logic disregards its vital character and undermines the preservation of biodiversity, which is indispensable for the continuity of life on the planet. As Marés (2003, p. 197) asserts, "the land serves, functions, and has life in order to give life, to produce life — not for each individual separately, but for all its inhabitants, plants, animals, and humans."

The Cerrado, in turn, known as Brazil's "cradle of waters," plays a fundamental role in ecological balance and in sustaining national ecosystems. Despite its importance, this biome is highly vulnerable to periodic fires, intensified by the climatic characteristics of its dry season, which cause severe losses to biodiversity, local livelihoods, and regional economies. Occupying about one quarter of the national territory, the Cerrado is the second-largest vegetation formation in Brazil and harbors a still poorly studied biodiversity, being considered the richest and most threatened tropical savanna on the planet (Scariot, Sousa-Silva, & Felfili, 2005).

The Cerrado's climatic conditions, marked by distinct dry and rainy seasons, make its vegetation highly susceptible to ignition during the dry period. Natural fires, caused by lightning or intense solar radiation, are common, and many plant species have developed

specific adaptations to survive fire events, such as thick bark and the ability to resprout after burning (Scariot, Sousa-Silva, & Felfili, 2005). In this regard, Lopes, Vale, and Schiavini (2009, p. 695) note that "the burning regime is one of the main factors altering the structure and species composition of plant communities."

Beyond natural factors, human activities have exacerbated the problem. Urban growth, agricultural expansion, and the intensive exploitation of natural resources have increased the frequency of fires, making the Cerrado the biome with the highest proportion of burned area in Brazil. The environmental and socioeconomic impacts are significant, involving biodiversity loss, soil degradation, greenhouse gas emissions, and damages to human health and local economies (Pereira, Fiedler, & Medeiros, 2004; Santos, Pereira, & Rocha, 2014; Rocha & Nascimento, 2022).

Environmental degradation is largely linked to the capitalist model of consumption, which subordinates nature to the logic of profit. To mitigate the impacts of this model, initiatives that combine environmental conservation, technological innovation, and local community engagement are essential (Silva et al., 2024). In this sense, "conservation comes to be understood as an investment, since scarcity increases costs, while preservation actions become economically advantageous for the productive arrangement" (Silva et al., 2024, p. 5).

Between 1999 and 2018, the Cerrado recorded 1,390,251 fire outbreaks, with an average of 8,082 per microregion. The most affected states were Tocantins, Maranhão, Piauí, and western Bahia (Rocha & Nascimento, 2022). In critical years, such as 2007 and 2010, the number of fire occurrences exceeded 130,000. According to Pereira, Fiedler, and Medeiros (2004), effective prevention depends on public investment in infrastructure, whereas Rocha and Nascimento (2022) emphasize the importance of using technology to identify critical areas and value traditional practices of sustainable land management.

In the state of Goiás — largely covered by the Cerrado — environmental policies have been implemented to monitor, prevent, and combat fires. Within this context, this research seeks to answer the following question: What are the main challenges to reducing wildfires in the Cerrado of Goiás between 2019 and 2024?

The general objective is to analyze, based on literature and secondary data, the limitations and possibilities of environmental policies and legislation applied to the Cerrado of Goiás. Specifically, the study aims to: a) examine the characteristics of the biome and the historical, environmental, and social dimensions related to fires; b) evaluate the policies for fire prevention and control in the Cerrado of Goiás; and c) correlate the occurrence of fires with the advances and setbacks in environmental policies implemented between 2019 and 2024.

The relevance of this study lies in its analysis of fires as both an environmental and political phenomenon, shaped by economic interests — such as agricultural expansion — and by the need for coherent, integrated, and long-term public policies. It seeks to broaden the debate on the multiple dimensions of this issue and contribute to a critical reflection on the notions of (de)development and conservation in the Cerrado. The term "(de)development" is intentionally employed to question the traditional concept of development, which often disregards local and cultural particularities in favor of homogeneous and exclusionary economic models (Porto-Gonçalves, 2015; Silva et al., 2019).

To structure the investigation, the article is divided into two sections in addition to this introduction. The first, Materials and Methods, describes the deductive and qualitative methods adopted, including the bibliographic review, documentary analysis, and secondary data study. The second, Results and Discussion, is organized into three subsections: the first addresses the Characteristics of the Cerrado and Wildfires, exploring the biome's specificities, vulnerabilities, and the impacts of fire; the second discusses Environmental Policies and Fire Prevention, examining legislation and public actions between 2019 and 2024; and the third analyzes the Relationship Between Environmental Policies and Fire Dynamics, linking policy implementation to data on fire outbreaks, emphasizing the outcomes achieved and the persistent challenges.

2 MATERIALS AND METHODS

This section outlines the methodological pathways adopted in the research, emphasizing the procedures that guided data collection and analysis. The **deductive method** was chosen because it moves from general premises toward specific conclusions, allowing the logical application of broad environmental theories to the specific context of the Cerrado biome in Goiás (Marconi & Lakatos, 2003). In parallel, a **qualitative approach** was employed to provide an in-depth understanding of the social and behavioral phenomena associated with wildfires through the analysis of non-numerical data, aiming to "[...] describe with precision phenomena such as attitudes, values, representations, and ideologies contained in the analyzed texts" (Gil, 2002, p. 90).

According to Gil (2002, p. 44), a **bibliographic research** is "developed based on material that has already been elaborated, consisting mainly of books and scientific articles." For this study, relevant authors addressing the Cerrado and environmental perspectives related to fire prevention and control were selected. Google Scholar served as the primary search tool, using two sets of keywords: "queimada" and "Cerrado" and "Goiás"; and "incêndio" and

"Cerrado" and "Goiano." No temporal restriction was applied, and priority was given to texts written in Portuguese.

Data collection was carried out between November 18 and 20, 2024, covering the time span from 2000 to 2024, resulting in 2,240 initial records. Based on the analysis of titles, abstracts, and descriptors, all items that were not scientific articles published in journals, duplicates, or those not freely and fully accessible were excluded. Only articles appearing in both descriptor groups were retained, totaling 38 results for full reading. Among these, **ten (10) scientific articles** were selected to compose the corpus of the research due to their direct relevance to the study's theme. This methodological approach ensured the **reliability and consistency** of the materials used in the investigation.

