



Climate injustices from Curitiba and metropolitan region residents perception

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Injustiças climáticas a partir da percepção dos moradores de Curitiba e Região Metropolitana

RESUMO

Objetivo: O estudo tem como objetivo analisar de que forma fatores de raça, gênero e renda influenciam a percepção dos impactos das mudanças climáticas em Curitiba e Região Metropolitana, buscando evidenciar as desigualdades socioambientais presentes nos territórios urbanos.

Metodologia: A pesquisa adotou uma abordagem quantitativa, com aplicação de questionário estruturado a 645 moradores da região estudada. Os dados foram analisados estatisticamente, de modo a identificar padrões de percepção e suas correlações com variáveis sociodemográficas.

Originalidade/relevância: O estudo insere-se no debate sobre justiça climática e interseccionalidade, abordando um gap teórico e empírico existente nas análises sobre percepções climáticas em contextos urbanos brasileiros. A relevância reside na integração de dimensões sociais à compreensão dos impactos ambientais, contribuindo para o avanço das discussões sobre vulnerabilidade climática urbana.

Resultados: Os resultados apontam que mulheres, pessoas negras e de baixa renda relatam maior percepção de impactos relacionados a chuvas intensas e alagamentos. Esses grupos demonstram maior sensibilidade aos riscos climáticos cotidianos, refletindo desigualdades estruturais e territoriais.

Contribuições teóricas/metodológicas: O estudo reforça a importância de incorporar variáveis interseccionais em pesquisas sobre mudanças climáticas urbanas, contribuindo para o aprimoramento de modelos analíticos que integram fatores sociais e ambientais na avaliação da vulnerabilidade climática.

Contribuições sociais e ambientais: A pesquisa evidencia a necessidade de políticas públicas que articulem justiça climática, equidade social e planejamento urbano, orientando a formulação de estratégias de adaptação que promovam resiliência e redução das desigualdades nos territórios urbanos brasileiros.

PALAVRAS-CHAVE: Mudanças Climáticas. Justiça Climática. Interseccionalidade. Percepção Urbana. Vulnerabilidade.

Climate injustices from Curitiba and metropolitan region residents perception

ABSTRACT

Objective: This study aims to analyze how race, gender, and income influence the perception of climate change impacts in Curitiba and its Metropolitan Region, highlighting the socioeconomic and environmental inequalities present in urban territories.

Methodology: A quantitative approach was adopted through the application of a structured questionnaire to 645 residents of the study area. Statistical analyses were conducted to identify perception patterns and their correlations with sociodemographic variables.

Originality/relevance: The study contributes to the debate on climate justice and intersectionality, addressing a theoretical and empirical gap in the analysis of climate perceptions within Brazilian urban contexts. Its relevance lies in integrating social dimensions into the understanding of environmental impacts, thereby advancing discussions on urban climate vulnerability.

Results: The results indicate that women, Black people, and low-income groups report a higher perception of impacts related to heavy rainfall and flooding. These groups demonstrate greater sensitivity to everyday climate risks, reflecting structural and territorial inequalities.

Theoretical/methodological contributions: The study highlights the importance of incorporating intersectional variables into research on urban climate change, contributing to the improvement of analytical models that integrate social and environmental factors in the assessment of climate vulnerability.

Social and environmental contributions: The findings underscore the need for public policies that combine climate justice, social equity, and urban planning, guiding the development of adaptation strategies that promote resilience and reduce inequalities in Brazilian urban territories.

KEYWORDS: Climate change. Climate justice. Intersectionality. Urban perception. Vulnerability.

Injusticias climáticas desde la percepción de los habitantes de Curitiba y su Región Metropolitana

RESUMEN

Objetivo: El estudio tiene como objetivo analizar cómo los factores de raza, género e ingresos influyen en la percepción de los impactos del cambio climático en Curitiba y su Región Metropolitana, destacando las desigualdades socioeconómicas y ambientales presentes en los territorios urbanos.

Metodología: Se adoptó un enfoque cuantitativo mediante la aplicación de un cuestionario estructurado a 645 residentes del área de estudio. Los datos fueron analizados estadísticamente para identificar patrones de percepción y sus correlaciones con variables sociodemográficas.

Originalidad/relevancia: El estudio se inserta en el debate sobre justicia climática e interseccionalidad, abordando un vacío teórico y empírico en los análisis de percepciones climáticas en contextos urbanos brasileños. Su relevancia radica en integrar las dimensiones sociales a la comprensión de los impactos ambientales, contribuyendo al avance de las discusiones sobre vulnerabilidad climática urbana.

Resultados: Los resultados muestran que las mujeres, las personas negras y los grupos de bajos ingresos perciben con mayor intensidad los impactos relacionados con lluvias intensas e inundaciones. Estos grupos presentan mayor sensibilidad ante los riesgos climáticos cotidianos, reflejando desigualdades estructurales y territoriales.

Contribuciones teóricas/metodológicas: El estudio refuerza la importancia de incorporar variables interseccionales en las investigaciones sobre cambio climático urbano, contribuyendo al perfeccionamiento de modelos analíticos que integren factores sociales y ambientales en la evaluación de la vulnerabilidad climática.

Contribuciones sociales y ambientales: La investigación evidencia la necesidad de políticas públicas que articulen justicia climática, equidad social y planificación urbana, orientando la formulación de estrategias de adaptación que promuevan la resiliencia y reduzcan las desigualdades en los territorios urbanos brasileños.

PALABRAS CLAVE: Cambio climático. Justicia climática. Interseccionalidad. Percepción urbana. Vulnerabilidad.

1 INTRODUCTION

The accelerated process of urbanization and industrialization, population growth, massive economic inequalities, irresponsible and unsustainable consumption and production patterns with extreme environmental impacts, disjointed development characterized by intense vertical expansion, soil compaction and sealing, the removal of vegetation and waterways, and the delay in implementing infrastructure adequate for the growth of cities, intensify the effects of climate change and reveal the unpreparedness of cities for the arrival of this new model of social structure (Costa, 2024; Nobre; Young, 2011; Robina, 2021).

David Harvey (2009) discusses globalization as a geopolitical project that has exacerbated inequalities between and within countries, resulting in an increased concentration of wealth and power in the hands of a few. This has led to devastating environmental consequences caused by the logic of relentless economic growth. Based on this line of thought, historically, we can perceive the relationships at play within the Brazilian context. Singer (2010) argues that urban development in Brazil is inseparable from the country's economic and territorial formation. Urbanization is a process intrinsically linked to capitalist development, where cities not only concentrate economic activities but also perpetuate structural inequalities. Thus, urban growth is driven by the demand for industrial labor and services, creating a cycle of economic growth that benefits urban elites while marginalizing the poorest segments of society. This generates regional disparities resulting from this process, influenced by the cumulative advantages and agglomeration economies concentrated in urban areas.

