# (Un)Safe Landscape: Vulnerabilities in Curitiba, Paraná, Brazil

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## Abstract

**Faced with increasing violence in large urban areas in Brazil, the main objective of this research is to establish connections between vulnerabilities and violence in the city of Curitiba, Paraná State, as a case study. Based on the theoretical references, the environmental constraints, landscape components, and socioeconomic conditions were assessed. In this context, the relation between social-environmental vulnerability and homicide number was determined based on spatial analysis techniques, notably geographically weighted regression (GWR) processed in ArcGis 10.6 software. The results show that this model explains 95.3% of this kind of crime incidence in the neighborhoods of the city studied. Still, when the local coefficients of determination values (R l) are considered, this percentage is lower in central region (20.0% - 40.0%). However, it can be concluded that the reduction of the social and environmental vulnerability would be a determinant factor to decrease the criminality levels in Curitiba.**

## Introduction

Between 1960 and 2010 the urban population in Brazil went from about 45% to over 85% (IBGE, 2019). In most cases, without the adequate planning, which contributed to intensify problems of the environment and the society, especially in metropolitan regions, where the areas of environmental and social degradation are directly related (Hogan; Marandola Júnior, 2006).

This relation, one of the main arguments for the development of this study, is due to the pressure exerted by the real estate market, where the low-income population occupies unsuitable places for urbanization, breaching the current environmental legislation, specifically the permanent preservation areas (PPAs) of rivers, which contributes to the occurrence of floods (Tucci, 2008). These factors establish a relationship between environmental vulnerability, social inequality, and its impacts on the quality of life of urban communities.

According to the Brazilian Forestry Code (Brasil, 2012), the PPAs aim at preserving water quality and biodiversity, supporting soil conditions and ensuring the well-being of the population. Besides the conservation of the natural resources, the protection of these areas is related to people's quality of life, since, according to Tucci (2008), the impairment of these areas, particularly in an urban context, is one of the main factors which contribute to the aggravation of flood occurrence.

It is important to highlight that, according to Couto (2013), the social exclusion caused by living in marginalized spaces of society, such as in those environmentally vulnerable, contributes to the development of drug trafficking as an economic alternative, thus being a palliative solution to the lack of opportunity to these individuals. In this way, the establishment of parks and plazas, a responsibility of municipal governments, would be relevant to maintain the environmental conditions and improve the population's quality of life. Nevertheless, due to the lack of maintenance and ineffective management, these places are often related to insecurity, violence, and drug problems (Cozens, 2008).

Considering the approach of the importance of the problems and the theoretical assumptions presented above, the main objective of this research is to establish connections between

social-environmental vulnerability and violence in the city of Curitiba, Paraná State, Brazil.

A study developed by United Nations Children's Fund (UNICEF, 2002) shows that drug use by young people is higher in classes A and B (21.6% and 20.5% respectively) than in D (16.5%) and C (11.4%). However, Cruz and Sá (2011) points out that the lack of leisure options and recreation in irregularly occupied areas contribute to the sense of social exclusion and not belonging to the city and the consequent increase of violence and consumption of psychoactive substances.

## Methodological Procedures

In order to assess the socio-spatial determinants of crime in Curitiba, located in Southern Brazil (Figure 1), it was considered the analysis of various aspects and the main data from the local context are presented below. Regarding the **environmental constraints**, flooded areas, in 1987, and subjected to flooding (IPPUC, 2001) and PPAs, defined from a buffer of 30 meters along the water courses, in accordance to the Federal Law Nº 12,651, of May 25, 2012 (Brasil, 2012), were mapped.

The analysis of **landscape components** was carried out according to the following characterization of:

a) open public spaces, consisting of conservation units in Curitiba, defined by Municipal Law nº 9,804, of February 3, 2000 (Curitiba, 2000), including: conservation, linear and leisure parks; biological reserves: conservation, leisure and relevant native forests; and other typologies, such as squares; environmental and core gardens; and animation axes;
b) irregular occupations, registered by the municipality (IPPUC, 2016).

Aiming at identifying the **socioeconomic conditions** of the vulnerable population, the following data from the 2010 Census (IBGE, 2010) - the last performed - were considered:

a) global and adults (people aged 18 years or over) demographic density;
b) literacy - percentage of literate population, considered the individuals who can both read and write with understanding a short simple statement in his/her known language (IBGE, 2010);
c) income - average values of the total nominal monthly incomes of people aged 10 or above.