Preference was given to articles published in **Brazilian academic journals**. This choice was deliberate, as national journals tend to address topics that reflect the country's socioeconomic, cultural, and environmental specificities, providing a deeper and more contextually grounded understanding of local realities. Moreover, such journals ensure that the studies are conducted with consideration of local challenges, which may not be the focus of international publications. The selected articles were organized in **Table 1**, listed chronologically, presenting the year, authorship, title, journal, and corresponding Qualis classification.

Table 1

Presentation of Selected Articles

Year	*Authors*	*Title*	*Journal*	*Qualis*
2004	Pereira, Cláudio Augusto; Fiedler, Nilton César; Medeiros, Marcelo Brilhante de	Analysis of prevention and fire-fighting actions in Cerrado conservation units	Floresta	B2
2009	Lopes, Sérgio de Faria; Vale, Vagner Santiago do; Schiavini, Ivan	Effects of burning on the structure and composition of woody vegetation in the Cerrado of Caldas Novas, GO	Revista Árvore	B1
2014	Santos, Paula Resende; Pereira, Gabriel; Rocha, Leonardo Cristian	Spatial distribution of fire foci in the Cerrado biome (2002–2012)	Caderno de Geografia	A1
2016	Fachin, Paulo Ângelo; Wouk, Tatiane; Pereira, Adalberto Alves; Thomaz, Edivaldo Lopes	The effect of burning on soil hydraulic conductivity in slash-and-burn agriculture	GeoAmbiente On-line	A3
2017	Winck, Licurgo Borges; Fernandes, Diogo Moreira	Efficiency of the fire and panic code of the Goiás State Fire Department in Goiânia and Aparecida de Goiânia	Revista Flammae	B3
2020	Matos, Renata Mariana Póvoa; Aguiar, Lívia Lima Leite; Martins, Patrick Thomaz de Aquino	Fire occurrence in Chapada dos Veadeiros National Park, Goiás, Brazil: recent history in the context of its expansion	GeoTextos	A3

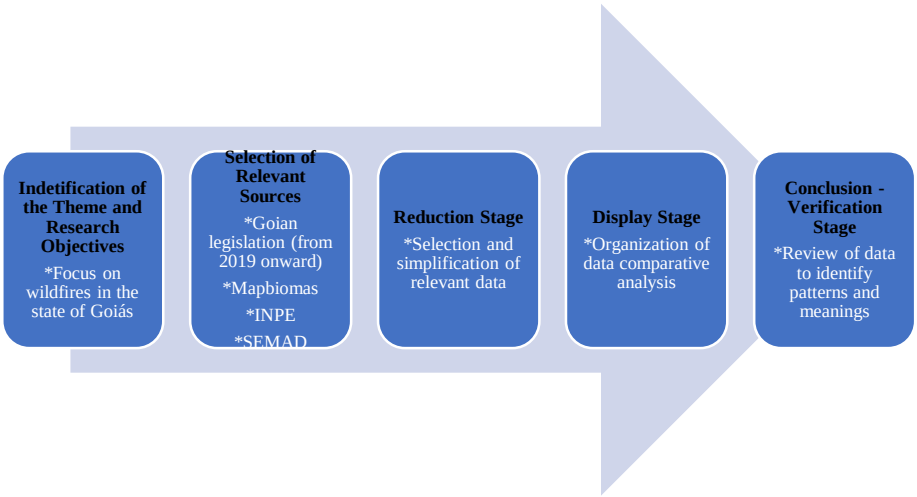
2020	Santos, Matheus Bleza; Faria, Karla Maria Silva	Environmental vulnerabilities of the Cerrado biome: a study of northern Goiás	ACTA Geográfica	A2
2022	Rocha, Maíra Iaê Savioli; Nascimento, Diego Tarley Ferreira	Spatial-temporal patterns and trends of fire occurrence in the Cerrado (1999–2018)	Boletim Goiano de Geografia	A2
2023	Dias, Daniela Pereira; Corrêa, Thomas Rieth	Fire foci and performance of forest fire danger indices (2017–2021) in Jataí – Goiás	Avanços da Ciência Florestal	B4
2024	Conceição, Igor Barbosa da; Aguiar, Lívia Lima Leite; Martins, Patrick Thomaz de Aquino	Characterization of the fire regime in Terra Ronca State Park, Goiás	GeoSaberes	A2

Source: Organized by the authors (2025).

Additionally, documentary research was conducted, defined as one that uses "materials that have not yet received analytical treatment or that can still be reworked according to the research objectives" (Gil, 2002, p. 45). In this process, emphasis was placed on Goiás state legislation related to wildfires, particularly those enacted or in force since 2019. Complementary analyses were conducted using data from the National Institute for Space Research (INPE), the State Secretariat for Environment and Sustainable Development of Goiás (SEMAD), and MapBiomas — an initiative of the Greenhouse Gas Emissions Estimation System of the Climate Observatory (SEEG/OC), developed by a collaborative network of NGOs, universities, and technology companies organized by biomes and cross-cutting themes.

Figure 1

Provides an overview of the procedures followed for the documentary analysis



Source: Organized by the authors (2025).

Data analysis followed the three stages proposed by Gil (2008, pp. 175–176): a) The first stage, *reduction*, involved "the selection, focus, simplification, abstraction, and transformation of the original data into organized summaries according to the themes or patterns defined in the research objectives."; b) The second stage, *display*, consisted of organizing the selected data to enable systematic analysis of similarities, differences, and interrelationships; and c) Finally, the *conclusion/verification* stage involved identifying the meaning of the data, as well as regularities, patterns, and possible explanations.

The selection of documentary sources was guided by their relevance and capacity to provide specific and updated information on wildfires in Goiás. Goiás state legislation was prioritized to understand the local regulatory framework and its recent developments, particularly from 2019 onward, when new policies and measures were introduced. The MapBiomas and INPE databases were chosen for their detailed spatial and temporal data on land cover and fire incidence — essential for a comprehensive analysis. The SEMAD data complemented this by providing contextual and localized information on environmental management and sustainable development policies in Goiás. This combination of sources ensured a holistic and integrated perspective, enabling a more precise and context-sensitive analysis.

3 RESULTS AND DISCUSSION

The results highlight the complexity of the relationship between the Cerrado biome in Goiás, the use of fire, and the environmental policies implemented between 2019 and 2024. The analysis was structured around three axes: the first addresses the ecological characteristics of the biome and the role of fire in its natural dynamics; the second examines the legal frameworks and public policies aimed at fire prevention and control; and the third discusses the mechanisms of enforcement, monitoring, and accountability. The integration of these axes allows for an understanding of how ecological, economic, and institutional factors interact in fire management and in the challenges of conserving the Cerrado.

