



# Espaço & Geografia

GREENING IN SCHOOLYARDS AND  
SURROUNDING AREAS: ENVIRONMENTAL  
INEQUALITY BETWEEN CENTRAL AND  
PERIPHERAL ZONES IN DISTRITO FEDERAL  
(DF)

ARBORIZAÇÃO NO PÁTIO E NO ENTORNO DAS  
ESCOLAS: DESIGUALDADE AMBIENTAL ENTRE  
CENTRO E PERIFERIA NO DISTRITO FEDERAL



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## ABSTRACT

This article analyzes environmental inequality between public schools in Plano Piloto and Samambaia, two administrative regions of the Federal District, focusing on the presence of trees in schoolyards and their surroundings. The study aims to understand how the unequal distribution of green areas influences school environments, student well-being, and academic performance. A qualitative methodology was adopted, based on documentary and bibliographic analysis, complemented by satellite image observation using Google Earth Pro. Official data from the Basic Education Development Index (Ideb) were also used to correlate green infrastructure with school performance. The results show that schools in Plano Piloto benefit from more extensive vegetation cover and a greater presence of trees, while schools in Samambaia are characterized by sparse vegetation, predominantly grasses, and a lack of shaded areas. These environmental differences directly impact thermal comfort, outdoor usability, and the overall quality of school spaces. The findings indicate that such disparities are closely linked to historical patterns of socio-spatial segregation and are reflected in educational indicators. The study concludes that public policies focused on equitable school greening are essential to address territorial exclusion and ensure the right to healthy and inclusive educational environments across all regions of the Federal District.

**Keywords:** Greening. Education. Federal District.

## RESUMO

Este artigo analisa a desigualdade ambiental entre escolas públicas do Plano Piloto e de Samambaia, no Distrito Federal, com foco na arborização dos pátios e entornos escolares. O objetivo é compreender como a distribuição desigual de áreas verdes influencia a ambiência escolar, o bem-estar e o desempenho dos estudantes. A metodologia adotada é qualitativa, baseada em análise documental, bibliográfica e observação de imagens de satélite obtidas por meio do *Google Earth Pro*. Também foram utilizados dados oficiais do Índice de Desenvolvimento da Educação Básica (Ideb) para correlacionar infraestrutura verde e desempenho escolar. Os resultados mostram que as escolas do Plano Piloto possuem maior cobertura vegetal, com presença significativa de árvores, enquanto as escolas de Samambaia apresentam áreas com vegetação esparsa, predominantemente gramínea, e pouca sombra. Essa diferença impacta diretamente o conforto térmico, a permanência dos alunos em ambientes externos e a qualidade do espaço escolar. A pesquisa evidencia que tais desigualdades ambientais acompanham padrões socioespaciais e se refletem em indicadores educacionais. Conclui-se que é necessário implementar políticas públicas de arborização escolar com foco em justiça ambiental e educacional, a fim de mitigar os efeitos da exclusão territorial e promover o direito ao ambiente escolar saudável em todas as regiões do Distrito Federal.

**Palavras-Chave:** Arborização. Educação. Distrito Federal

## RESUMEN

Este artículo analiza la desigualdad ambiental entre escuelas públicas del Plano Piloto y de Samambaia, en el Distrito Federal, con enfoque en la arborización de los patios y entornos escolares. El objetivo es comprender cómo la distribución desigual de áreas verdes influye en la ambientación escolar, el bienestar y el rendimiento de los estudiantes. La metodología adoptada es cualitativa, basada en análisis documental, bibliográfico y observación de imágenes satelitales obtenidas mediante *Google Earth Pro*. También se utilizaron datos oficiales del Índice de Desarrollo de la Educación Básica (Ideb) para correlacionar infraestructura verde y desempeño escolar. Los resultados muestran que las escuelas del Plano Piloto tienen mayor cobertura vegetal, con presencia significativa de árboles, mientras que las escuelas de Samambaia presentan áreas con vegetación dispersa, predominantemente herbácea, y poca sombra. Esta diferencia impacta directamente en el confort térmico, la permanencia de los alumnos en espacios exteriores y la calidad del ambiente escolar. La investigación evidencia que dichas desigualdades ambientales siguen patrones socioespaciales y se reflejan en indicadores educativos. Se concluye que es necesario implementar políticas públicas de arborización escolar con enfoque en justicia ambiental y educativa, con el fin de mitigar los efectos de la exclusión territorial y promover el derecho a un entorno escolar saludable en todas las regiones del Distrito Federal.