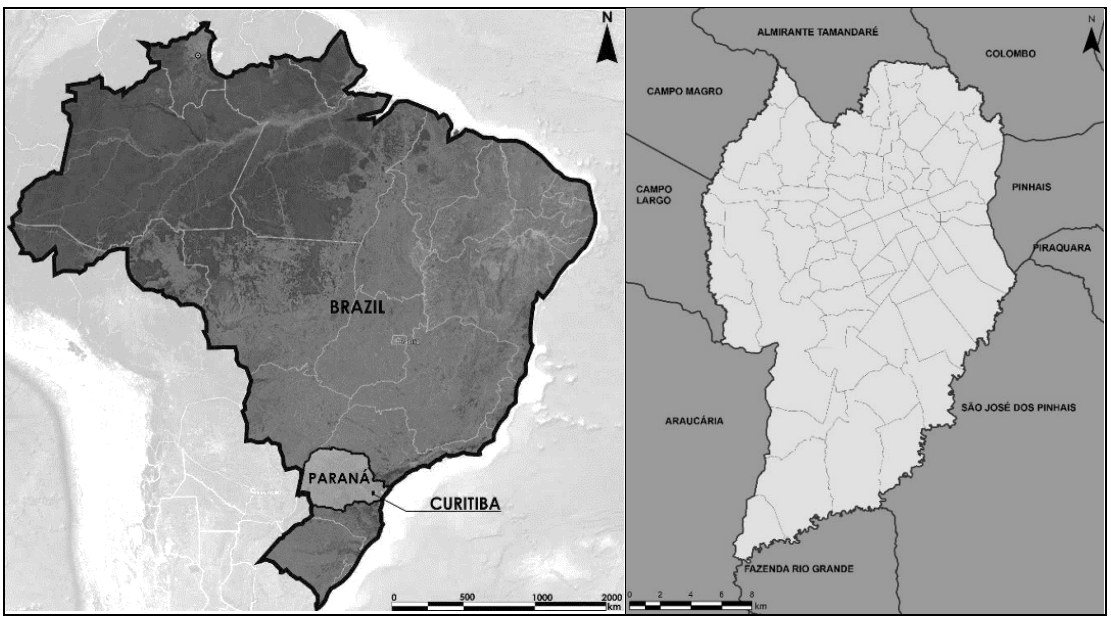


Figure 1. Maps of location of Curitiba, Paraná, Brazil, and its neighborhoods. Source: Based on Google Earth (2019) and IPPUC (2019).

Regarding **violence rates** as dependent variable of the previous one, it was considered the number of victims of crimes related to death in 2010 (IPPUC, 2010). The data collected was organized by neighborhood, because some information is only available in this area. To determine the relationship between homicide rate and landscape components, environmental constraints and socioeconomics conditions, the geographically weighted regression (GWR) was used and processed in ArcGis 10.6 software. In this model, the parameters were estimated for each studied area, so diversity of values show the impacts of local variation in the dependent variables on others (Fotheringham; Brunsdon; Charlton, 2002).

## Results discussion

Curitiba houses 1,933,105 people with demographic density of 4,027.04 inhab./km$^2$. It is the eighth most populous municipality of the country (IBGE, 2019). Its territory includes 75 neighborhoods, which were defined according to patterns of land occupation and socioeconomics characteristics.

Those that present the greatest **environmental constraints** to urban development due to water resources, by the need to preserve the areas along bodies of water or the flooding risk (Figure 2), are in the outlying areas of the municipality.

Among the **landscape components**, it is notice that most part of the irregularly occupied areas are included in the neighborhoods with greater percentage of environmental constraints. Curitiba's main irregular occupations are located in outlying regions (see Figure 2) On the other hand, in the central part of the city, where the land price is higher and the environmental conditions are more favorable to the urban occupation process (Gutberlet, 2008), they are not detected.

At the beginning of the current decade, nearly 162,000 people lived in irregular occupations (IBGE, 2010). Considering that, about 21.0% of them (approximately 13,000 residences - IPPUC; COHAB-CT, 2007) registered in Curitiba are subject to environmental risks, that is, the young population that inhabits these areas would have lower quality of life, being more exposed to drug trafficking and consumption (Abramovay et al., 2002). Concerning open public spaces, it is stand out those located in the neighborhoods to the east and west of the municipality due to the presence of parks and other types of conservation units.