3.1 THE CERRADO AND FIRE: IMPORTANCE OF THE CERRADO FOR ECOLOGICAL BALANCE AND WILDFIRES AS AN ELEMENT OF ENVIRONMENTAL DEGRADATION

The Cerrado is one of Brazil's core biomes, characterized by species adapted to seasonal climates and nutrient-poor soils. Covering approximately two million square kilometers, it is

recognized by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as a global conservation priority due to its unique biodiversity (Scariot, Sousa-Silva, & Felfili, 2005). Historically, fire has interacted with the biome, shaping its ecological dynamics and conferring resilience against low-intensity burns.

Hosting around 5% of the world's biodiversity, the Cerrado plays a crucial role in biological and ecological cycles, although it still receives less attention than other biomes, such as the Amazon (Scariot, Sousa-Silva, & Felfili, 2005). Beyond its biological significance, it serves as Brazil's main hydrological regulator, often referred to as the nation's "water tank," as it feeds the country's major river basins. The biome also contributes to climate stability by absorbing carbon and mitigating global warming (Sano, Almeida, & Ribeiro, 2008). This study follows Niro Higuchi's recommendation regarding the use of the term *climate change* in the singular, based on the understanding that the technological processes responsible for greenhouse gas emissions result in a single phenomenon—global temperature rise. Once this increase is addressed, its local consequences would also be mitigated (Lima & Higuchi, 2015).

Geographically, the Cerrado encompasses plateaus and high plains whose diverse topography favors the formation of microhabitats and enhances biodiversity (Scariot, Sousa-Silva, & Felfili, 2005). Its strategic location connects multiple ecosystems, functioning as an ecological corridor that enables species migration and sustains ecosystem services (Conceição, Aguiar, & Martins, 2024).

The biome is classified into four main physiognomies—*campo limpo* (grassland), *campo sujo* (shrubby grassland), *Cerrado sensu stricto*, and *cerradão* (wooded savanna)—reflecting variations in soil and climatic conditions (Conceição, Aguiar, & Martins, 2024). Each physiognomy plays a distinct role in biodiversity conservation and requires specific management to preserve its integrity (Scariot, Sousa-Silva, & Felfili, 2005). The flora includes woody species with deep roots, grasses, and shrubs adapted to fire and nutrient scarcity. This diversity results from the continuous interaction between climate, soil, and topography (Conceição, Aguiar, & Martins, 2024). The fauna is also diverse, including endemic species such as the maned wolf (*Chrysocyon brachyurus*) and the giant armadillo (*Priodontes maximus*), both dependent on the biome's ecological conditions (Parron et al., 2008).

The tropical seasonal climate, alternating between wet and dry periods, directly influences crop cycles and wildlife dynamics. During the dry season, part of the vegetation enters dormancy and reduces its metabolic activity, demonstrating the species' adaptive capacity (Sano, Almeida, & Ribeiro, 2008).

In the state of Goiás, the Cerrado occupies a central position in environmental and productive disputes. The region combines significant biological diversity with intense agricultural activity, being one of Brazil's main grain-producing areas (Santos & Faria, 2020). However, the advance of the agricultural frontier intensifies pressure on ecosystems, making the adoption of conservation policies that reconcile production and sustainability indispensable (Pelá & Castilho, 2010).

The predominant physiognomies in Goiás—*Cerrado sensu stricto* and *cerradão*—shape the landscape and harbor species of great ecological value (Santos & Faria, 2020). Transitional zones connect the Cerrado with other biomes, reinforcing the need for integrated management and conservation strategies (Conceição, Aguiar, & Martins, 2024). In addition to its ecological relevance, the biome constitutes a cultural heritage, sustaining communities that depend on its resources for subsistence. Initiatives such as ecotourism in protected areas have helped mitigate impacts and promote environmental awareness (Conceição, Aguiar, & Martins, 2024).

Although fire is part of the Cerrado's natural dynamics, its frequency and intensity have increased due to human activities, particularly agricultural expansion (Dias & Corrêa, 2023). Controlled fire can serve as a management tool, provided it is accompanied by technical monitoring and consistent environmental policies (Scariot, Sousa-Silva, & Felfili, 2005). Studies such as López-Aguilar (2022), conducted in the Silvânia National Forest (Goiás), show that controlled burns alter species composition even without reducing overall abundance, affecting local diversity.

Anthropogenic fires associated with agriculture and irregular land occupation cause soil degradation and biodiversity loss (Scariot, Sousa-Silva, & Felfili, 2005; Fachin et al., 2016). The adoption of agricultural technologies less dependent on fire is essential to mitigate these impacts (Conceição, Aguiar, & Martins, 2024; Dias & Corrêa, 2023). When used indiscriminately, burning disrupts nutrient cycles and hinders the biome's regeneration, fragmenting native vegetation and facilitating the spread of invasive species (Dias & Corrêa, 2023; Lopes, Vale, & Schiavini, 2009).

Environmental recovery requires integrated restoration actions and strict enforcement (Pereira, Fiedler, & Medeiros, 2004). Despite such efforts, protected areas remain exposed to illegal burning. In Goiás, the use of remote monitoring has contributed to fire detection, while partnerships among governments, organizations, and local communities are vital for protecting priority areas (Conceição, Aguiar, & Martins, 2024; Dias & Corrêa, 2023).

Thus, although fire is a natural component of the Cerrado, its uncontrolled increase threatens ecological balance. Integrated fire management, combined with public policies that

acknowledge its ecological role, is essential to reduce negative impacts (Dias & Corrêa, 2023). Management plans and emergency action strategies, together with research on fire behavior and community engagement, strengthen conservation efforts (Matos, Aguiar, & Martins, 2020).

Finally, the creation of ecological corridors and public awareness campaigns enhances biodiversity protection and fosters collective involvement in preservation (Conceição, Aguiar, & Martins, 2024). The continuity of the Cerrado depends on coordinated efforts among governments, researchers, and communities to ensure the maintenance of environmental services that sustain both climatic and ecological balance on a global scale (Conceição, Aguiar, & Martins, 2024; Matos, Aguiar, & Martins, 2020).