This phenomenon perpetuates a cycle of impoverishment in less-favored regions, exacerbating socioeconomic inequalities in Brazil. This analysis must be considered in contemporary discussions on regional development and social inclusion policies (Singer, 2010). Thus, megaprojects are essential for the construction of the hegemony of financial capital, promoting a shift in the political model of governance that prioritizes contractual demands over democratic decisions. Guided by this discourse, the relationships between urban space, territory, and the environment are shaped by the inequality and injustice caused by spatial segregation, which further increases the complexity of cities, since the impacts will be felt differently across each segment of the population, and heightens concerns that these phenomena will occur in the coming years, whether in city centers or on the peripheries (Rolnik, 2015).

These counterpoints help to understand the logic of occupation in metropolises and their class dynamics, marked by profound social disparities that disproportionately affect the lives of metropolitan populations. Such inequalities constitute a central dimension for the analysis of territorial heterogeneities and demonstrate that there is no neutrality in the formulation of guidelines and plans—or the lack thereof—for shaping urban development (Deschamps, 2004; Iwama et al., 2016; Nobre; Young, 2011).

The state, through privatization and the adoption of private criteria in public management, has promoted the commodification of urban life. This trend weakens the provision of urban services and social rights, prioritizing financial gain at the expense of universal

access. The result is a permanent budget crisis, limiting the state's ability to act effectively in the face of the climate emergency, which has emerged as the greatest recent global humanitarian challenge. Addressing this crisis requires innovation to tackle accumulated inequalities and climate impacts, taking into account different social realities and vulnerabilities, and, above all, aiming for a new way of living; the only solution for a future world lies in an equitable model of life (Costa, 2024).

Currently, Brazil ranks among the countries with the greatest socioeconomic inequalities in the world (Costa, 2024). This scenario becomes even more critical in the face of climate change, which exacerbates social injustices and environmental risks by highlighting the greater exposure of vulnerable social groups to extreme weather events. At the city level, inadequate land use and poor urban infrastructure contribute to socio-spatial segregation, concentrating low-income populations in high-risk areas (Instituto Pólis, 2023; Waidelich et al., 2024).

The city's peripheral growth occurred in a haphazard manner with little planning, leading to the formation of informal settlements in areas inhabited by vulnerable populations. The low level of integration in these regions has reinforced processes of socio-spatial segregation, revealing an urban structure that limits equitable access to opportunities. In this context, a morphological analysis of the city is essential to guide planning policies that promote greater territorial integration (Tochetto et al., 2024).

The climate emergency, therefore, necessitates a deeper debate on the most vulnerable populations and territories, especially in urban centers (Acseirad, 2002). These heterogeneities become even more evident given the low resilience of urban spaces to the risks of climate-related disasters, a major global challenge we face. The complexity of this phenomenon is rooted in the multiple layers of political, social, cultural, and economic relations that intertwine at various scales, revealing conflicting interests and differentiated impacts (Instituto Pólis, 2023; Jacobs, 2014).

The link between the unequal production of urban space and the contemporary debate on climate change highlights that climate vulnerability is a socially produced, territorially distributed, and politically conditioned phenomenon, and not merely the result of natural or environmental factors. In this context, climate impacts follow the geography of urban inequality, affecting with greater intensity peripheries marked by precarious housing, infrastructure deficits, and historical neglect of public policies. At the same time, current urban policies tend to reinforce this pattern by concentrating investments and climate adaptation strategies in central and more valued areas (Godoy et al., 2026).

Beyond the technical debate on sustainability in urban settings, it is necessary to consider social, cultural, political, economic, and territorial factors. The attempt to establish connections between the social and environmental dimensions resonates with issues such as water security, basic sanitation, electricity supply, adequate housing, and waste management. Climate change cannot be treated merely as a meteorological or technical event. It is necessary to move toward an understanding of vulnerability that integrates environmental and built dimensions (Robina, 2021). It is equally important to prioritize the principles of justice, equality,

diversity, and public participation as elements that build a truly sustainable environment (Louback; Lima, 2022; Masieiro, 2023; Rolnik et al., 2015).

In this context, it is urgent for governments to adopt policies and measures to combat the causes of climate change and ensure the adaptation and resilience of cities. Adaptation, in this sense, encompasses the set of actions necessary for cities and institutions to address climate impacts and risks (Maior; Cândido, 2014). Understanding these risks is a fundamental prerequisite for proposing effective measures that enhance urban resilience. Internal regulation can drive public policies more aligned with the new environmental reality. The future of cities will increasingly depend on the adoption of integrated planning and management systems capable of responding to profound transformations in the economic, social, and political spheres (Coelho et al., 2024; Mendonça; Del Vachio-Lima, 2020).

In order to address the structural and dynamic consequences of the interaction between two or more axes of subordination, it is understood that forms of oppression do not operate in isolation but are intertwined, creating unique experiences of inequality and exclusion (Pereira, 2021). For the purposes of this study, intersectionality, in short, refers to the investigation of power relations that influence social relations in societies marked by diversity, as well as individual experiences in everyday life (Collins Hill; Bilge, 2021). Therefore, vulnerability to climate impacts is not distributed homogeneously, being influenced by social, economic, environmental, and cultural factors (Amorim-Maia et al., 2022; IPCC, 2023; Leite, 2023).

The literature highlights the need for inclusive policies that account for these inequalities in the formulation of climate resilience strategies. Marginalized communities, including racialized populations, women, and low-income groups, often perceive climate change as a more imminent threat due to their greater vulnerability to extreme events such as floods, heatwaves, and environmental degradation. These populations face structural barriers to adaptation, such as a lack of resilient infrastructure, limited access to information on climate mitigation, and public policies that do not always account for their specific realities (Meenar et al., 2023; Climate Observatory, 2022; Robina, 2021).

Studies such as those by Burbidge et al. (2022) indicate that the unequal distribution of urban infrastructure, such as the presence of green spaces, directly affects exposure to heat stress. Similarly, Zoll et al. (2023) demonstrate that the perception of climate risk is influenced by factors such as gender and race, with women and racialized groups showing greater concern and engagement in mitigation actions. Furthermore, studies such as those by Pazhuhan and Amirzadeh (2024) clarify that the lack of access to financing and adequate public policies exacerbates the vulnerability of low-income populations, limiting their ability to adapt to the impacts of climate change. The review of the articles shows that different social groups understand and react to climate change in distinct ways, depending on their direct exposure to environmental impacts, access to information, and trust in institutions.