However, leisure parks, squares and gardens are distributed throughout the municipal territory. It is still verified the lack of these locals in Southern portions of the municipal territory (see Figure 2). Considering the analysis of the **socioeconomic conditions**, it is observed the concentration of the population in the central areas and the gradual reduction of the income levels and literacy as neighborhoods move away from the city center (see Figure 2), as also commented by Klein and Walker (2005).

Based on the analysis of the variables cited by Alves (2006), income, young population, literacy level, education and proximity of habitations to water courses, also investigated in this study and applied to the reality of Curitiba, it is verified that according to these criteria the population most exposed to environmental risks is in the most peripheral regions of the city. These issues can be confirmed with the analysis of Figure 2, in which it is observed that the central portions of Curitiba have lower **homicides rates**.

The results obtained from the weighted geographic regression analysis confirm that the environmental constraints, landscape components and socioeconomic conditions selected in this study explain 95.3% of the crime occurrences in Curitiba. The existence of spatial autocorrelation of the results was calculate by the Moran's Index of the model residuals, which shows that there is no evidence of spatial relation of the data (values close to zero).

According to Figure 3, that the selected model is adequate to the majority of neighborhoods, since the local coefficients of determination values (R  l) are higher than 0.7, that is, they explain approximately 70.0% of the crime rate variation in Curitiba, being less when applied to the central and northern regions of the municipality, indicating that the selected variables are not sufficient to determine violence indexes in these areas.

## Conclusion

The conceptual foundations presented allowed the choice of aspects related to social-environmental vulnerability with greater interference on crime rates. According to the previous characterization, it is possible to observe that Curitiba's urbanization process presents similar patterns to those from other Brazilian metropolitan, where the impoverished people are concentrated in regions with greater environmental constraints and more distant from central areas.

