Geopauta

Issue 8, 2024, e14300
ISSN: 2594-5033
Original article
http://periodicos2.uesb.br/index.php/geo
https://doi.org/10.22481/rg.v8.e2024.e14300

Urban socio-environmental risks and vulnerability in Iranduba-Amazonas

Riesgos socioambientales urbanos y vulnerabilidad en Iranduba-Amazonas

Riscos e Vulnerabilidade socioambiental urbana em Iranduba-Amazonas

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Received on: 01/15/2024
Accepted for publication on: 03/30/2024

Abstract

The mapping and zoning of high-risk areas are considered tools to deal with natural disasters. Due to the increase in population and disorganized occupation of the territory, the municipality of Iranduba (AM) is subject to various types of risks. The objective of this research was to identify socially vulnerable areas that overlap with environmentally favorable spaces for mass movements, creating a risk map for the occurrence of this phenomenon in the urban area of Iranduba. The determination and analysis of risk were based on the understanding that risk stems from the combination of physical environmental factors (natural hazards) and socio-economic conditions (vulnerability) of the exposed population. The results indicate vulnerability as the main factor determining local risk.

Keywords: Natural disasters; Mass movements; Geomorphological hazards

Resumen

El mapeo y sectorización de áreas de alto riesgo se consideran herramientas para hacer frente a los desastres naturales. Debido al aumento de la población y a la ocupación desordenada del territorio, el municipio de Iranduba (AM) está sujeto a varios tipos de riesgos. El objetivo de esta investigación fue identificar áreas socialmente vulnerables que se superponen con espacios ambientalmente favorables a los movimientos masivos, creando un mapa de riesgo para la ocurrencia de este fenómeno en el área urbana de Iranduba. La determinación y análisis del riesgo se basó en el entendimiento de que él surge de la combinación de factores ambientales físicos (amenazas naturales) y condiciones socioeconómicas (vulnerabilidad) de la población expuesta. Los resultados apuntan a la vulnerabilidad como el principal determinante del riesgo local.

Palabras clave: Desastres naturales; Movimientos de masas; Riesgos geomorfológicos

Resumo

O mapeamento e setorização de áreas de alto risco são considerados ferramentas para lidar com desastres naturais. Devido ao aumento populacional e à ocupação desordenada do território, o município de Iranduba (AM) está sujeito a diversos tipos de riscos. O objetivo desta pesquisa foi identificar áreas socialmente vulneráveis que se sobrepõem a espaços ambientalmente favoráveis aos movimentos de massa, criando um mapa de risco para a ocorrência deste fenômeno na zona urbana de Iranduba. A determinação e análise do risco basearam-se no entendimento de que o risco decorre da combinação de fatores ambientais físicos (perigos naturais) e condições socioeconómicas (vulnerabilidade) da população exposta. Os resultados apontam a vulnerabilidade como principal fator determinante do risco local.

Palavras-chave: Desastres naturais; Movimentos de massa; Riscos geomorfológicos.

Introduction

Studies in Brazil aimed at analyzing natural disasters, such as landslides and urban floods, have intensified in recent decades due to their widespread increase in the Brazilian territory, and bring to light a concern regarding society's ability to cope and adapt to the face of to these disasters. It is well known that catastrophic natural phenomena have their effects heightened, in terms of socioeconomic impacts, when they affect social groups that live on the threshold of poverty and present conditions of high vulnerability.

According to the Disaster Risk Index in Brazil (DRIB index) (ALMEIDA, 2021), which is based on the understanding that disaster risk derives from the combination of physical risks and vulnerability of exposed people, vulnerability hotspots in Brazil are located in municipalities in the North and Northeast regions, that is, due to the very high vulnerability of these municipalities, events of the same magnitude can cause more serious consequences, and these would have greater difficulty in dealing with the impacts of a disaster, compared to municipalities from the central-south region of the country.

In Brazil, for the period from 1991 to 2012, the most frequent and devastating natural disasters were droughts, floods and storms, which represented 91.07% of the total records, while landslides, sudden and gradual floods were responsible for 87.15% of all deaths related to natural disasters in Brazil (UFSC, 2013).

In order to face this situation, the Geological Survey of Brazil (CPRM), since 2013, has been carrying out a survey of risk areas in the State of Amazonas in several municipalities, including the municipalities that make up the Metropolitan Region of Manaus (RMM). The main objective is to map geological risk areas and sectorize these risks in currently inhabited areas. In general, the geological risk areas mapped by the Brazilian Geological Survey are related to the possibility of accidents caused by mass movements, erosive features, flooding and inundation (BRASIL, 2018).