Meanwhile, Ayoade and Ahmed (2020) highlight that, in some regions, low perception of climate risk may be influenced by the normalization of natural disasters. Communities accustomed to recurring floods or long periods of drought may not associate these events with climate change, but rather with a cyclical climate pattern. Significant differences between formal

and informal settlements indicate that marginalized populations tend to perceive climate risks as less imminent, hindering the adoption of preventive measures (Rana et al., 2023).

Research by Bacha et al. (2021) shows that factors such as deforestation, pollution, and population growth are widely recognized as causes of climate change, while extreme weather events, such as droughts and floods, are perceived as direct threats. However, socioeconomic and educational barriers hinder the implementation of effective adaptation strategies, suggesting the need for public policies that strengthen local knowledge and response capacity. Thus, effective policies must be multi-scalar, considering not only environmental factors but also social determinants that influence the resilience of vulnerable populations.

Zoll et al. (2023) found differences in how social groups perceive climate change. Women and racialized people demonstrate greater environmental concern, as they often live in more vulnerable areas and have fewer resources for adaptation. Furthermore, women tend to be more involved in community networks and, therefore, recognize the importance of collective action to mitigate environmental impacts.

The vulnerability of urban populations to climate change is linked not only to urban infrastructure but also to unequal access to essential services such as transportation, sanitation, and public health. Studies indicate that the impacts of global warming are exacerbated in areas with poor infrastructure, resulting in transportation disruptions, flooding, and health risks, particularly affecting children and the elderly (Leite, 2023). Climate change directly impacts housing security, compromising access to adequate housing and increasing maintenance and energy costs.

Studies indicate that low-income populations and racialized communities are more vulnerable to these challenges, facing energy insecurity and forced displacement due to extreme weather events (Hernández, 2022). This underscores the need for participatory approaches in developing adaptation strategies that take local realities into account and ensure climate justice. Hence the need for policies that integrate risk reduction and the fight against social inequality (Rahman; Atun; Martinez, 2022). Variations in adaptive capacity across different areas and social groups suggest that intervention strategies must consider context-specific aspects, recognizing the complexity of adaptation in informal settings (Waters; Adger, 2017).

Lenzholzer et al. (2020) analyze climate awareness and the urgency of adaptation among different social groups, including citizens, politicians, urban planners, and experts. The study finds that, despite a general perception of the need for climate adaptation, knowledge about specific urban phenomena, such as heat islands and wind patterns, remains low among citizens and politicians. The research suggests that educational strategies tailored to each group can raise awareness and facilitate the implementation of adaptation policies.

Finally, the literature highlights the need for more inclusive climate policies that take structural inequalities into account when formulating adaptation and mitigation strategies. Thus, the urban environment can be understood as a set of interrelated elements within an environmental dynamic, undergoing changes and being (re)created through human interventions, encompassing natural and/or artificial elements that make up the city. Measures such as green infrastructure in vulnerable communities, social participation in climate planning, and expanded access to information on environmental risks are essential for reducing

inequalities. The combination of intersectional factors suggests that one-size-fits-all solutions are insufficient and that localized approaches, aligned with the socioeconomic and cultural realities of each group, are fundamental to a more equitable climate response (Meenar et al., 2023).

These studies reinforce the importance of integrated approaches to climate adaptation, combining risk reduction policies with participatory strategies and strengthening social and community networks. Vulnerability is not merely an environmental issue but a reflection of structural inequalities that influence the resilience of populations exposed to climate risks. Thus, this research aims to diagnose how climate change has unfolded in Curitiba, Paraná, and the Curitiba Metropolitan Region, highlighting the heterogeneities of these territories based on the perceptions of city residents.

2 METHODOLOGY

The research method used in this study is the survey, which aims to collect primary data on the characteristics, behaviors, or opinions of a specific group of people through a predefined research instrument, typically a questionnaire (Hair Jr. et al., 2005). This study is based on the author's doctoral dissertation. The tool used to conduct the survey was Google Forms, administered following approval by the Human Research Ethics Committee of the Federal Technological University of Paraná, as per the opinion recorded in case CAAE 85591124.0.0000.5547.

Based on the literature review, the essential information for developing the data collection instrument was identified. The first part of the form consisted of open-ended and multiple-choice questions; the second part consisted of closed-ended questions, where the quantitative measurement of these characteristics was performed using a five-point semantic differential scale.

Those possessing information relevant to data collection are considered relevant. To define the target population for this study, a broad audience was sought; thus, the criteria defined for participant inclusion were: being over 18 years of age and residing in Curitiba or the metropolitan area.

The use of electronic means of data collection limits access to information from certain groups of individuals (for example, the economically disadvantaged population). Furthermore, in this type of collection, there is no control over the exact number of participants or the origin of the data. Therefore, in order to reach a diverse sample, the research was also conducted in the field in communities in Curitiba, Paraná.

For the analysis of the data obtained, the sampling strategy will focus on stratification. Stratification consists of dividing the population into subgroups (strata) that share a certain degree of homogeneity regarding one or more factors (e.g., income or type of housing) (Brei; Liberali Neto, 2006). A non-probability sample was adopted, as the study utilized individuals who were available to answer the questionnaire, rather than those selected based on statistical criteria.

The questionnaire was structured based on bibliometric analyses and a literature review of the main studies on perceptions of climate change in urban areas. For this study, two groups of variables were analyzed: perceptions of the impacts of climate change and sociodemographic profile, as shown in Table 1.

Table 1 – Variables and groups in the study's data collection instrument

Group	Variable	
Impact of climate change	Increase in rainfall	Increase in flooding
	Discomfort due to cold	Discomfort due to heat
Sociodemographic profile	Age	Average gross income of residents
	Gender identity	Primary occupation
	Educational level	Number of residents in the household
	Self-declared race/ethnicity	Marital status

Source: Author (2025).

Descriptive statistical analyses were performed to provide a preliminary overview of the data and the characteristics of the sample. According to (Hair Jr et al., 2005), descriptive statistical analysis allows, based on the systematization of a set of responses, the drawing of initial inferences about the data, describing their main characteristics and identifying possible trends, patterns, or inconsistencies. Furthermore, this step enables the verification of the quality of the collected data, contributing to the validation of the instruments used.

In the present study, descriptive analysis was initially applied to characterize the average behavior of the sample, with an emphasis on variables belonging to the "Sociodemographic Profile" group, as presented in Table 1. Among the variables analyzed, the following stand out: gender, educational level, number of household members, marital status, among others. This characterization was fundamental for contextualizing the data and for conducting subsequent analyses.

3 RESULTS

The data collection yielded 645 respondents, with a predominance of residents in Curitiba (81.09%), followed by municipalities in the Metropolitan Region. The sample composition shows a higher proportion of self-identified white individuals (72.5%), with an average income between R\$ 3,039.00 and R\$ 12,158.00 and a high level of education, with 75.08% holding a college degree or postgraduate degree. There is also a higher proportion of women (66.98%), which may reflect greater engagement of this group in research related to socio-environmental issues, as shown in Table 2.