3.2 ENVIRONMENTAL NORMS AND POLICIES FOR THE PREVENTION AND CONTROL OF FIRE IN THE CERRADO OF GOIÁS

Environmental policies for combating wildfires in Brazil, at the federal level, are structured around a set of laws aimed at balancing economic development and environmental protection, while promoting the sustainable management of natural resources. Table 2 presents the main legal milestones that compose this legal framework:

Table 2

Federal legal framework on policies to combat wildfires in Brazil

Number/Year	*Title/Subject*	*Description*
Law No. 6,938 of 31 August 1981	National Environmental Policy	Establishes the National Environmental Policy, its objectives and instruments, as well as mechanisms for its implementation, and provides other measures.
Law No. 7,735 of 22 February 1989	Creation of the Brazilian Institute of Environment	Extinguishes federal agencies, creates the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), and provides other measures.
Law No. 9,605 of 12 February 1998	Environmental Crimes Law	Establishes criminal and administrative sanctions for conduct and activities harmful to the environment, and provides other measures.
Law No. 12,651 of 25 May 2012	Brazilian Forest Code	Regulates the protection of native vegetation; amends Laws No. 6,938 of 31 August 1981, 9,393 of 19 December 1996, and 11,428 of 22 December 2006; revokes Laws No. 4,771 of 15 September 1965 and 7,754 of 14 April 1989, and Provisional Measure No. 2,166-67 of 24 August 2001; and provides other measures.
Law No. 14,944 of 31 July 2024	National Policy on Integrated Fire Management	Establishes the National Policy on Integrated Fire Management and amends Laws No. 7,735 of 22 February 1989, 12,651 of 25 May 2012 (Forest Code), and 9,605 of 12 February 1998 (Environmental Crimes Law).

Fonte: Organizado pelos autores (2025).

Law No. 6,938/1981 is considered the starting point of Brazilian environmental policy, as it establishes the fundamental principles for the preservation, improvement, and recovery of environmental quality. This statute created the National Environmental Policy (Política Nacional do Meio Ambiente – PNMA), defining objectives and instruments aimed at preventing and mitigating environmental impacts, including those arising from wildfires. The PNMA also established the National Environmental System (Sistema Nacional do Meio Ambiente – SISNAMA), responsible for coordinating actions among federal entities, and introduced environmental impact assessment as an essential mechanism to control human activities affecting ecosystems (Brasil, 1981).

Subsequently, Law No. 7,735/1989 created the Brazilian Institute of Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA), consolidating the institutional structure responsible for implementing and enforcing environmental policies. Among its duties are wildfire monitoring, the application of administrative sanctions, and the management of protected areas. The agency also plays a key role in wildfire prevention and suppression, in coordination with states and municipalities (Brasil, 1989).

Complementing this framework, Law No. 9,605/1998 — known as the Environmental Crimes Law — established criminal and administrative sanctions for harmful conduct against the environment, including illegal burning. The statute provides for penalties such as fines and imprisonment, applicable to individuals and legal entities, reinforcing civil and criminal liability for environmental damage (Brasil, 1998).

The Forest Code, enacted by Law No. 12,651/2012, introduced parameters for the conservation of native vegetation by establishing Permanent Preservation Areas (Áreas de Preservação Permanente – APPs) and Legal Reserves, which function as natural barriers against the spread of fire. The law also mandates the restoration of degraded areas, contributing to the reduction of fire outbreaks (Brasil, 2012).

More recently, Law No. 14,944/2024, which establishes the National Policy on Integrated Fire Management, represents a significant step forward in the integrated and preventive approach to fire use across the country. This policy updates previous legislation, such as the Forest Code and the Environmental Crimes Law, by defining guidelines focused on fire prevention and impact control. It also promotes sustainable practices and the recognition of traditional fire management techniques, particularly in rural and Indigenous communities (Brasil, 2024).

Taken together, these statutes reflect a continuous and articulated effort to address the problem of wildfires in Brazil. By combining diverse approaches — from repressing illegal

practices to encouraging sustainable management — the country seeks to mitigate the impacts of fire on biodiversity, water resources, and air quality.

However, the effectiveness of these policies depends on strict enforcement, ongoing evaluation, and the promotion of environmental awareness. Strengthening inter-institutional actions, alongside the active engagement of civil society, is essential to ensure that these policies are effective and innovative, contributing both to the conservation of Brazilian biomes and to sustainable development.

Among federal programs, a key initiative is the Burned Area and Forest Fire Monitoring Program of the National Institute for Space Research (INPE), in operation since 1998. Its purpose is to monitor land cover and fire impacts using satellite imagery, supporting environmental management and deforestation control (INPE, 2024, online). The monitoring system generates digital maps and time-based comparisons, assisting in the assessment of the effects of fire on vegetation (SNIF, 2019).

Another important instrument is Prevfogo – National Center for Wildfire Prevention and Fighting, which coordinates operational actions and environmental education initiatives, including the training of local communities. Although its primary focus is the Amazon, its headquarters in Brasília facilitates direct action in the Cerrado of Goiás (Fundo Amazônia, 2023).

During the Bolsonaro administration, environmental policies were weakened, as reflected in the dismantling of the Ministry of the Environment and the reduced operational capacity of agencies such as IBAMA and ICMBio. This institutional context undermined enforcement effectiveness and contributed to increased wildfire and deforestation rates, as analyzed by Camargo (2020).

At the state level, the Government of Goiás created the State Committee for Forest Fire Management by Decree No. 9,909/2021, bringing together public agencies and civil society representatives to coordinate prevention and response actions (Goiás, 2021). Among the integrated initiatives, the Cerrado Vivo Operation stands out as a partnership between the Goiás Military Fire Department (CBMGO) and the State Secretariat for Environment and Sustainable Development, maintaining specialized teams in protected areas that operate 24 hours a day in monitoring and controlling fire hotspots.

In addition to these measures, annual decrees have reinforced prevention efforts. Decree No. 10,503/2024, for example, declared an environmental emergency due to the high probability of forest fires, guiding municipalities on preventive measures during the months with highest incidence, between August and October (Goiás, 2024a). Complementarily, Law No. 22,978/2024 established the State Policy on Public Security for the Prevention and Combating of Criminal Fire,

strengthening enforcement, introducing stricter sanctions, and promoting educational campaigns (Goiás, 2024b). This policy integrates public agencies, the private sector, and civil society organizations, and also requires full reparation of environmental damage.