**Palabras clave:** Arborización. Educación. Distrito Federal.

## 1. INTRODUCTION

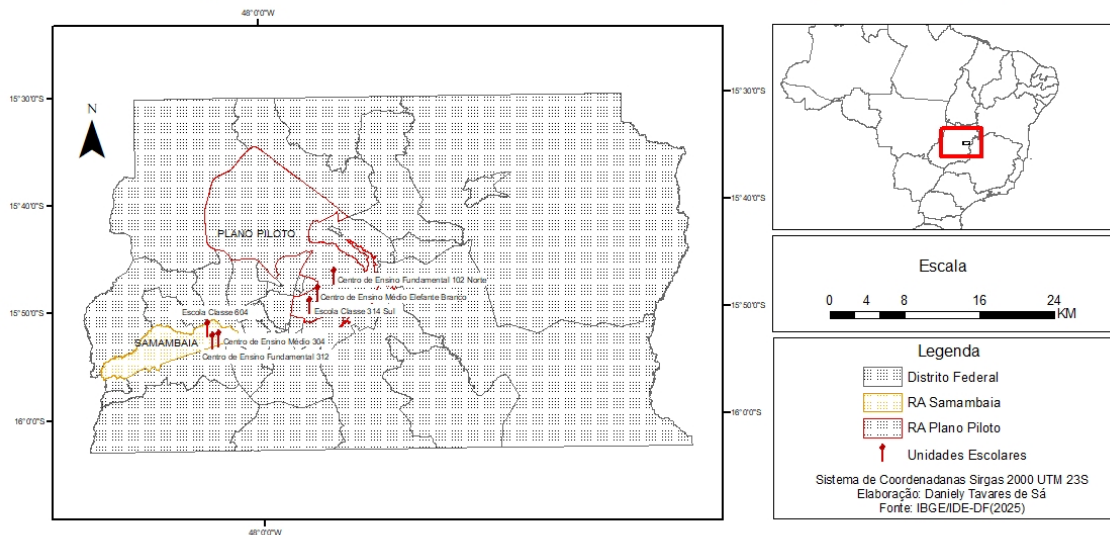
The unequal distribution of green infrastructure between central and peripheral regions of the Federal District (DF) reveals historical patterns of socio-spatial segregation and generates significant impacts on the school environment. Schools located in central areas, such as Plano Piloto, tend to be surrounded by dense tree vegetation and qualified urban environments, while peripheral institutions, such as those in Samambaia, face a scarcity of trees in both schoolyards and surroundings. This difference compromises thermal comfort, students' permanence in outdoor environments, and can negatively influence school performance, especially in the context of an urban climate crisis.

This article aims to analyze the environmental inequality between schools in Plano Piloto and Samambaia, using tree cover in schoolyards and their immediate surroundings as the comparative focus. The analysis is based on the hypothesis that the scarcity of tree cover in peripheral regions is related to patterns of territorial exclusion that directly impact student well-being and performance. To achieve this objective, the article adopts a qualitative approach, with documentary, bibliographic analysis and use of satellite images obtained via Google Earth Pro. Official data from the Basic Education Development Index (Ideb) and information from institutional reports such as those from Instituto Alana et al., the Planning Company of the Federal District (CODEPLAN) and the United Nations Children's Fund (UNICEF) are also used. In conclusion, the article engages with recent legislative proposals on the subject, such as the Complementary Bill presented in the Legislative Chamber of the Federal District that recognizes environmental inequality in the territory.

The article is organized as follows: after this introduction, the methodology used is presented; the results are then discussed based on the comparison between schools from the two administrative regions; finally, the concluding remarks are presented.

## 2. METHODOLOGY

This study adopts a qualitative approach of an exploratory and comparative nature, based on documentary, observational, and bibliographic analysis. The study areas were selected intentionally and non-probabilistically, considering the historical, socioeconomic, and urban planning contrast between the planned central region of the Federal District and a consolidated peripheral region in the context of unequal urban expansion. Six schools were analyzed, as shown in Figure 1: three located in Plano Piloto and three in Samambaia, all belonging to the public school network of the DF.



**Figure 1:** Location of school units analyzed in Plano Piloto and Samambaia, Federal District (2025). Source: organized by the author, with technical elaboration by SA, Daniely Tavares de.

A comparative case study strategy was adopted, widely used in socio-environmental and educational research that seeks to understand specific territorial inequalities rather than produce statistical generalizations (Minayo, 2017). The selection criteria considered, first and foremost, the territorial location of the institutions in historically contrasting Administrative Regions of the Federal District: Plano Piloto, a planned central area with greater urban infrastructure, and Samambaia, a peripheral region marked by lower average income and environmental deficits, as indicated by studies from CODEPLAN (2021) and reports from Instituto Alana (2024).

Furthermore, the socioeconomic contrast between the regions was considered, as well as the availability of official educational data, such as the Basic Education Development Index, and the possibility of observing green infrastructure through high-resolution satellite images. This methodological procedure engages with the literature that associates environmental inequality with socio-spatial segregation and the unequal distribution of urban green areas (Dadvand et al., 2016; Markevych et al., 2020; UNICEF, 2022). It is recognized, however, that the limited number of schools and the intentional nature of the sample impose limits on the generalization of results to all public schools in the DF. In this sense, the findings should be interpreted as analytical evidence of broader structural processes of environmental inequality, contributing to a deeper understanding of specific socio-environmental dynamics that affect the school environment and the right to education in unequal urban contexts.

The analysis of tree cover was carried out through systematic observation of satellite images obtained using the Google Earth Pro software. The visual quantification of tree cover considered tree density, the continuity of the tree canopy, and the presence of shade in schoolyards and their immediate surroundings. The quantification of tree cover adopted a comparative visual procedure based on qualitative categories, descriptively classified as: high tree cover (continuous presence of dense tree canopies), intermediate tree cover (spaced trees with discontinuous shaded areas), and low tree cover (absence or residual presence of trees, with a predominance of impermeable surfaces or grasses). This procedure, though non-metric, allows for systematic comparison among the analyzed school environments.