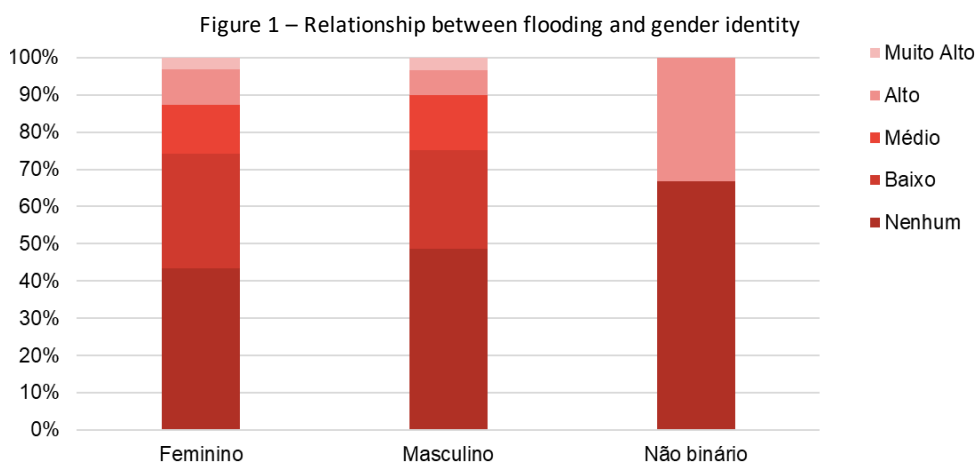
Table 2 – Profile

Self-identified race/ethnicity		Average gross income of residents	
White	72,50%	From R\$ 6,079.00 to R\$ 12,158.00	27,34%
Brown	19,69%	From R\$ 3,039.00 to R\$ 6,078.00	25,76%
Black	4,84%	From R\$ 1,519.00 to R\$ 3,038.00	18,76%
Yellow	1,56%	From R\$ 12,159.00 to R\$ 24,316.00	15,74%
I prefer not to specify	1,09%	Over R\$ 24,316.00	7,31%
Indigenous	0,31%	Up to R\$ 1,518.00	5,09%
Self-declared gender identity		Level of education	
Female	66,98%	Graduate studies	38,63%
Male	32,08%	Higher education	36,45%
Non-binary	0,63%	High school	19,47%
I prefer not to identify	0,31%	Elementary school	4,67%
		No formal education	0,78%
City		Primary occupation	
Curitiba	81,09%	Employed with a formal contract	39,87%
São José dos Pinhais	4,22%	Self-employed/freelancer	19,94%
Campo Largo	3,91%	Student	16,48%
Colombo	2,34%	Business owner/entrepreneur	10,68%
Balsa Nova	2,03%	Retired	8,48%
Almirante Tamandaré	1,41%	Informal worker	2,83%
Quatro Barras	0,78%	Unemployed	1,73%
Fazenda Rio Grande	0,63%		
Piraquara	0,63%		
Araucária	0,47%		
Campina Grande do Sul	0,16%		

Source: Author (2025).

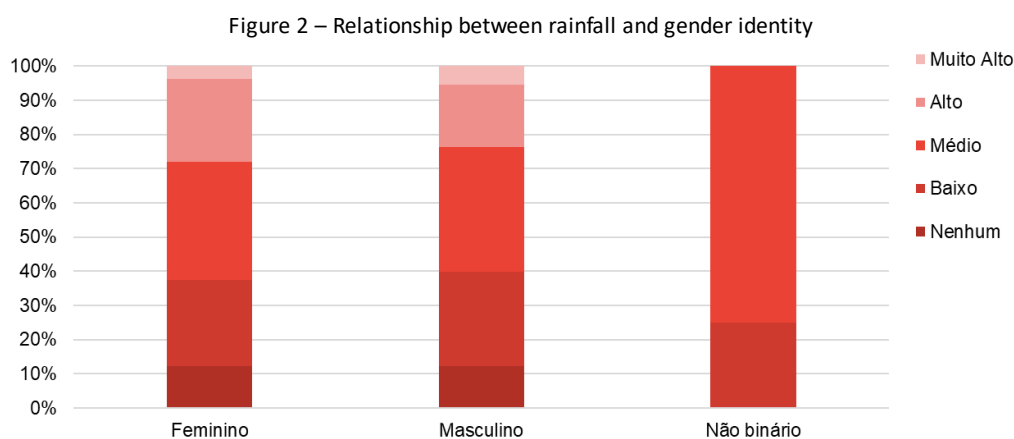
Table 2 shows that, although the sample is relatively well-educated and predominantly middle-income, the results reveal significant differences in the perception of climate impacts among social groups, indicating that factors such as gender, income, and race influence how environmental risks are perceived in urban areas.

Based on the results, a descriptive analysis was conducted to relate sociodemographic variables (gender identity, race, and income) to residents' perceptions of the impacts of rainfall and flooding on their homes. Figures 1 through 6 present the results by impact scale.



Source: Author (2025).

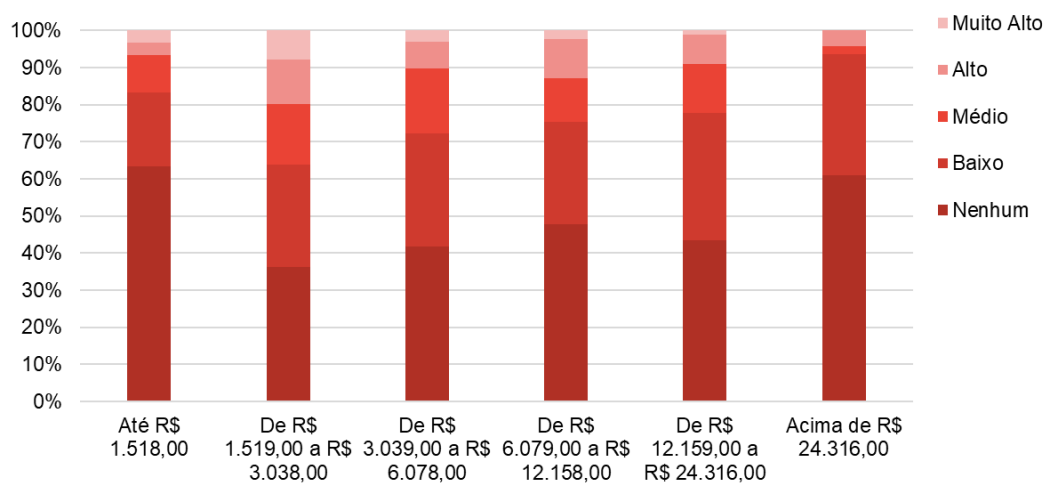
Figure 1 shows that women and non-binary individuals reported the highest levels of flooding in their homes (very high and high). At the same time, non-binary individuals were the most likely to report no flooding. This result suggests that women tend to be more sensitive to environmental risks in everyday urban life. Studies such as that by Zoll et al. (2023) indicate that women often demonstrate greater concern about climate issues, partly due to their greater participation in community networks and the social role historically associated with managing domestic and family care. Furthermore, women are often more exposed to the indirect impacts of extreme weather events, especially in contexts of precarious housing and unequal access to urban infrastructure. In this sense, the higher perception observed in this study may reflect not only greater environmental awareness but also concrete experiences of territorial vulnerability. The same trend is observed in the relationship between gender and perception of heavy rainfall (Figure 2).