In the last survey carried out by CPRM in the municipality of Iranduba, in 2018, sixteen high and very high risk sectors were mapped in the urban area, covering the risk typologies mentioned above. The methodology used by CPRM to classify risk is based on the proposal of the Ministry of Cities (MCID, 2004) and the Institute of Technological Research (IPT, 2007), the degree of which is determined according to the existence of some signs, which may vary in risk low (R1) to very high risk (R4). This CPRM survey served as a guide for the present study, which was carried out with an emphasis on areas of risk to mass movements.

In Iranduba and other municipalities in Amazonas, society is subject to the most diverse types of risk, whether in the urban environment or in riverside areas. In the urban environment, in recent decades, there has been a swelling of these urban areas and the formation of areas considered at risk due to the disorderly process of occupation of the territory, in this case, it is necessary to map these most susceptible areas, including those not currently occupied and which, if inadequately inhabited, may pose a risk to the population. In riverside areas, the population is subject to the annual floods of rivers that predominate in the Amazon landscape, and which cause the loss of material goods and lives. The riverside man seeks to adapt to the seasonal changes of the region's rivers, subjecting himself to their hydrological regime.

Mapping risk areas is part of a list of preventive and mitigating measures, known as non-structural, to reduce socioeconomic risks in urban areas. The identification and inclusion of risk areas in the municipalities' master plan is extremely important, especially in municipalities undergoing urban development, so that there is planning in the process of occupying these areas.

The Master Plan of the municipality of Iranduba, Law No. 129 of 11/10/2006, determines, in several articles, the adoption of measures such as: the removal of equipment and people from risk areas (Art. 9); the diagnosis of homes at risk (Art. 108); considers them unsuitable for urbanization in areas of high risk to the safety of their occupants (Art. 122); classifies high-risk areas as Special Environmental Preservation Zones (Art. 127°); and the granting of the Onerous Grant of the Right to Build may be denied if there is a possibility of risk of compromising the urban landscape (Art. 150°). Despite all these citations in the law, it does not specify the types of hazards or the areas most susceptible to their occurrence, hence the importance of mapping the risk areas in the urban environment of the municipality, based on the analysis of the natural danger and the vulnerability of society as proposed by authors such as Deschamps (2004), Mendonça (2004), Mendonça and Leitão (2008); Goerl et al. (2012), Goerl and Kobiyama (2013), Parizzi (2014), Santos (2015), Silva et al. (2019) and Almeida (2021), among others.

In this context, the objective of the research is inserted, which, through surveys of physical factors and social variables, sought to identify socially vulnerable populations that overlap environmentally susceptible spaces to mass movements, producing a risk map for mass movements in the area. urban area of Iranduba. This product, added to the municipality's Master Plan, thus contributes to the planning of urban occupation in an adequate and sustainable way.

Risks: social vulnerability x natural danger

The implementation of cities imposes demands on the physical environment in the most varied ways, changing its dynamics with the creation or acceleration of countless processes. When society appropriates the natural environment and resources, it promotes significant structural transformations to meet its desires and needs. These transformations, for the most part, do not consider the limitations imposed on the most fragile environments, such as urban slopes and flood plains of the main watercourses, triggering impacts and emerging risks (SANTOS; ROSS, 2012; BRASIL, 2013; PARIZZI, 2014).

According to Mendonça and Buffon (2021), associated with the natural fragility of these environments (natural risks), there are technological and social risks, the latter arising from the very context of crises in the social, economic and political system, and manifest themselves in situations of misery, poverty, unemployment, violence, disturbances, etc., clearly resulting from segregation and urban fragmentation, from diseases that affect an individual or social group. For the authors, the formation of risk situations is the result of a conjuncture of social, economic, cultural, demographic and natural factors that are present in relationships between men, social groups, and between these and nature.

Thus, risk, a social object, can be defined as the perception of danger, of possible catastrophe. It exists only in relation to an individual and a social or professional group, a community, a society that apprehends it through mental representations and lives with it through specific practices. There is no risk without a population or individual who perceives it and who could suffer its effects. Risks are taken, which are assumed, rejected, estimated, calculated. “Risk is the translation of a threat, of a danger for those who are subject to it and perceive it as such” (VEYRET, 2007, p.10).

In this way, the risk of disasters derives from a combination of physical risks and vulnerability of exposed people, that is, the level of adverse consequences of a dangerous event, is largely determined by the vulnerability and exposure of society and socio-ecological systems (ALMEIDA, 2021) . The Regional Disaster Information Center for Latin America and the Caribbean (CRID, 2001) defines vulnerability as the degree of susceptibility or risk to which a population is exposed to suffering damage from a natural disaster.