For the analysis of the school surroundings, an approximate spatial influence area of 100 meters around the school units was adopted, considering the scale of children's daily life and the direct influence of the immediate surroundings on thermal comfort, acoustic quality, and the school environment. The choice of this radius is based on studies that highlight the importance of vegetation near schools for children's daily environmental experience, especially in dense urban contexts (DADVAND et al., 2015).

The temporal scope of the analysis was based on the selection of satellite images from 2024, a period considered adequate for capturing the recent configuration of urban vegetation cover and minimizing distortions associated with older structural changes in land use. For each school unit analyzed, priority was given to selecting images from temporally close dates whenever the data base allowed, with the aim of reinforcing comparability between records and reducing biases arising from extreme seasonal variations or specific urban interventions.

The technical criteria for image selection prioritized the best available spatial resolution, the absence or minimal interference of cloud cover, artificial building shadows and atmospheric distortions, as well as the sharpness necessary for the visual identification of tree cover in schoolyards and their immediate surroundings. The criterion of temporal stability of land use was also considered, avoiding images obtained during construction periods, school renovations, or evident urban changes, in order to ensure greater analytical consistency.

Additionally, secondary data from official documents and public databases were used, including the Basic Education Development Index (2023), the report by Instituto Alana, MapBiomias and Fiquem Sabendo (2024), the Urban Environmental Performance Index of the DF (CODEPLAN, 2021), the DF Observatory report (2023), and technical materials from the New Capital Urbanization Company (NOVACAP). These data assisted in the triangulation of spatial information with educational and socio-environmental quality indicators.

As an essential part of the methodological approach, an extensive literature review was conducted on environmental inequality, green infrastructure, socio-spatial segregation, and their impacts on the educational context. National and international scientific articles, technical reports, and institutional documents were consulted. This review provided a theoretical basis for the categories of analysis and enabled dialogue with authors who discuss the effects of the absence of green areas on cognitive development, thermal comfort, and territorial justice.

The interpretation of results was conducted based on qualitative content analysis, associating the empirical evidence with the categories of environmental inequality, territorial exclusion, and climate justice. The analysis is grounded in a critical perspective based on socio-environmental geography and urban studies, particularly focused on the interrelationship between environmental infrastructure and educational equity.

### 3. DISCUSSION AND RESULTS

Numerous studies point to the benefits of green areas in the school environment. The report Access to Green Spaces and Climate Resilience in Schools of Brazilian State Capitals, by Instituto Alana, MapBiomias and Fiquem Sabendo, conducted in

2024, demonstrates that tree cover is related to stress reduction, improved concentration, and increased thermal comfort. The document *Benefits of Nature in the Development of Children and Adolescents: Orientation Manual*, prepared by the Brazilian Society of Pediatrics (SBP) in 2019, reinforces that contact with nature is essential for the integral development of children. Additionally, UNICEF, through its 2022 report entitled *The Necessity of Urban Green Space for Children's Optimal Development*, highlights the importance of urban green spaces for children's physical and emotional health.

Lourenço et al. (2016) highlights that "vegetation reduces temperatures due to its evapotranspiration and production of shade" and that "green areas have pollutant filtering functions, both for particulate matter and gases" (LOURENÇO et al. 2016, p. 115). The author also cites numerous studies that corroborate the beneficial relationship between green spaces and human health in different aspects:

Cognitive development and attention: The study conducted by Dadvand et al. (2015) investigated the relationship between exposure to green spaces and cognitive development in 2,593 children attending primary schools. The findings showed progress in working memory and a reduction in inattentiveness during learning, associated with the presence of green areas at the school and its surroundings.

Thermal regulation: Vegetation reduces temperatures due to its evapotranspiration and production of shade. A 10% increase in vegetation cover in Munich during summer can reduce surface temperature by up to 1.4 °C (Pauleit; Duhme, 2000).

Noise reduction: Urban green areas have also been associated with the attenuation of noise at different frequencies, acting as vertical barriers (Yang et al., 2010). Gidlöf-Gunnarsson and Öhrström (2007) evaluated residents living in locations with high and low noise intensity attributed to vehicular traffic. The results showed that locations with larger vegetation areas tend to reduce long-term discomfort generated by vehicular noise.

Mental health: The absence of green areas in residential locations has been associated with one of the contextual factors that play an etiological role in the occurrence of common mental disorders (Araya et al., 2007). (LOURENÇO et al. 2016, p. 117-118).

The studies cited by Lourenço et al. (2016), even though they were not conducted in Brazil, provide an important basis for reflection on the need for green areas in school environments and their surroundings. Directly analyzing the study by Dadvand et al. (2015), conducted by the Center for Research in Environmental Epidemiology (CREAL) in Barcelona, a strong correlation is observed between the presence of green areas in the school surroundings and children's cognitive development.

The research followed 2,593 students aged 7 to 10 years, from 36 different schools, over the course of one year, using satellite images to measure the level of vegetation around the institutions. According to the authors, "exposure to greenery around the school was associated with increases in cognitive development, particularly in executive functions and working memory" (DADVAND et al., 2015, p. 7932). This positive relationship was also evidenced through standardized cognitive performance tests, as the researchers highlight:

Our results indicate that exposure to greenery at school, more than at home, is significantly associated with an improvement in children's cognitive development over time. The greater presence of green areas around schools led to a 5% increase in working memory and a 1% reduction in inattentiveness. (DADVAND et al., 2015, p. 7932).