Source: Author (2025).

Figure 2 shows that women reported the highest levels of perceived impact from rainfall on their homes (very high and high). Conversely, men were the group most likely to report no impact from rainfall. This difference may indicate that the perception of climate risk is directly associated with daily experiences of the effects of rainfall, such as leaks, flooding, and difficulties with urban mobility. These results corroborate the literature pointing to gender differences in the perception of environmental risks, highlighting that climate change is not experienced uniformly across social groups.

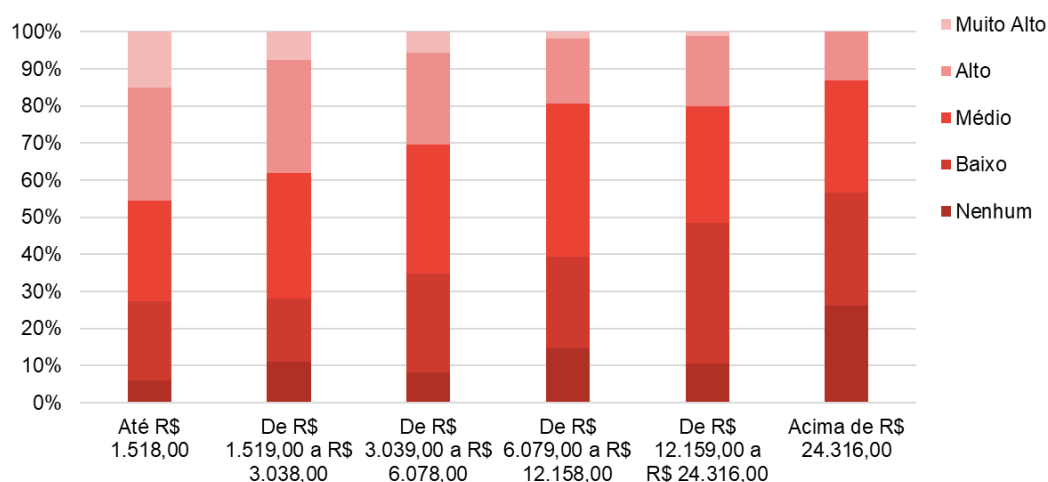
Figure 3 – Relationship between flooding and income



Source: Author (2025).

Analysis of the income variable reveals a consistent relationship between lower income and a greater perception of climate impacts. Figure 3 shows that people with an average gross income of R\$ 1,519.00 to R\$ 3,038.00 reported the highest levels of flooding in their homes (very high and high). This result suggests that lower-income populations tend to reside in areas more exposed to environmental risks, often characterized by poor urban infrastructure, insufficient drainage, and greater soil sealing. This pattern is widely documented in the literature on socio-environmental vulnerability in Latin American cities, where economically vulnerable populations are often located in areas more susceptible to extreme events (Amorim-Maia et al, 2022; Meenar et al., 2023).

Figure 4 – Relationship between rainfall and income



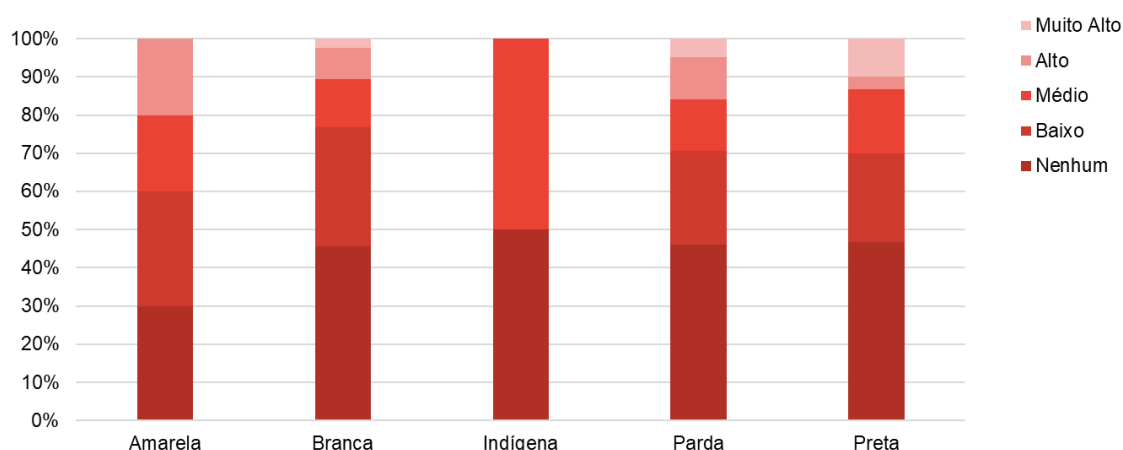
Source: Author (2025).

The same trend is observed in perceptions of the impacts of rainfall (Figure 4). People with an average income of up to one minimum wage reported the highest levels of rainfall-related impacts on their homes. This relationship diminishes as income increases. Notably,

among those with incomes above R\$ 24,316.00, more than 50% of the sample reported low or no impacts. This difference highlights how socioeconomic inequality translates into environmental inequality. Higher-income populations generally have greater access to resilient urban infrastructure, housing with better construction quality, and locations in areas with lower exposure to environmental risks.

Analysis of the race variable also reveals significant differences in the perception of climate impacts (Figures 5 and 6).