The new state legislation combines preventive, educational, and punitive instruments, constituting an important milestone in fire management in Goiás. Carnevalli (2024) reports that, in September 2024, the governor demanded greater effectiveness in combating wildfires during a meeting at the Presidential Palace. According to the author, the state has a real-time satellite monitoring system operated by the Secretariat for the Environment and Civil Defense, although it still requires additional financial resources.

The damages caused by wildfires help explain the urgency of such measures. In August and September 2024, different incidents led to fatalities in São Paulo and Goiás, demonstrating the direct risks to human life (G1 – Rio Preto e Araçatuba, 2024; Marcus, 2024; Cruz, 2024). Beyond the loss of life, the Secretary-General of the State Government estimated total damages of up to BRL 1.5 billion, considering economic, social, and environmental costs (Goiás, 2024c).

Although the financial impact is significant, it does not exhaust the problem's dimension. Marés (2003) argues that the social function of land must prevail over strictly economic interests, while Porto-Gonçalves (2015) criticizes the market logic that subordinates nature to capital accumulation. Public policies must therefore take into account not only material damages but also the social and ecological effects of wildfires, reaffirming life and the environment as collective goods.

The Mauro Borges Institute (IMB), together with the Secretary-General of Government, estimated that by August 2024 there had been 342 hospital admissions for respiratory diseases related to wildfires, generating a public expenditure of BRL 496,000 (Goiás, 2024c).

The State Secretariat for Environment and Sustainable Development (SEMAD, 2024) highlighted that the Climate Change and Ecosystem Services Management Unit (GECLI) coordinates five initiatives at different stages of development: a) *Goiás Resilient Project*, focused on climate adaptation and risk management in municipalities of Goiás; b) *PSA Cerrado em Pé*, a pilot Payment for Environmental Services initiative aimed at reducing deforestation in the Cerrado biome; c) *REDD+ Goiás Project*, designed to establish the foundations of the Goiás Carbon Neutral 2050 Strategy; d) *Plan for the Prevention and Control of Deforestation, Wildfires and Forest Fires (PPCDQIF) 2024–2028*, whose objective is to prevent, control, and monitor deforestation, burning, and forest fires throughout the state; e) *Goiás Forum on Climate Change and Sustainable Development*, a consultative space for environmental policy formulation.

The PPCDQIF 2024–2028 is the main state planning instrument aimed at reducing deforestation and wildfires, as well as articulating different institutions to fulfill the Zero Illegal Deforestation Pact by 2030 and the Goiás Carbon Neutral 2050 Strategy.

Based on Decree No. 10,464/2024, which approved SEMAD's internal regulations, two additional units are central to wildfire prevention: the Management Unit for Fire and Environmental Accident Prevention (GEGIA) and the Meteorological and Hydrological Information Center of Goiás (CIMEHGO). Recent actions also include the creation of the Siga-GO platform and the Monitor de Queimadas app, the hiring of firefighting brigades, and the training of civil servants. Regulatory changes, such as Normative Instruction No. 7/2025, which improves the process for authorizing controlled burning, and Normative Instruction No. 14/2025, which regulates administrative liability for irregular use of fire and the regularization of environmental liabilities, reinforce the preventive system.

However, market-based instruments such as Payments for Environmental Services (PSA) and REDD+, although promoted as conservation solutions, may reproduce broader economic interests, as pointed out by Eloy, Coudel, and Toni (2013). This critique underscores the need to examine their implementation in Goiás to ensure that environmental protection is not subordinated to market logic.

In summary, the set of environmental norms and policies targeting the Cerrado of Goiás reveals important institutional advances, but the effective implementation of these measures still faces obstacles. The success of these policies depends on consistent enforcement, social participation, and sustained political commitment.

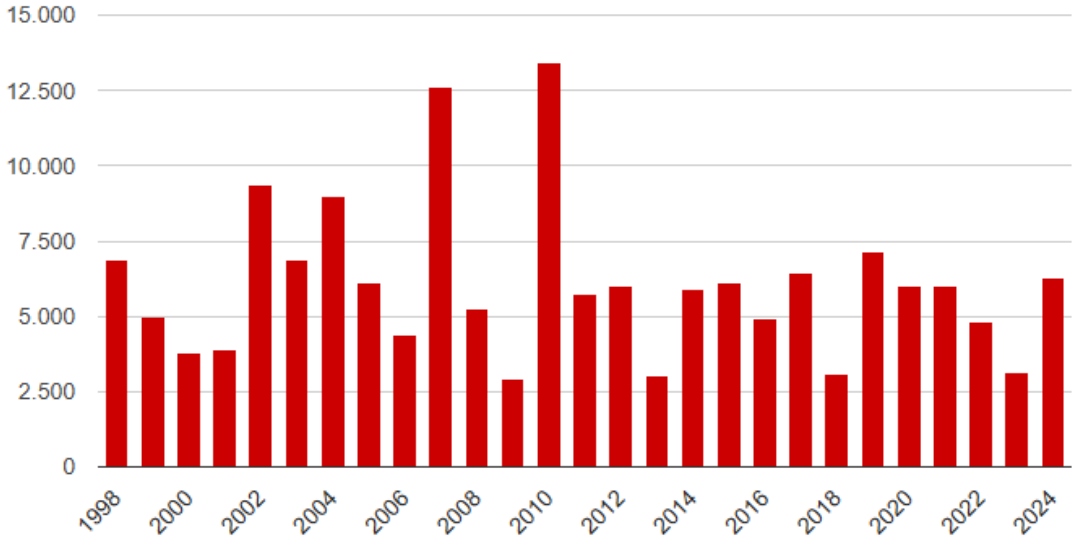
The next section examines the mechanisms of control, enforcement, and accountability, discussing the persistent barriers to wildfire reduction and exploring pathways to enhance the protection of the Cerrado.

3.3 CONTROL, ENFORCEMENT, AND ACCOUNTABILITY: OBSTACLES TO REDUCING WILDFIRES IN THE CERRADO OF GOIÁS

Data from the National Institute for Space Research (INPE, 2024) present a historical series of wildfire occurrences in the state of Goiás between 1998 and 2024. Figure 2 illustrates the annual variation in fire hotspots, highlighting significant peaks in 2007 (12,639 occurrences) and 2010 (13,419 occurrences). These increases reflect extreme climatic conditions—such as prolonged droughts—as well as the expansion of agricultural and livestock practices that rely on fire as a management tool.