Furthermore, tree vegetation proved to be more effective than lawns or shrubs in promoting these benefits, suggesting that the quality of green cover also influences the effects on children's cognition:

We observed that tree cover, more than grass or shrub cover, was the main factor in the association between school vegetation and cognitive development. This suggests that not all green spaces have the same impact, and that trees may provide more cognitive benefits, possibly due to their visual complexity, cooling effects, and ability to attenuate noise. (DADVAND et al., 2015, p. 7934).

The authors further highlight that "the integration of green areas into school spaces may be an important strategy for the brain development of school-age children" (DADVAND et al., 2015, p. 7934). The researchers conclude by emphasizing the positive effects of exposure to school greenery on children's cognitive development, with significant impacts on memory, attention, and the general well-being of students:

Over a period of 12 months, we observed that an increment of exposure to the interquartile range (IQR) in the total surrounding greenery index was associated with a 5% increase in working memory progress, a 6% increase in superior working memory progress, and a 1% reduction in inattentiveness. Among our evaluated exposure measures, we observed the strongest associations for greenery within or around school boundaries. [...] Therefore, the capacity of school greenery to reduce pollutant levels may partly explain why we observed the strongest associations for school greenery. (DADVAND et al., 2015, p. 7940).

Based on these results, the presence of tree vegetation in the school environment and its surroundings goes far beyond an aesthetic or thermal comfort issue: it is a factor directly related to children's cognitive development and well-being. The study shows that green areas act as reducers of air pollution and noise, while also encouraging physical activity and positive visual stimuli, elements that, combined, significantly influence students' attention and memory capacity. In this way, tree cover in the school surroundings should be understood as a strategic tool for promoting public health and the quality of education, especially in urban contexts marked by unequal access to green infrastructure.

Based on the report *Access to Green Spaces and Climate Resilience in Schools of Brazilian State Capitals*, prepared by Instituto Alana, MapBiomias and Fiquem Sabendo (2024), we find that the presence of green areas in Brazilian schools is strongly marked by environmental inequality. The report conducted a comprehensive analysis of the proportion of green area within school plots, considering 17,337 early childhood and elementary education establishments (public and private) with available data on plot perimeter. An area was considered green when it was vegetated, and not paved, built upon, or covered by water (INSTITUTO ALANA et al., 2024, p. 8), not necessarily covered by trees, but also by shrubs and grasses.

Among the report's main findings, we can highlight that more than one third of schools (37.4% of the total) have no green area on their plot. Of the schools with green area on the plot, 33% have up to 20% green area. Only 20.6% have more than 30% green area. And 43.5% of early childhood education schools have no green area on the plot (INSTITUTO ALANA et al., 2024). More than a third of schools in Brazilian state capitals have no green areas on their plots, and this deficiency is even more pronounced among early childhood education schools and in the most socioeconomically vulnerable regions, where "more than half (52.4%) of schools located within favelas and urban communities have no green area. Only 10% of schools in favelas have more than 30% green area" (INSTITUTO ALANA et al., 2024, p. 8). This fact raises concern because:

Schools with schoolyards rich in green areas are also better adapted spaces to face the climate crisis, with more shade, biodiversity, and permeable soil, and are more capable of fostering strategies that think of the school curriculum from the perspective of access to and connection with nature and its benefits for health, climate education, and sustainability. (INSTITUTO ALANA et al., 2024, p. 11).

The convergence between the data from Dadvand et al. (2015) and Instituto Alana et al. (2024) reinforces the urgency of public policies aimed at expanding green areas in early childhood schools. The study by Dadvand et al. (2015) demonstrated that daily exposure to greenery around early childhood schools is associated with significant gains in children's cognition.

This finding has a worrying parallel in the report by Instituto Alana et al. (2024), which reveals that 43.5% of early childhood schools in Brazilian state capitals have no green area whatsoever. The absence is even more pronounced in schools located in favelas, where this number rises to more than half (INSTITUTO ALANA et al., 2024). According to the report, "the absence of nature is even greater for students enrolled in early childhood education [...] the poorer and blacker a school is, the less nature it has, both within the boundaries of its land and in its surroundings" (INSTITUTO ALANA et al., 2024, p. 4). Thus, while Dadvand et al. (2015) demonstrate the positive effects of daily contact with green areas on memory and attention, the Brazilian report reveals a reality marked by the environmental exclusion of individuals who most need these stimuli as they are in their formative phase.

Other evidence presented by Instituto Alana et al. (2024) indicates that the scarcity of green areas is not limited to school plots, extending significantly to the surroundings of educational institutions. According to the report, 20% of schools in Brazilian state capitals have no squares or parks within a radius of up to 500 meters, which directly impacts more than 1.5 million students distributed across 4,144 schools. This deficiency is even more pronounced in the initial stages of basic education, since 78% of early childhood schools without squares and parks within this radius are located within or up to 1 km from favelas and urban communities, a pattern that is repeated in elementary education, where 62% of schools without squares within a 1,000-meter radius are in the same territorial conditions. The study also shows that environmental inequality has an explicit racial and socioeconomic dimension, as 30.1% of schools that predominantly serve Black students have no green areas within a 500-meter radius, a figure significantly higher than that observed among schools with a majority of white students (11.4%).