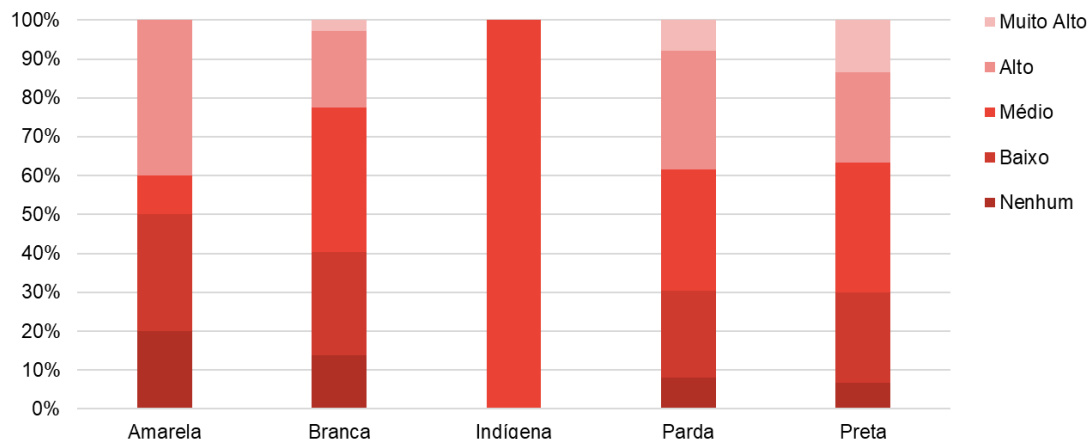
Figure 5 – Relationship between flooding and race



Source: Author (2025).

Figure 5 shows that self-identified Black, Brown, and Asian individuals reported the highest levels of flooding in their homes (high and very high). This finding is consistent with the literature on environmental racism, which highlights the greater exposure of racialized populations to environmental risks in urban settings. The unequal distribution of urban infrastructure and housing opportunities means that these groups are often located in more vulnerable areas, with less access to public services and greater exposure to extreme events.

Figure 6 – Relationship between rainfall and breed



Source: Author (2025).

Figure 6 shows that Black people experienced very high impacts from the rains, while Black, Brown, and Asian people experienced high impacts. These results reinforce the empirical evidence presented by Zoll et al. (2023), which demonstrates that race and gender significantly influence experiences and perceptions related to climate change. In urban contexts marked by structural inequality, these factors contribute to widening disparities in exposure to and adaptive capacity regarding environmental risks.

The joint analysis of the variables indicates that the perception of climate impacts is associated with the overlap of social factors, reinforcing the relevance of the intersectional approach adopted in this study. The results show that women, low-income individuals, and racialized individuals consistently exhibit higher levels of perception of the impacts of heavy rainfall and flooding on their homes.

These findings are consistent with the IPCC (2023), which notes that climate vulnerability results from the interaction between exposure to risks, sensitivity to impacts, and adaptive capacity—elements strongly influenced by socioeconomic and territorial inequalities. In this sense, the heightened perception observed among socially vulnerable groups may reflect more direct experiences with the effects of climate change in everyday urban life.

In the context of Brazilian cities, this relationship was also discussed by Acseirad (2002), who highlights the unequal distribution of environmental risks in urban spaces, creating situations of environmental injustice. Research on the Curitiba Metropolitan Region reinforces this perspective by demonstrating that historical urbanization processes have contributed to the formation of territories with greater socio-environmental vulnerability, often associated with poor infrastructure and greater exposure to extreme events (Deschamps, 2004; Mendonça; Del Vachio-Lima, 2020).

Furthermore, the results align with studies indicating that factors such as gender and race influence perceptions and experiences related to climate change. Zoll et al. (2023) indicate that women and racialized populations tend to express greater concern about environmental risks, partly due to their greater exposure to more vulnerable housing and territorial conditions. Similarly, Meenar et al. (2023) highlight that low-income urban communities often face greater climate impacts due to the unequal distribution of urban infrastructure.

This evidence can also be understood in light of the dynamics of urban space production discussed by Santos (1993) and Rolnik (2015), who point out how Brazilian urbanization has been marked by processes of socio-spatial segregation that displace lower-income populations to peripheral and more vulnerable areas.

Thus, the results reinforce that the impacts of climate change are mediated by structural inequalities present in cities. The intersectional approach allows us to understand how gender, race, and class interact in the production of climate vulnerability, highlighting the need for adaptation policies that integrate social justice, urban planning, and the reduction of territorial inequalities (Amorim-Maia et al., 2022).

4 CONCLUSIONS

Global environmental transformations, particularly climate change, can no longer be understood solely through a technical, environmental, or meteorological lens. They are, above all, manifestations of an exclusionary and predatory socioeconomic system that shapes urban areas unequally and exposes their populations to climate risks in different ways. This study, by investigating perceptions of the impacts of climate change in Curitiba and the Metropolitan Region through the lens of intersectional variables such as race, gender, and income, sought to highlight how these structural inequalities operate in the daily life of cities and are reflected in the concrete experience of extreme events such as heavy rains and flooding.

The research results indicate that the effects of climate change are not experienced uniformly. Women, low-income individuals, and racialized people perceive the impacts on their homes more intensely, revealing that social and identity-based belonging directly affects how these events are experienced and perceived. This reality is rooted in a history of inequalities that has shaped Brazilian urbanization, characterized by precarious settlements in high-risk areas, a lack of adequate infrastructure, deficient public services, and an ongoing process of territorial marginalization.

In this sense, climate justice emerges as a central concept for understanding and addressing the contemporary challenges of the environmental crisis. More than a normative principle, climate justice must be a practical tool for analysis and action, enabling the development of public policies that consider the multiple dimensions of urban vulnerability. Intersectionality, adopted as the theoretical framework in this study, proved fundamental for capturing the complexity of the inequalities experienced by different social groups, revealing that race, class, gender, and territory do not operate in isolation but intertwine to produce oppression and lack of protection.

The data collection conducted through the semi-structured questionnaire revealed that, although extreme weather events are widespread in the city, their severity is greater among those with lower incomes and belonging to vulnerable social groups. These data align directly with the reviewed literature, which points to the existence of areas where environmental risks are more intense and adaptive capacities are limited. These areas, often overlooked by public policies and conventional urban planning, are home to a large portion of the population living in housing insecurity, with poor sanitation, a lack of green spaces, and restricted access to urban infrastructure.

Given this situation, we must rethink approaches to urban planning and governance. The hegemonic logic of corporate urbanization, as conceptualized by Milton Santos, has prioritized the interests of financial capital and real estate speculation at the expense of the city's social function. The development of urban space in recent decades has promoted increasingly pronounced territorial segregation, relegating disadvantaged social groups to the margins of the urban system, both physically and symbolically. This marginalization is reflected in varying levels of vulnerability to climate change and reinforces cycles of poverty, exclusion, and injustice.

The way people understand and relate to extreme weather events is influenced not only by their concrete experience of the impacts, but also by access to information, trust in

public institutions, and the historical experience of neglect by the state. Historically underserved populations tend to normalize risks, often associating floods or landslides with “fate” or “routine,” which can compromise their ability to mobilize and demand their rights.