Figure 2

Comparison of the total number of active fire hotspots detected by reference satellites per month, from 1998 to 24 November 2024



Source: National Institute for Space Research (INPE, 2024, online).

From 2012 onward, the data show a relative stabilization, although high numbers persist in some years. These figures underscore the urgency of effective public policies—such as integrated fire management and stronger enforcement—to prevent high-intensity fire events. Particular attention should be paid to years classified as critical due to climatic conditions and land-use patterns in the Cerrado of Goiás, to mitigate the socio-environmental impacts of wildfires.

The first term of the Governor of Goiás began on 1 January 2019 and lasted until 2022. Before assuming office, Ronaldo Ramos Caiado had been a member of the Parliamentary Agricultural Front ("rural caucus") in the National Congress, a group known for supporting agribusiness expansion (Graciano et al., 2023). Re-elected in 2022, Caiado remained in office until the conclusion of this study (October 2025), maintaining his alignment with agribusiness interests (Carnevalli, 2024) and positioning himself as a presidential pre-candidate, criticizing the federal government for allegedly failing to adequately address wildfires in the Cerrado.

Between 2019 and 2024, INPE (2024) recorded the following number of fire outbreaks during the critical months of August and September: 4,847 (2019), 2,789 (2020), 3,690 (2021), 2,126 (2022), 1,139 (2023), and 4,231 (2024, up to November). These fluctuations suggest multiple interacting causes—both natural and anthropogenic—making it difficult to establish linear cause-and-effect relationships.

Climatic conditions and moisture cycles partly explain these variations: wetter years, such as 2020, tend to reduce fire occurrences, whereas drier years, like 2024, favor increases. The COVID-19 pandemic also temporarily affected patterns of land use and human mobility, slightly reducing pressure on the land.

The expansion of the agro-hydro-industrial complex in Goiás, characterized by the growth of pasturelands, remains a major contributing factor, since fire continues to be used for pasture renewal. This raises concerns about the sustainability of such practices and their effects on vegetation physiognomies with differing vulnerability levels. Additionally, illegal fires—sometimes linked to organized groups clearing protected areas for productive use—exacerbate the problem and demand coordinated responses addressing natural, human, and socioeconomic dimensions.

Agricultural expansion in regions such as MATOPIBA and northern Goiás continues to rely on fire for pasture cleaning and land renewal (Lopes, Vale, & Schiavini, 2009; Rocha & Nascimento, 2022). Slash-and-burn agriculture, still practiced among small farmers, worsens soil degradation and biodiversity loss (Dias & Corrêa, 2023; Fachin et al., 2016). Between May and October, the combination of drought and high temperatures makes the Cerrado particularly susceptible to fires, and human negligence often amplifies the damage (Dias & Corrêa, 2023). Anthropogenic factors—whether intentional or accidental—are closely tied to land-use pressures (Matos, Aguiar, & Martins, 2020; Santos & Faria, 2020).

According to Silva et al. (2024), illegal burning in protected areas (Unidades de Conservação, or UCs) poses a particular challenge in Goiás, where land tenure irregularities fuel conflicts and undermine the management of natural resources. Agrarian reform, combined with sustainable agricultural practices and the valorization of ecosystem services, is indicated as a necessary pathway.

Public policies in Goiás face well-known obstacles: lack of land regularization in protected areas, absence of effective management plans, and operational difficulties in implementation (Silva et al., 2024). Benjamin (2007) emphasizes that expanding public participation strengthens environmental governance and helps reduce both fires and deforestation. In Goiás, the State Secretariat for Environment and Sustainable Development (SEMAD) held public service recruitments in 2022–2023, yet staffing remains insufficient. As of 2025, there are only five criminal experts assigned to environmental crime scenes and a single specialized police division statewide—an example of the so-called “green crime gap”, referring to environmental offenses that go unpunished due to the State’s limited investigative capacity (Silva & Jordão, 2023).

Recommended solutions include greater public investment in infrastructure, sustainable land-use practices, integrated strategies that consider meteorological variables, and stronger inspection mechanisms (Pereira, Fiedler, & Medeiros, 2004; Rocha & Nascimento, 2022; Dias & Corrêa, 2023).

In parallel, several authors propose technical and regulatory instruments. Santos, Pereira, and Rocha (2014) and Matos, Aguiar, and Martins (2020) advocate the use of Geographic Information Systems (GIS) and integrated management in protected areas; Fachin et al. (2016) and Santos and Faria (2020) recommend soil management policies and protection of vulnerable zones; Winck and Fernandes (2017) and Conceição, Aguiar, and Martins (2024) stress the importance of effective legal frameworks in both urban and rural areas. The creation of ecological corridors and the strengthening of protected areas enhance the biome's resilience by ensuring connectivity and conserving biodiversity (Silva et al., 2024). Hence, an integrated approach among governments, researchers, and civil society is necessary to combat wildfires and foster sustainable (de)development in the Cerrado.

Legal permissiveness and environmental impunity remain persistent challenges in Goiás. Jordão, Barreira, and Araújo (2022) observe that the lack of land regularization and the absence of effective management plans foster conditions in which environmental law enforcement is often ineffective. The difficulty in identifying those responsible for forest fires—partly due to resource scarcity and investigative complexity—results in widespread impunity. This situation is aggravated by the limited inspection infrastructure, with only four environmental forensic experts and one specialized police unit in the entire state (Bianchi & Acordi, 2019).

Moreover, Conduct Adjustment Terms (TACs)—legal instruments intended to mitigate environmental damage—often fail to achieve their purpose due to poor implementation and monitoring (Jordão, Barreira, & Araújo, 2022). Barreto et al. (2009) note that the inconsistent application of TACs, combined with weak oversight, allows offenders to avoid penalties, perpetuating a culture of impunity. To overcome these challenges, it is essential to strengthen enforcement mechanisms and ensure that penalties for environmental crimes are applied consistently and effectively, promoting environmental governance that genuinely protects and conserves the Cerrado.

4 FINAL CONSIDERATIONS

The analyses conducted in this research reaffirm the importance of the Cerrado biome in Goiás for Brazil's environmental and socioeconomic balance. The study aimed to understand the main challenges to reducing wildfires between 2019 and 2024, examining both the

limitations and possibilities of environmental policies and legislation applied to this biome. The results indicate that, although there have been significant normative and structural advances, the consolidation of an effective environmental policy still requires improvements in its implementation and continuity.