Furthermore, schools with the lowest Socioeconomic Level Indicator (INSE) concentrate the greatest deprivations of green infrastructure. These data reinforce that the unequal distribution of green areas in urban space reproduces historical patterns of socio-spatial, racial, and economic segregation, deepening the environmental and educational inequalities that affect children in the most vulnerable territories (INSTITUTO ALANA et al., 2024). By correlating international findings with national data, it is possible to infer that the scarcity of vegetation in Brazilian schools, especially in early childhood schools in vulnerable territories, represents not only an environmental inequality, but also an obstacle to cognitive development, learning, and educational equity.

The territorial exclusion of green infrastructure in schools deprives thousands of children of benefits essential to their cognitive, emotional, and physical development. Environmental inequality is not limited to the exclusion of access to natural assets, but also encompasses the systematic exposure of peripheral populations to degraded and dangerous conditions, such as pollution, extreme heat, and the absence of healthy educational spaces.

This exclusionary dynamic is based on the logic of segregation between center and periphery in large Brazilian cities. In this scenario, Brasília, in the Federal District, even though it is known for its modern urban planning project and the presence of large tree-covered areas in Plano Piloto, the data from the Instituto Alana et al. (2024) report reveals a worrying reality for many schools in the federal capital, especially those located outside the central area.

The DF presents a significant inequality in access to green areas between schools located in Plano Piloto and those situated in peripheral administrative regions, such as Samambaia, Ceilândia, and Sol Nascente/Pôr do Sol. This disparity expresses a pattern of environmental exclusion that primarily affects Black children and those from low-income families.

According to the report, 34.7% of schools in the DF have no green area on their plots, which compromises the thermal comfort and well-being of students (INSTITUTO ALANA et al., 2024, p. 8). This data is especially relevant considering that the Federal District has regions with a high incidence of heat islands and extreme drought events, which are increasingly frequent with climate change. The absence of tree cover worsens thermal discomfort and can negatively impact school performance, mainly in public schools in peripheral areas.

Furthermore, 51.6% of schools in the DF are in areas with vegetation cover below 20%, and 25.4% are in areas with cover below 10% (INSTITUTO ALANA et al., 2024, p. 9). These indicators show that, even with the "park city" image that Brasília carries, access to green spaces is not equitable and reflects historically constructed territorial and socioeconomic inequalities.

The situation is further aggravated by the fact that 12.3% of DF schools are located in areas with average temperatures up to 1.49 °C above the urban average (INSTITUTO ALANA et al., 2024, p. 15), which indicates that these institutions are under the influence of more severe urban microclimates. The absence of tree vegetation in these locations contributes to the intensification of the effects of extreme heat, a risk factor for health, especially for children. As previously noted, Lourenço et al. (2016) highlighted that "vegetation reduces temperatures due to its evapotranspiration and production of shade", citing the study by Pauleit and Duhme (2000) which found that "a 10% increase in vegetation cover in Munich during summer can reduce surface temperature by up to 1.4 °C" (LOURENÇO et al., 2016, p. 117). In other words, the mere implementation of green areas in schools or their surroundings in peripheral areas of Brasília could offset the temperature increase that affects 12.3% of DF schools.

Given the data presented, it becomes evident that access to green infrastructure in schools of the Federal District is far from uniform. The distribution of green areas follows the historical pattern of socio-spatial segregation, in which more central regions, such as Plano Piloto, concentrate greater investments in urbanization and environmental quality, while peripheral regions, such as Samambaia, live with a chronic deficit of vegetation and green infrastructure (such as parks and squares). This environmental inequality between center and periphery will be further explored below, with a specific focus on the comparison between the realities of green areas in school spaces and their surroundings in the Administrative Regions (AR) of Plano Piloto and Samambaia.

Marques and Torres (2005) state that "environmental inequalities refer to the differentiated exposure of social groups to environmental risk situations, normally associated with location conditions and the quality of available urban infrastructure" (MARQUES; TORRES, 2005, p. 47). Taking this definition and using the spatial units analyzed in this section (Plano Piloto and Samambaia) as reference, we can observe the environmental inequalities in the Federal District based on data from the report Map of Inequalities of the DF (2023), prepared by the Institute of Socioeconomic Studies (INESC), which identifies disparities between Plano Piloto and peripheral regions, affirming that "inequalities in access to public policies in the DF reveal historical patterns of exclusion based on territory, income, and race" (INESC, 2023, p. 12).

According to the data, 99% of households in Plano Piloto are located near parks and gardens, while only 30% of households in Samambaia have this same access (INESC, 2023, p. 74). Furthermore, when analyzing the presence of tree-lined streets, Plano Piloto again appears among the best indices, with 99% of households located on streets with tree cover, while in Samambaia this percentage is significantly lower, at only 67% (INESC, 2023, p. 75).

Another study, conducted by the Public Policy Observatory of the Federal District (ObservaDF), entitled Sustainable Habits and Environmental Inequalities in the Federal District (2023), reinforces the diagnosis that environmental inequalities in the DF are strongly associated with the socioeconomic profile of the Administrative Regions. Based on interviews with residents from 31 ARs, the study reveals that the lower the income, the worse the environmental conditions perceived by residents. Lower-income regions, such as Samambaia, have less urban tree cover, greater presence of noise, and lower thermal and acoustic comfort (OBSERVADF, 2023, p. 6).