In this context, urban policy must move away from a technocratic approach and open itself to actively listening to the most vulnerable populations. The production of knowledge regarding the impacts of climate change must incorporate popular wisdom, local experiences, and the perspectives of those who face environmental risks on a daily basis. Data reveal, for example, that women—especially Black and low-income women—are more vulnerable to climate impacts, which may be related to their central role in managing households, caring for children and the elderly, and community organizing. This vulnerability must be valued and incorporated as an asset in the processes of developing more responsive and equitable public policies.

Thus, it is urgent and necessary to implement structural measures that combine mitigation and adaptation but, above all, are sensitive to intersectional inequalities. This requires a multi-scale approach, ranging from community-based actions to broad institutional changes, including participatory risk mapping, housing programs with criteria of territorial justice, strengthening of community-based civil defense, and integrated and participatory urban planning.

In the specific case of Curitiba and the Metropolitan Region, the data collected highlight intra-urban disparities, marked by a more structured center and increasingly precarious peripheries. The municipalities of the RMC, despite being functionally integrated with the capital, exhibit significant gaps in terms of planning, investment, and environmental governance. This institutional fragmentation hinders the development of a regional strategy for climate change adaptation and reinforces the need for coordination among federal entities, metropolitan consortia, and participatory forums.

Building resilient cities therefore requires a profound reconfiguration. Territorial justice must be promoted as a guiding principle of public policy, ensuring that resources, facilities, and infrastructure are distributed equitably among all social groups. Climate justice is not limited to protecting the most vulnerable—it demands transforming the structures that produce vulnerability. This implies revising funding criteria, regulatory frameworks, management models, and, above all, the very role of the state in promoting the common good.

Finally, in the face of the climate collapse already looming in various parts of the planet, there is no longer room for superficial approaches or generic solutions. We must build a new urban paradigm that is environmentally sustainable, socially just, and politically democratic. This new paradigm involves recognizing the right to the city as a collective right, strengthening local communities, and ensuring the active participation of residents in territorial planning and management. The future of cities will depend, increasingly, on the ability to address climate challenges equitably.

4 REFERENCES

ACSELRAD, Henri. Justiça ambiental e construção social do risco. *Desenvolvimento e Meio Ambiente*, [s. l.], v. 5, 2002.

AMORIM-MAIA, Ana T. *et al.* Intersectional climate justice: A conceptual pathway for bridging adaptation planning, transformative action, and social equity. **Urban Climate**, [s. l.], v. 41, p. 101053, 2022. Disponível em: <https://linkinghub.elsevier.com/retrieve/pii/S2212095521002832>.

AYOADE, Oladotun; AHMED, Vian. Knowledge influences on perception of innovation drivers for sustainable housing development models. **International Journal of Knowledge Management Studies**, [s. l.], v. 11, n. 1, p. 1–19, 2020. Disponível em: <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85079862988&doi=10.1504%2FIIJKMS.2020.105070&partnerID=40&md5=ded6e414fb0b7269d93e44264bd43946>.

BACHA, Muhammad Suleman *et al.* The Dynamics of Public Perceptions and Climate Change in Swat Valley, Khyber Pakhtunkhwa, Pakistan. **Sustainability**, [s. l.], v. 13, n. 8, p. 4464, 2021.

BREI, Vinícius Andrade; LIBERALI NETO, Guilherme. O Uso da técnica de modelagem em equações estruturais na área de marketing: um estudo comparativo entre publicações no Brasil e no exterior. **Revista de Administração Contemporânea**, [s. l.], v. 10, n. 4, p. 131–151, 2006. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1415-65552006000400007&lng=pt&tlng=pt.

BURBIDGE, Manon *et al.* Don't blame it on the sunshine! An exploration of the spatial distribution of heat injustice across districts in Antwerp, Belgium. **Local Environment**, [s. l.], v. 27, n. 2, p. 160–176, 2022.

COELHO, Cíntia de Albuquerque Wanderley *et al.* **Mudança do clima no Brasil: síntese atualizada e perspectivas para decisões estratégicas**. Brasília: [s. n.], 2024.

COLLINS HILL, Patricia; BILGE, Sirma. **Interseccionalidade**. tradução Red. São Paulo: Boitempo Editorial, 2021.

COSTA, Marco Aurélio (org.). **50 Anos de regiões metropolitanas no Brasil e a Política Nacional de Desenvolvimento Urbano: no cenário de adaptação das cidades às mudanças climáticas e à transição digital**. [S. l.]: Ipea, 2024. Disponível em: https://repositorio.ipea.gov.br/bitstream/11058/13179/1/50_Anos_de_regioes_BOOK.PDF.

DAVID HARVEY. **Espaços de Esperança**. 3. ed. Ipiranga: Edições Loyola, 2009.

DESCHAMPS, Marley Vanice. **Vulnerabilidade socioambiental na região metropolitana de Curitiba/PR**. 2004. Tese (Doutorado em Meio Ambiente e Desenvolvimento) - Universidade Federal do Paraná, Curitiba, 2004.

GODOY, Jeane Aparecida Rombi de; BENINI, Sandra Medina; SILVA, Allan Leon Casemiro da. Segregação socioespacial e vulnerabilidade climática nas periferias urbanas. **Periódico Eletrônico Fórum Ambiental da Alta Paulista**, [S. l.], v. 21, n. 3, p. e2508, 2026. DOI: 10.17271/1980082721320256223. Disponível em: https://publicacoes.amigosdanatureza.org.br/index.php/forum_ambiental/article/view/6223

HAIR JR, Joseph *et al.* **Fundamentos de métodos de pesquisa em administração**. Porto Alegre: Bookman, 2005.

HERNÁNDEZ, Diana. Climate Justice Starts at Home: Building Resilient Housing to Reduce Disparate Impacts From Climate Change in Residential Settings. **American Journal of Public Health**, [s. l.], v. 112, n. 1, p. 66–68, 2022. Disponível em: <https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2021.306611>.

INSTITUTO PÓLIS (org.). **Justiça climática e infraestruturas urbanas: reflexões e propostas para a cidade que queremos**. São Paulo: [s. n.], 2023.

IPCC. **Climate Change 2022 – Impacts, Adaptation and Vulnerability**. [S. l.]: Cambridge University Press, 2023. Disponível em: <https://www.cambridge.org/core/product/identifier/9781009325844/type/book>.

IWAMA, Allan Yu *et al.* Risco, Vulnerabilidade E Adaptação Às Mudanças Climáticas: Uma Abordagem Interdisciplinar. **Ambiente & Sociedade**, [s. l.], v. XIX, n. 2, p. 95–118, 2016.

JACOBS, Jane. **Morte e Vida de Grandes Cidades**. 3. ed. São Paulo: Editora WMF Martins Fontes, 2014.

LEITE, Clauber. **Justiça climática e infraestruturas urbanas: reflexões e propostas para a cidade que queremos**. São Paulo: Instituto Pólis, 2023.