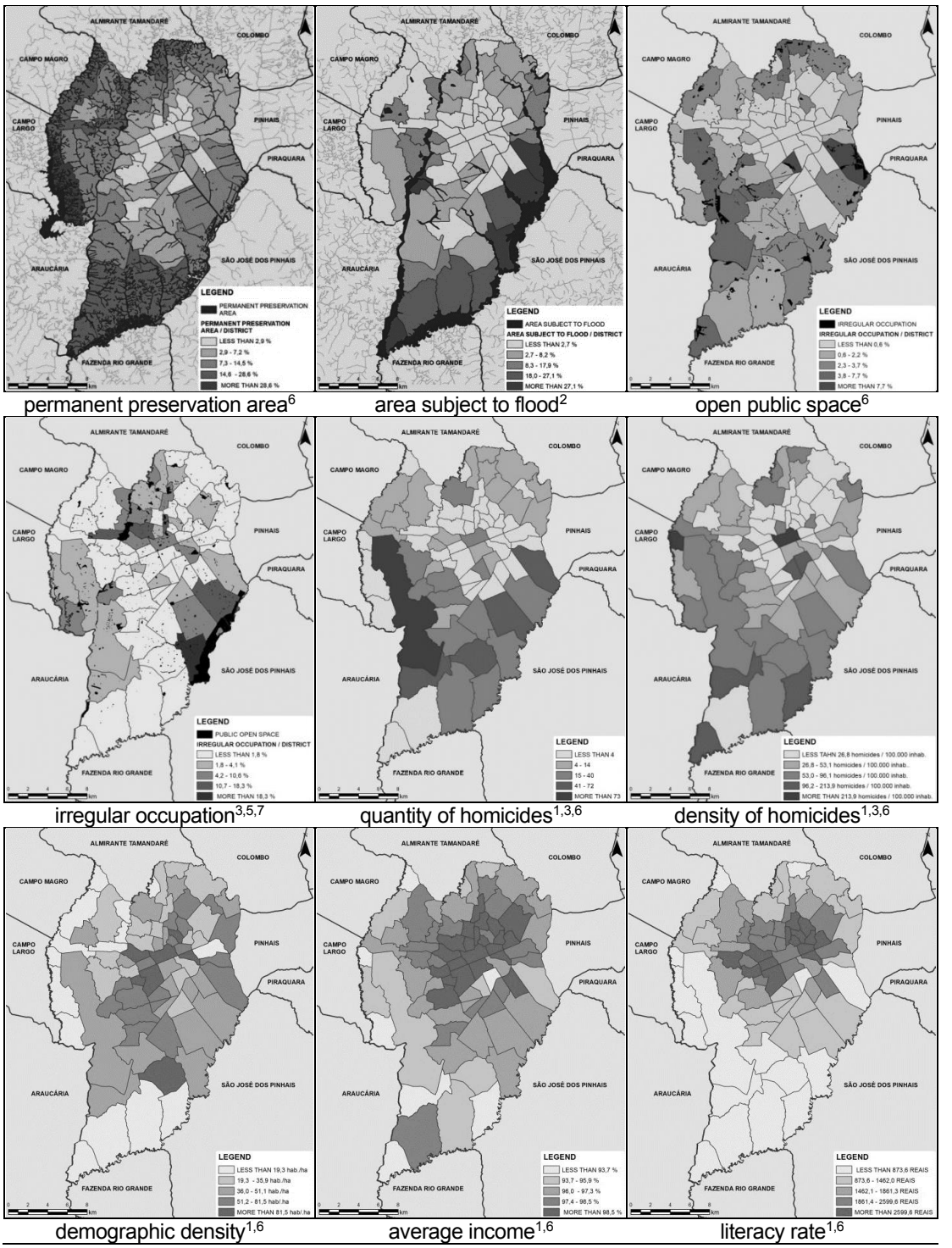


Figure 2. Characterization maps of environmental constraints, landscape components, homicides rates and socioeconomic conditions in Curitiba, Paraná, Brazil. Source: Based on IBGE (2010[1]), IPPUC (2001[2]; 2010[3]; 2012[4]; 2016[5]; 2019[6]) and IPPUC and COHAB-CT (2007[7]).

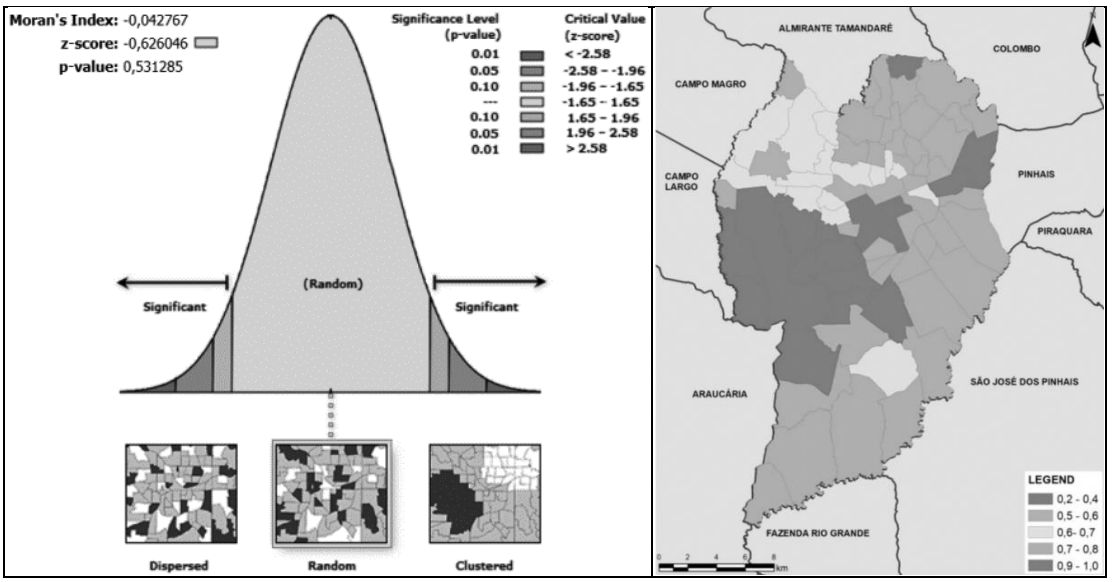


Figure 3. Graphic of spatial autocorrelation - Global Moran Index – and characterization map of the local coefficient of determination (R l) in Curitiba, Paraná, Brazil. Source: Based on geographically weighted regression (GWR) processed in ArcGis 10.6 software.

Regarding the relation between the two subjects of the study, the spatial distribution analysis of the selected variables, associated to the geographically weighted regression technique, validate this hypothesis, considering that the adopted model explains 95.3% (R global) of crimes incidence in Curitiba. However, when analyzed the local determination coefficients (R l), the results are less significant in central areas, showing that other variables should be added to explain the occurrence of criminal acts in these locals.

The main limitation of this study is the data aggregation by neighborhood, since this method does not allow identifying the specificities of each area. Nevertheless, this research results can supply subsidies to urban planning and management, being effective for both monitoring and proposing actions and projects that aim to minimize socio-environmental impacts and reduce urban violence rates in cities.

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## Endnotes

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