The research demonstrated that wildfire occurrences in the Cerrado are influenced by multiple factors, including climatic conditions, land use, and production practices. The expansion of agribusiness and the recurrent use of fire for pasture clearing continue to play a major role in shaping environmental dynamics. It was observed that, even in a biome naturally adapted to periodic fire, the intensification and frequency of these events have increasingly affected vegetation, soil, and water resources.

From a legal and institutional perspective, important progress has been made in structuring environmental public policies at both federal and state levels. In Goiás, the creation of specific legislation and the expansion of monitoring and fire-prevention mechanisms reflect a growing governmental commitment to protecting the biome. However, the data analyzed reveal that the effectiveness of these measures remains inconsistent, primarily due to operational limitations, shortages in human and financial resources, and the lack of integration across administrative levels.

The correlation between fire hotspot data and the public policies adopted during the study period reveals that the positive outcomes achieved in certain years were not sustained over time. This fluctuation suggests that, although the legal framework has been strengthened, improvements are still needed in policy implementation, as well as in technical oversight and evaluation, to ensure greater consistency and stability in environmental results.

The study successfully met its main objective by analyzing, through both literature review and secondary data, the environmental policies and legislation applied to the Cerrado of Goiás. The findings emphasize that effectively addressing wildfires requires a combination of planning, monitoring, and environmental education, along with the active participation of local communities and productive sectors. The consolidation of integrated and sustainable policies depends on continuous evaluation processes and institutional adjustments that align strategies with the biome’s ecological particularities.

In conclusion, while the state of Goiás has advanced in formulating environmental management programs and regulatory instruments, the data indicate that achieving long-term results still demands enhancement of practical actions. Strengthening administrative structures, improving coordination among federal, state, and municipal entities, and fostering cooperation

with civil society are essential pathways toward increasing policy effectiveness and ensuring the sustainable conservation of the Cerrado.

ACKNOWLEDGMENTS

The authors express their gratitude to the State University of Goiás (Universidade Estadual de Goiás – UEG) and the Federal University of Goiás (Universidade Federal de Goiás – UFG). Through their graduate programs — the *Graduate Program in History (PPGHIS/UEG)* and the *Graduate Program in Agribusiness (PPGAGRO/UFG)* — these institutions made the development of this research possible.

REFERENCES

Barreto, P., et al. (2009). *A impunidade de infratores ambientais em áreas protegidas da Amazônia.* Imazon, 13, 1–6. Retrieved from https://documentacao.socioambiental.org/noticias/anexo_noticia/4012_20090821_102613.pdf

Benjamin, A. H. V. (2007). *Direito constitucional ambiental brasileiro.* In J. J. G. Canotilho & J. R. M. Leite (Eds.), *Direito constitucional ambiental brasileiro* (Part II, pp. 57–130). São Paulo: Saraiva.

Bianchi, R. C., & Acordi, C. F. (2019). *Incêndios florestais: a atuação estatal e a responsabilização do agente causador do incêndio. Ignis: Revista Técnico-Científica do Corpo de Bombeiros Militar de Santa Catarina,* 4(1), 1–15.

Brasil. (1981). *Lei nº 6.938, de 31 de agosto de 1981.* Política Nacional do Meio Ambiente. Retrieved from https://www.planalto.gov.br/ccivil_03/leis/l6938.htm

Brasil. (1989). *Lei nº 7.735, de 22 de fevereiro de 1989.* Criação do Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA). Retrieved from https://www.planalto.gov.br/ccivil_03/leis/l7735.htm

Brasil. (1998). *Lei nº 9.605, de 12 de fevereiro de 1998.* Lei de Crimes Ambientais. Retrieved from https://www.planalto.gov.br/ccivil_03/leis/l9605.htm

Brasil. (2012). *Lei nº 12.651, de 25 de maio de 2012.* Código Florestal Brasileiro. Retrieved from https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm

Brasil. (2024). *Lei nº 14.944, de 31 de julho de 2024.* Política Nacional de Manejo Integrado do Fogo. Retrieved from https://www2.camara.leg.br/legin/fed/lei/2024/lei-14944-31-julho-2024-796016-publicacaooriginal-172511-pl.html

Camargo, S. (2020). *As táticas do governo Bolsonaro para sucatear órgãos de proteção ambiental.* Mongabay Brasil. Retrieved from https://brasil.mongabay.com/2020/06/as-taticas-do-governo-bolsonaro-para-sucatear-orgaos-de-protecao-ambiental/

Carnevalli, J. (2024). *Goiás intensifica ações de combate aos incêndios.* Agência Cora Coralina de Notícias – Secretaria de Segurança Pública, Governo de Goiás. Retrieved from https://agenciacoradenoticias.go.gov.br/131409-caiado-cobra-acoes-efetivas-do-governo-federal-no-combate-as-queimadas-no-pais

Conceição, I. B., Aguiar, L. L. L., & Martins, P. T. A. (2024). *Caracterização do regime de queimadas do Parque Estadual da Terra Ronca, Goiás. Geosaberes,* 15, 91–101.

Cruz, G. (2024). *Fazendeira morre queimada ao tentar apagar incêndio em fazenda de Goiás. G1 Goiás.* Retrieved from https://g1.globo.com/go/goias/noticia/2024/09/19/mulher-morre-carbonizada-durante-incendio-em-fazenda-de-goias.ghtml

Dias, D. P., & Corrêa, T. R. (2023). *Foco de incêndio e desempenho dos índices de perigo de incêndio florestal de 2017 a 2021 em Jataí – Goiás. Advances in Forestry Science,* 10(3), 2091–2098.

Eloy, L., Coudel, E., & Toni, F. (2013). *Implementando pagamentos por serviços ambientais no Brasil: caminhos para uma reflexão crítica. Sustentabilidade em Debate,* 4(1), 21–42.

Fachin, P. A., et al. (2016). *O efeito da queimada na condutividade hidráulica do solo em agricultura de roça-de-toco. GeoAmbiente On-line,* 27, 1–17.

Fundo Amazônia. (2023). *Projeto Prevfogo/Ibama*. Retrieved from https://www.fundoamazonia.gov.br/pt/projeto/Prevfogo---Ibama/

G1 – Rio Preto e Araçatuba. (2024). *Homem morre ao tentar conter queimada em propriedade rural no interior de SP*. *G1 São Paulo.* Retrieved from https://g1.globo.com/sp/sao-jose-do-rio-preto-aracatuba/noticia/2024/08/19/homem-morre-ao-tentar-conter-queimada-em-propriedade-rural-no-interior-de-sp.ghtml

Gil, A. C. (2002). *Como elaborar projetos de pesquisa* (4th ed.). São Paulo: Atlas.