The occurrence of a natural disaster is always associated with losses, whether economic, social or environmental. In this context, the term risk (R) is adopted in this work, which can be considered as the probability of harmful consequences or losses resulting from the interaction between natural hazards and human systems, as defined by the United Nations Development Program (UNDP , 2004). Usually, to define risk, the following function is adopted: R= f(H,V), where R is risk, H is danger (Hazard), and V is vulnerability (GOERL et al., 2012).

Danger (H) refers to the possibility of a potentially harmful natural process or phenomenon occurring in a specific location and period; vulnerability (V) refers to the set of processes and conditions resulting from physical, social, economic and environmental factors, which increases the susceptibility of a community (element at risk) to the impact of hazards (TOMINAGA, 2015).

Each and every society lives permanently at the mercy of one or more risks, which are inherent to the life and evolution of any human community, among which are landslides that, annually, cause thousands of deaths around the world, including in Brazil. The factors that contribute to the occurrence of landslides are prolonged rain and the relatively steep slope of the slopes (AVELAR et al., 2013; GUERRA et al., 2007; GUERRA; JORGE, 2009; HART, 1986; SELBY, 1993; COELHO NETTO , 1994).

Mass movements, including landslides, are directly related to geological and geomorphological aspects, which are indicators of the most likely locations for the triggering of this type of surface dynamics. The way in which slopes are occupied by man can trigger these movements, as they generate an increase in shear stresses along a potential slip surface until it equals the available shear resistance, thus causing mass movements (GUERRA, 2008 ; GUERRA; JORGE, 2009; In this occupation process, the main problems are associated with cuts and landfills carried out to create a flat region for the construction of houses, problems with drainage of wastewater and rainwater, and the inadequate disposal of waste (UFSC, 2013).

Área de estudo

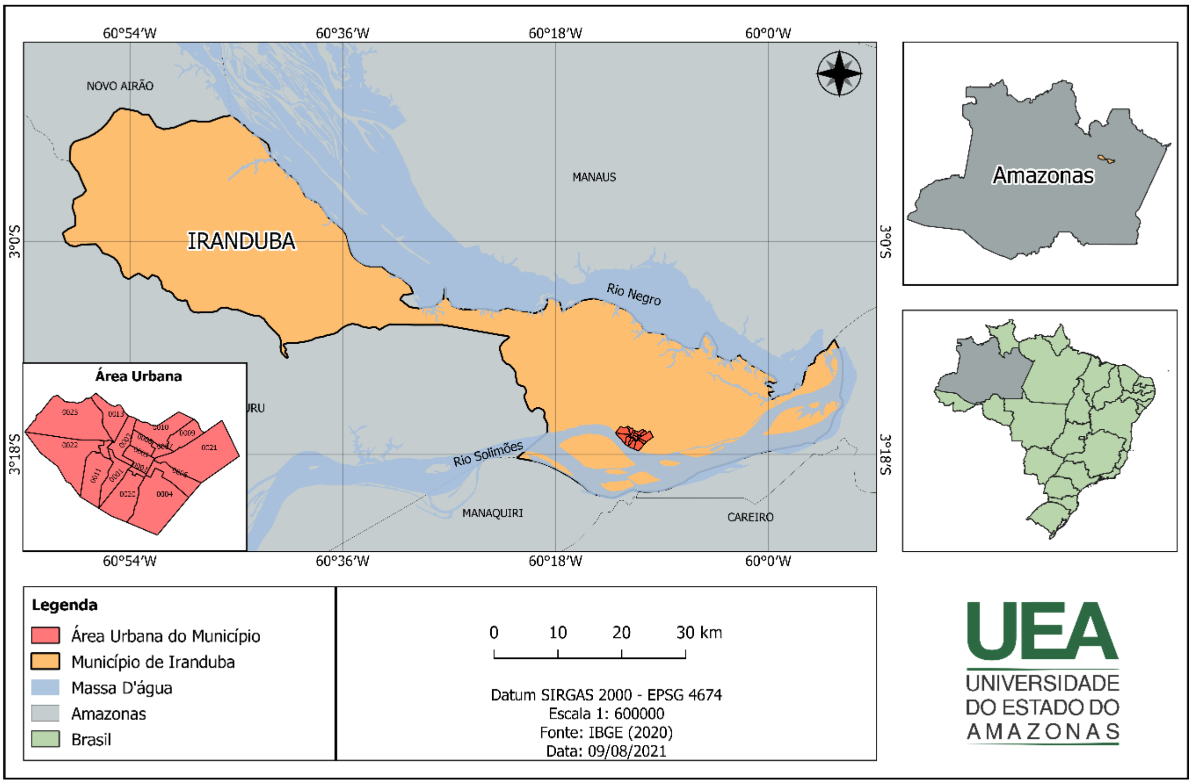
The municipality of Iranduba is part of the Metropolitan Region of Manaus – RMM, and its urban area is located on the banks of the Solimões River; It is limited to the municipalities of Careiro, Manaquiri, Manacapuru, Novo Airão and Manaus (map 1). Access to the municipality can be done by river or land, and in this case, it is via the Manoel Urbano – AM-070 and AM-352 highways, for approximately 34 km from Manaus.