Furthermore, the use of ecological parks and leisure areas is significantly lower among residents of these regions, highlighting the exclusion from the right to access nature and environmentally qualified leisure. Finally, the study also points out that most of the population in lower-income regions expresses pessimism about the possibility of environmental improvement, believing that climate and urban problems tend to worsen in the coming years (OBSERVADF, 2023, p. 28).

Regarding children, the article by Markevych et al. (2020) conducted a systematic review of 21 international studies and concluded that there is consistent evidence that contact with green areas is associated with benefits for children's mental health, including reduction of symptoms of anxiety, depression, and attention deficit hyperactivity disorder (ADHD). According to Markevych et al. (2020):

The reviewed studies suggest a beneficial relationship between exposure to green areas and the mental well-being of children, especially in restoring attention and reducing behavioral difficulties" (MARKEVYCH et al., 2020, p. 14).

UNICEF also states that "contact with nature supports cognitive development, reduces symptoms of ADHD, and improves mood. The greener the environment, the better the outcome for children" (UNICEF, 2022, p. 8). Furthermore, Markevych et al. (2020) emphasize that the positive effects are most evident when green areas are close to the residence or school, reinforcing the importance of the presence of vegetation in the school surroundings. On the other hand, the authors also highlight that populations with lower socioeconomic levels tend to have less access to quality green spaces, which amplifies existing inequalities:

Children from low-income families are less likely to live near green areas or to have access to them, which can worsen existing health inequalities. (MARKEVYCH et al., 2020, p. 12)

In the same vein, UNICEF corroborates by stating that "children living in poor neighborhoods generally have much more limited access to nature than those in wealthier areas" (UNICEF, 2022, p. 4). This finding reinforces the importance of public policies that promote equity in access to green spaces, especially in urban contexts where the unequal distribution of these spaces can negatively impact children's development. The integration of green areas in school and residential environments, especially in low-income communities, is essential for promoting children's mental health and well-being, contributing to the reduction of existing social and environmental inequalities.

Using geospatial data and satellite images, it was possible to observe a significantly greater concentration of green areas in the schoolyards and surroundings of Plano Piloto compared to Samambaia. For the comparative visual analysis, Google Earth Pro was used, which offers high-resolution images and allows visualization not only of school plots, but also of their immediate surroundings. The inclusion of the surroundings in the analysis is essential, because studies indicate that vegetation around schools also influences children's well-being and cognitive performance (MARKEVYCH et al., 2020; INSTITUTO ALANA et al., 2024).

Figures 2 and 3 are presented below, corresponding, respectively, to images of Escola Classe 314 Sul (EC 314 Sul), located in Plano Piloto, and Escola Classe 604 (EC 604), located in Samambaia. Both are elementary schools serving the initial years (1st to 5th grade).



**Figure 2.** Satellite image of Escola Classe 314 Sul in Plano Piloto. Source: Google Earth Pro (2025).



**Figure 3.** Satellite image of Escola Classe 604 in Samambaia. Source: Google Earth Pro (2025).

As observed in Figure 2, referring to EC 314 Sul, located in Plano Piloto, the tree cover is dense, with large trees with wide canopies, a greening pattern that was planned since the city's founding in the 1960s, demonstrating that the presence of

vegetation is integrated into the daily school and residential life (school surroundings). In contrast, Figure 3, which shows EC 604 and its surroundings in Samambaia, reveals an environment marked by low tree cover, both in the schoolyard and in the urban surroundings, with open areas and sparse vegetation predominating, leaving it more exposed to heat islands and with lower indices of thermal and acoustic comfort. Reinforcing the role of green areas in children's mental development, Markevych et al. (2020) states that:

Proximity to green areas was frequently associated with better psychological outcomes among children, indicating the importance of daily exposure in residential and school environments. The presence of green spaces can be a protective factor for children's emotional and behavioral development, acting in stress reduction and the promotion of cognitive functions. (MARKEVYCH et al., 2020, p. 10-11)

The school performance data measured by the National Institute of Educational Studies and Research Anísio Teixeira (Inep), through the Ideb, for the year 2023, reveal disparities between the two schools: while EC 114 Sul achieved 6.9 in the Ideb (2023), EC 604 in Samambaia had a lower performance, with 6.6 in the Ideb in the same year. The Ideb data (2023) corroborate the thesis that environmental inequality is also linked to social inequality, and that both impact children's school performance.

The greenery observed in Samambaia, while present in some school areas, refers mainly to ground-level vegetation composed of grasses, which has limited effectiveness in terms of thermal, acoustic, and environmental comfort. The significant absence of tree cover with dense canopies compromises the capacity of these spaces to act as natural barriers against excessive heat, direct solar radiation, noise pollution, and the effects of heat islands, phenomena that are particularly intense in peripheral urban areas. Thus, it is not merely a matter of quantitative vegetation presence, but above all of its quality and typology.

In a complementary manner, Markevych et al. (2020) also highlight that "proximity to tree-covered areas is associated with thermal regulation, reduction of urban noise, and positive sensory stimuli, all factors that directly influence children's cognitive performance" (MARKEVYCH et al., 2020, p. 14). Thus, the lack of trees in the surroundings of schools in Samambaia is not only an indicator of environmental inequality, but also a concrete barrier to students' full development, worsening the educational vulnerabilities already present in lower-income regions.