LENZHOLZER, Sanda *et al.* Urban climate awareness and urgency to adapt: An international overview. **Urban Climate**, [s. l.], v. 33, p. 100667, 2020.

LOUBACK, Andréia Coutinho; LIMA, Letícia Maria R. T. **Quem precisa de Justiça Climática no Brasil?** Hivos: [s. n.], 2022. Disponível em: <https://generoeclima.oc.eco.br/lancamento-quem-precisa-de-justica-climatica-no-brasil/>.

MAIOR, Mônica Maria Souto; CÂNDIDO, Gesinaldo Ataíde. Avaliação das metodologias brasileiras de vulnerabilidade socioambiental como decorrência da problemática urbana no Brasil. **Cadernos Metrópole**, [s. l.], v. 16, n. 31, p. 241–264, 2014.

MASIERO, Érico; MENEGALDO, Vanize; TAVARES, Sílvia Garcia. Análise crítica dos planos municipais de adaptação e mitigação às mudanças climáticas. **Periódico Eletrônico Fórum Ambiental da Alta Paulista**, [S. l.], v. 19, n. 4, 2023. DOI: [10.17271/1980082719420234328](https://doi.org/10.17271/1980082719420234328).

MEENAR, Mahbubur *et al.* “The Urban Poor and Vulnerable Are Hit Hardest by the Heat”: A Heat Equity Lens to Understand Community Perceptions of Climate Change, Urban Heat Islands, and Green Infrastructure. **Land**, [s. l.], v. 12, n. 12, p. 2174, 2023.

MENDONÇA, Francisco; DEL VACHIO-LIMA, Myrian. Metropolização e periferização do Aglomerado Urbano de Curitiba: riscos e vulnerabilidades socioambientais em Fazenda Rio Grande (PR). In: A CIDADE E OS PROBLEMAS SOCIOAMBIENTAIS URBANOS: UMA PERSPECTIVA INTERDISCIPLINAR. Curitiba: Editora UFPR, 2020. p. 27–122.

NOBRE, Carlos A.; YOUNG, Andrea F. **Vulnerabilidades das megacidades brasileiras às mudanças climáticas: Região Metropolitana de São Paulo**. [S. l.]: Universidade Estadual de Campinas, 2011.

OBSERVATÓRIO DO CLIMA. **Quem precisa de justiça climática no Brasil? Observatório do Clima**. [S. l.]: Observatório do Clima, 2022. Disponível em: https://generoeclima.oc.eco.br/wp-content/uploads/dlm_uploads/2022/08/ESTUDO_Quem-precisa-de-justica-climatica.pdf.

PAZHUHAN, Mousa; AMIRZADEH, Melika. Flood risk perception and disaster preparedness in marginalised flood-prone communities: evidence from Saadi neighbourhood, Shiraz, Iran. **Local Environment**, [s. l.], v. 29, n. 5, p. 680–704, 2024.

PEREIRA, Bruna Cristina Jaquetto. Sobre usos e possibilidades da interseccionalidade. **Civitas - Revista de Ciências Sociais**, [s. l.], v. 21, n. 3, p. 445–454, 2021. Disponível em: <https://revistaseletronicas.pucrs.br/index.php/civitas/article/view/40551>.

RAHMAN, Md Zakiur; ATUN, Funda; MARTINEZ, Javier. The Relationship Between Disaster Risk Perception and Multiple Deprivation: A Study on Rangpur City, Bangladesh, Using Geospatial and Statistical Approaches. **Environment and Urbanization ASIA**, [s. l.], v. 13, n. 1, p. 27–43, 2022.

RANA, Irfan Ahmad *et al.* The impact of psychological distance to climate change and urban informality on adaptation planning. **Urban Climate**, [s. l.], v. 49, p. 101460, 2023.

ROBINA, Álvaro Puertas. **Direito à Cidade: caminhos para a Justiça climática**. Barcelona: Equipe de Apoio da Plataforma Global pelo Direito à Cidade Instituto Pólis, 2021. Disponível em: <https://www.right2city.org/wp-content/uploads/2021/11/Direito-a-CC%80-Cidade-caminhos-para-a-Justic%CC%A7a-Clima%CC%81tica-PGDC.pdf>

ROLNIK, Raquel *et al.* **Como fazer valer o direito das mulheres à moradia?** São Paulo: ONU para o Direito à Moradia Adequada, 2015. Disponível em: www.direitoamoradia.org.

ROLNIK, Raquel. **Guerra dos lugares**. São Paulo: Boitempo, 2015.

SANTOS, Milton. **A urbanização brasileira**. São Paulo: Hucitec, 1993.

SINGER, Paul. **Economia política da urbanização**. 2. ed. São Paulo: Contexto, 2010.



TOCHETTO, Fernanda; NECKEL, Alcindo; SILVA, Caliane Christie Oliveira de Almeida; SCHMITZ, Guilherme Peterle. A sintaxe espacial como ferramenta de análise de ocupação urbana: Um estudo ao Sul do Brasil. **Periódico Eletrônico Fórum Ambiental da Alta Paulista**, [s. l.], v. 20, n. 4, 2024. DOI: [10.17271/1980082720420245192](https://doi.org/10.17271/1980082720420245192).

WAIDELICH, Paul *et al.* Climate damage projections beyond annual temperature. **Nature Climate Change**, [s. l.], v. 14, n. 6, p. 592–599, 2024.

WATERS, James; ADGER, W. Neil. Spatial, network and temporal dimensions of the determinants of adaptive capacity in poor urban areas. **Global Environmental Change**, [s. l.], v. 46, p. 42–49, 2017.

ZOLL, Deidre *et al.* Intersectional climate perceptions: Understanding the impacts of race and gender on climate experiences, future concerns, and planning efforts. **Urban Climate**, [s. l.], v. 50, p. 101576, 2023.



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DECLARAÇÃO DE CONFLITOS DE INTERESSE

Nós, **Beatrice Lorenz Fontolan e Alfredo Iarozinski Neto**, declaramos que o manuscrito intitulado **"Injustiças climáticas a partir da percepção dos moradores de Curitiba e Região Metropolitana"**:

1. **Vínculos Financeiros:** Não possui vínculos financeiros que possam influenciar os resultados ou interpretação do trabalho. Este trabalho foi financiado por Capes código 001.
 2. **Relações Profissionais:** Não possui relações profissionais que possam impactar na análise, interpretação ou apresentação dos resultados. Nenhuma relação profissional relevante ao conteúdo deste manuscrito foi estabelecida.
 3. **Conflitos Pessoais:** Não possui conflitos de interesse pessoais relacionados ao conteúdo do manuscrito. Nenhum conflito pessoal relacionado ao conteúdo foi identificado.
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