Gil, A. C. (2008). *Métodos e técnicas de pesquisa social* (6th ed.). São Paulo: Atlas.

Goiás. (2021). *Decreto nº 9.909, de 20 de julho de 2021*. Institui o Comitê Estadual de Gestão de Incêndios Florestais. Retrieved from https://legisla.casacivil.go.gov.br/api/v2/pesquisa/legislacoes/104213/pdf

Goiás. (2024a). *Decreto nº 10.503, de 24 de julho de 2024.* Declara situação de emergência ambiental no Estado de Goiás.

Goiás. (2024b). *Lei nº 22.978, de 6 de setembro de 2024.* Política Estadual de Segurança Pública de Prevenção e Combate ao Incêndio Criminoso.

Goiás. Secretaria-Geral de Governo (SGG). (2024c). *Queimadas podem gerar perda de até R$ 1,5 bilhão para Goiás.* Retrieved from https://goias.gov.br/queimadas-podem-gerar-perda-de-ate-r-15-bilhao-para-goias/

INPE – Instituto Nacional de Pesquisas Espaciais. (2024). *Programa Queimadas: monitoramento de focos ativos por estado.* Retrieved from https://terrabrasilis.dpi.inpe.br/queimadas/situacao-atual/estatisticas/estatisticas_estados/

Lima, A., & Higuchi, N. (2015). *Se entendermos a floresta amazônica não será preciso derrubar um galho de árvore*. FAPEAM, Manaus. Retrieved from https://www.fapeam.am.gov.br/floresta-amazonica/

Lopes, S. F., Vale, V. S., & Schiavini, I. (2009). *Efeito de queimadas sobre a estrutura e composição da comunidade vegetal lenhosa do Cerrado sentido restrito em Caldas Novas, GO. Revista Árvore*, 33(4), 695–704.

López-Aguilar, T. P. (2022). *Diversidade de espécies de abelhas em uma área sob o efeito do fogo no Cerrado da Flona de Silvânia, Goiás, Brasil.*

Mapbiomas. (2024). *Cicatrizes de fogo (Coleção 3 – MAPBIOMAS Fogo): dados de área (ha) de cicatrizes de queimadas por bioma, estado e município (1985–2023).*

Marconi, M. A., & Lakatos, E. M. (2003). *Fundamentos de metodologia científica* (5th ed.). São Paulo: Atlas.

Marcus, E. (2024). *Dois funcionários morrem tentando apagar incêndio em usina no interior. Metrópoles.* Retrieved from https://www.metropoles.com/sao-paulo/dois-funcionarios-morrem-tentando-apagar-incendio-em-usina-no-interior

Marés, C. F. (2003). *Função social da terra.* São Paulo: SAFE.

Marés, C. F. (2017). *De como a natureza foi expulsa da modernidade. Revista de Direitos Difusos*, 68(2), 15–40.

Matos, R. M. P., Aguiar, L. L. L., & Martins, P. T. A. (2020). *Ocorrência de fogo no Parque Nacional da Chapada dos Veadeiros, Goiás, Brasil: histórico recente no contexto da sua ampliação. GeoTextos,* 16(2), 151–171.

Parron, L. M., et al. (2008). *Cerrado: desafios e oportunidades para o desenvolvimento sustentável.* Planaltina, DF: Embrapa Cerrados.

Pelá, M., & Castilho, D. (Eds.). (2010). *Cerrados: perspectivas e olhares.* Goiânia: Editora Vieira.

Pereira, C. A., Fiedler, N. C., & Medeiros, M. B. (2004). *Análise de ações de prevenção e combate aos incêndios florestais em unidades de conservação do Cerrado. Floresta,* 34(2), 95–100.

Porto-Gonçalves, C. W. (2015). *Del desarrollo a la autonomía: la reinvención de los territorios; el desarrollo como noción colonial. Revista Kavilando,* 7(2), 157–161.

Rocha, M. I. S., & Nascimento, D. T. F. (2022). *Padrões e tendências espaço-temporais da ocorrência de queimadas no Cerrado entre 1999 e 2018. Boletim Goiano de Geografia,* 42, e70659, 1–21.

Sano, S. M., Almeida, S. P., & Ribeiro, J. F. (2008). *Cerrado: ecologia e flora.* Brasília, DF: Embrapa Informação Tecnológica.

Santos, M. B., & Faria, K. M. S. (2020). *Vulnerabilidades ambientais do bioma Cerrado: estudo da região Norte Goiano – Goiás. ACTA Geográfica,* 14(34), 242–258.

Santos, P. R., Pereira, G., & Rocha, L. C. (2014). *Análise da distribuição espacial dos focos de queimadas para o bioma Cerrado (2002–2012). Caderno de Geografia,* 24(1), 133–142.

Scariot, A., Sousa-Silva, J. C., & Felfili, J. M. (Eds.). (2005). *Cerrado: ecologia, biodiversidade e conservação.* Brasília: Ministério do Meio Ambiente.

SEMAD – Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável. (2024). *Mudança climática e serviços ecossistêmicos.* Goiás.gov.br.

Silva, T. H. C., et al. (2019). *Entre o desenvolvimento e a decolonialidade: Santarém, os portos e os conflitos. Interações,* 20(1), 125–140.

Silva, T. H. C., et al. (2024). *Para além do papel: estudo das unidades de conservação brasileiras. Interações,* 25(2), e2523777.

Silva, T. H. C., & Jordão, L. R. (2023). *Maus-tratos contra os animais: uma análise da efetividade punitiva em Goiás. Revista Brasileira de Direito Animal,* 18, f282310, 1–24.

SNIF – Sistema Nacional de Información de Bosques. (2019). *Área queimada.* Retrieved from https://snif.florestal.gov.br/es/incendios-forestales/228-area-queimada

Winck, L. B., & Fernandes, D. M. (2017). *Eficiência da aplicação do código contra incêndio e pânico do Corpo de Bombeiros Militar do Estado de Goiás nos municípios de Goiânia e Aparecida de Goiânia. Revista Flammae,* 3(6), 75–95.