Two middle school institutions are presented below for comparison: Centro de Ensino Fundamental 102 da Asa Norte (CEF 102 Norte), located in Plano Piloto (Figure 4), and Centro de Ensino Fundamental 312 (CEF 312) in Samambaia (Figure 5).



**Figure 4. Satellite image of CEF 102 Norte in Plano Piloto. Source: Google Earth Pro (2025).**



**Figure 5. Satellite image of CEF 312 in Samambaia. Source: Google Earth Pro (2025).**

As observed in Figure 4, the courtyard of CEF 102 Norte, located in Plano Piloto, shows high tree cover, with several medium and large trees arranged both inside the school and along its outer edges. The immediate surroundings of the institution are also characterized by tree-lined streets and shaded sidewalks, composing an urban microenvironment with natural thermal comfort, better air quality, and less direct exposure to solar radiation. This urban configuration favors not only students' well-being but also their permanence in outdoor environments during breaks, which can positively contribute to cognitive performance, socialization, and physical and emotional health.

In contrast, the image in Figure 5 shows that CEF 312, located in Samambaia, is in a region with low tree cover. The school's courtyard has few sparse trees and there is no significant vegetation cover in its surroundings. The nearby streets and neighboring residential lots lack tree cover, creating an urban landscape exposed to excessive heat and with low microclimate regulation capacity. This environment can amplify the effects of urban heat islands and compromise students' thermal comfort, hindering their concentration and increasing physical strain during periods of higher solar radiation.

The absence of green areas around the school also reduces positive sensory stimuli and shaded resting spaces that are essential for a healthy school routine, especially in peripheral urban contexts marked by greater social and climate vulnerability. This difference between the two analyzed contexts clearly illustrates how environmental inequality manifests itself in the urban landscape and directly impacts the quality of the school experience.

Referring to the 2023 Ideb data, an apparently modest difference is observed between the performance of CEF 102 Norte, located in Plano Piloto, which scored 5.2, and CEF 312, located in Samambaia, with a score of 4.9. Although the numerical difference may seem small, it reveals a significant structural disparity when contextualized by the environmental conditions in which these schools are embedded.

CEF 102 Norte benefits from a surrounding with greater tree cover, better urban infrastructure, and lower levels of exposure to pollutants and heat islands. CEF 312, on the other hand, operates in a scenario marked by scarcity of quality green areas, predominance of ground-level vegetation, high solar radiation, and lower thermal and acoustic comfort, factors that directly impact students' concentration, well-being, and performance.

The scientific literature demonstrates that the presence of trees in the school environment is associated with improved cognitive performance, stress reduction, and increased attentional capacity (DADVAND et al., 2015; MARKEVYCH et al., 2020). Thus, it is not merely an educational difference measured by numerical indices, but an inequality that is rooted in environmental and territorial aspects. The lack of green infrastructure in Samambaia not only compromises the quality of the school environment, but also deepens the structural barriers that hinder equitable access to quality education.

It can therefore be stated that the unequal distribution of green areas between schools in Plano Piloto and Samambaia is not a secondary factor, but one of the central vectors in the perpetuation of educational inequalities in the Federal District. To conclude the comparative image display, we have the Centro de Ensino Médio (CEM) Elefante Branco in Plano Piloto (Figure 6) and CEM 304 in Samambaia (Figure 7).



**Figure 6.** Satellite image of CEM Elefante Branco in Plano Piloto. Source: Google Earth Pro (2025).



**Figure 7.** Satellite image of CEM 304 in Samambaia. Source: Google Earth Pro (2025).

As we can observe in Figures 6 and 7, the discrepancy in tree cover between the schoolyards and surroundings of schools in both ARs is a fact that marks environmental inequality in the DF and contradicts guidelines for the full development of individuals, since "children need safe and easy access to green spaces near where they live and learn. Tree-covered school environments promote well-being, mental health, and academic performance" (UNICEF, 2022, p. 6).

Regarding the Ideb (2023), once again the school in the center outperforms the one in the periphery: with 3.3 for CEM Elefante Branco and 3.0 for CEM 304. Despite the shared challenges related to public secondary education, it is important to note that CEM 304 is located in one of the regions with the lowest green infrastructure in the DF, also facing the typical social and urban pressures of peripheral areas. The absence of tree-covered areas around the school can intensify thermal stress, reduce environmental quality, and impair student engagement. Even with similar indices, the school in Samambaia operates in a context of significant environmental disadvantage, which deepens the effects of structural inequality in the educational process.

Official data attest to the inequality in green distribution among the Administrative Regions of the Federal District, as seen in official tree-planting data released by NOVACAP. Between 2023 and 2024, 7,841 trees were planted in Plano Piloto, while Samambaia received only 16 seedlings. Other ARs, such as Gama, Riacho Fundo, and Recanto das Emas, recorded no planting in the same period (FÉLIX, 2024).

Another piece of evidence highlighting the scenario of environmental inequality in the Federal District can be found in the study Urban Environmental Performance Index of the Federal District (IUDA-DF), prepared in 2021 by CODEPLAN. The report uses the concept of "dimensional index", which refers to the standardized numerical value assigned to each Administrative Region, ranging from 0 (worst performance) to 1 (best performance), based on dimensions such as green area, basic sanitation, sustainability, and resilience.

This index allows for an objective comparison of environmental conditions between different regions. The data reveal that Plano Piloto ranks among the regions with the best environmental performance, with an overall index of 0.805, while Samambaia

records 0.579, with significantly lower indicators in crucial aspects such as tree cover and urban vegetation cover. In the indicator of tree and shrub cover per capita, Samambaia appears among the most deprived regions, with only 5.00 m<sup>2</sup> of vegetation per inhabitant, an index comparable to that of Varjão (4.73 m<sup>2</sup>/inhab.) and Recanto das Emas (6.64 m<sup>2</sup>/inhab.). Although the report does not present the specific data for Plano Piloto in this regard, the structural inequality is evident, as the study itself highlights:

As the dimensional index grows, so does average household income, schooling, and the educational level of household heads. Higher-income ARs report being located in more tree-covered areas, with the presence of parks and gardens, while in lower-income ARs fewer residents report living in these conditions. The pattern is repeated for the perception of urban cleanliness, thermal and visual comfort, and access to green areas (CODEPLAN, 2021, p. 17).

The institutional recognition of this environmental inequality in the Federal District can be observed in the Complementary Bill proposed by district representative Fábio Félix in 2024, which establishes the District Policy for Urban Greening and Combating Environmental Inequalities. The proposal establishes clear goals, such as guaranteeing at least 15 m<sup>2</sup> of green area per inhabitant in all Administrative Regions and universal access to tree-covered spaces within a radius of up to 500 meters from residences. Furthermore, the bill acknowledges that peripheral regions of the DF, such as Samambaia, face a historical deficit of tree cover and are more vulnerable to the effects of climate change. By publicly acknowledging that the distribution of green areas is unequal and that this disproportionately affects the poorest populations, the State reveals that the issue is not merely technical or urban planning-related, but one of socio-environmental justice. It therefore represents an important step forward in addressing the ecological asymmetries that structure the urban space of the DF.

In light of the above, it is evident that the environmental inequality between central and peripheral regions of the Federal District goes beyond the mere absence of trees in schoolyards, constituting a concrete expression of the social and territorial injustices that structure urban space. Based on the integrated analysis of official data, satellite images, and legal and scientific frameworks, it is observed that unequal access to green infrastructure is associated with differentiated conditions of environmental well-being in school territories. Although a direct causal relationship between vegetation cover and school performance cannot be established, the evidence suggests that contexts characterized by less tree cover tend to offer less favorable environments for thermal comfort, outdoor permanence, and the school environment as a whole. This scenario reinforces the need for public policies guided by environmental equity, the recognition of historically vulnerable territories, and urban planning that incorporates the centrality of childhood, climate justice, and the addressing of structural inequalities that characterize the Federal District.

#### 4. FINAL CONSIDERATIONS

The analysis developed throughout this work made it possible to demonstrate, based on empirical data, scientific studies, and institutional reports, that the inequality in the distribution of green areas between Plano Piloto and Samambaia constitutes an example of socio-environmental inequality in the DF. The difference in vegetation cover of schoolyards and their surroundings between these two regions reveals a profound social, economic, and environmental asymmetry that directly affects the quality of the school environment and, consequently, the teaching-learning process, health, well-being, and the cognitive development of children.

Studies such as those by Dadvand et al. (2015) and Markevych et al. (2020) reinforce the relationship between the presence of green areas and psychosocial and cognitive benefits for childhood. The data from Instituto Alana et al. (2024), CODEPLAN (2021), NOVACAP, and ObservaDF (2023) show that schools located in lower-income regions are more exposed to the absence of tree cover, high temperatures, pollution, and low-quality school environments. This reality reinforces the idea that access to green spaces in schools cannot be understood as a privilege, but as a right associated with environmental justice and educational equity. In this sense, the empirical data analyzed deepen and confirm diagnoses already presented by institutional reports and academic research, by showing that the unequal distribution of urban green areas also affects school spaces.

The environmental inequality in the Federal District, as evidenced throughout the study, presents itself as an institutionalized and territorially produced phenomenon. The proposal of the Complementary Bill authored by district representative Fábio F%lix, which establishes guidelines for the District Policy for Urban Greening and Combating Environmental Inequalities, indicates that the State itself officially recognizes the existence of these socio-environmental asymmetries and the need to address them through legal and planning instruments. This legislative initiative makes explicit that the unequal distribution of green infrastructure is not merely the result of spontaneous historical processes, but also of political choices that can, and should, be revised.

As an implication for public policy, the results of this study reinforce the urgency of incorporating environmental justice as a structuring principle of urban planning and educational policies, with particular attention to the greening of urban spaces located in peripheral regions. These policies need to recognize childhood as a central axis of urban planning, considering that green infrastructure plays a relevant role in promoting well-being, environmental health, and territorial equity. By integrating educational and environmental policies, the possibility is created of mitigating historical inequalities and ensuring more just conditions of development and learning for children and adolescents.

It should be noted, finally, that future investigations with expanded samples and complementary quantitative methods can deepen the understanding of the relationships between school environment, socioeconomic conditions, and educational performance in the DF. The advancement of these investigations tends to qualify the scientific debate and the planning of public policies, by more robustly demonstrating how school green infrastructure articulates with the promotion of health, child well-being, and socio-environmental equity.

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## AUTHORS' CONTRIBUTION:

The author is responsible for all stages in the production of this paper.

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