With regard to physiographic aspects, the territorial area of the municipality is 2,214.251 km2; the predominant climate is hot and humid equatorial with no defined dry season, with an average annual temperature above 18°C and average annual rainfall of 2,000 to 2,300 mm.

The municipality's geological substrate is of Cretaceous-Tertiary age, where reddish silicified sandstones and unconsolidated fine- to medium-grained sandstones predominate, interspersed with clayey and kaolinite levels of the Alter do Chão Formation, covered by river terrace deposits and recent deposits. According to CPRM (2018), the intense laterization process of these rocks gave rise to the thick soils in the region. In the urban area of the municipality, yellow Oxisols predominate and, in the marginal areas of the Solimões river, Fluvic Neossolos.

The geomorphological units of the municipality are inserted in the Uatumã-Jarí Plateau, modeled after dissection with homogeneous characteristics. Fluvial dissection in different lithologies does not present remarkable structural control, characterized predominantly by hills and tabular interfluves. The formation of the top is tabular, defined as a set of relief forms that delineate features of gently inclined ramps and humps generally carved into unconsolidated sedimentary covers and crystalline rocks, denoting eventual structural control (IBGE, 2010).

Map 1 - Municipality of Iranduba (AM), highlighting the urban area and census sectors



Fonte: Elaboração: os autores, 2021, dados do IBGE, 2010

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In relation to elevation data, it is observed that the western portion of the municipality of Iranduba has the highest altitudes with altitudes ranging from 46 to 85 meters, with the exception of areas close to river banks whose altitude varies between 20 and 46 meters. In the southeast portion of the municipality, elevation levels are lower, and in the south of this area, in the portion bordered by the Solimões River, they are at the lowest elevations, not exceeding 72 meters in altitude. In the northwest portion of the Southeast of this municipality, bordered by the Negro River, the elevations are higher, exceeding 85 meters in many places (SILVA, 2020).

Methodology

The methodology used in the research was based on the proposal presented by Goerl et al. (2012) for flood risk areas and adapted by Silva et al. (2019) for areas at risk of mass movements in the urban area of the municipality of Iranduba (AM), which considers risk (R) as a product of the relationship between the vulnerability (V) of human groups and natural danger (P). As support, fieldwork was carried out to survey environmental weaknesses and identify the areas mapped by CPRM in 2018.

In constructing the Vulnerability Index (IV), data from the population of the 17 census sectors in the urban area of the municipality of Iranduba (map 1) from the census carried out in 2010 by the Brazilian Institute of Geography and Statistics - IBGE (table 1) were used. The population of the municipality, according to the last census of 2010, is 40,781 people. The census sector is the unit of analysis used by IBGE, and corresponds to the smallest territorial unit with physical limits identifiable in the field. Data from the 2010 census are the most consistent and representative available, since estimates made in subsequent years do not contain all the information necessary to carry out the calculation.

Table 1 - Iranduba (AM): Census Tracts, 2010

CENSUS SECTOR CODE		
13018520500**0001**	13018520500**0007**	13018520500**0013**
13018520500**0002**	13018520500**0008**	13018520500**0020**
13018520500**0003**	13018520500**0009**	13018520500**0021**
13018520500**0004**	13018520500**0010**	13018520500**0022**
13018520500**0005**	13018520500**0011**	13018520500**0023**
13018520500**0006**	13018520500**0012**	

Source: Organization: the authors, 2021, data from IBGE

Based on the proposal by Goerl et al. (2012), data on eight socioeconomic variables were collected from the census: number of residents in the sector, average number of residents per household, demographic density, percentage of the population over 65 years old and percentage of the population under 12 years old, percentage of illiterate people over 12 years, percentage of guardians without income and percentage of guardians with income of up to one minimum wage; and subsequently grouped into six vulnerability variables: number of residents in the sector, average number of residents in the sector, demographic density, sum of the percentage of the population over 65 and under 12 years old, percentage of illiterate people over 12 years old and sum of the percentage of those responsible with no income and those with income up to the minimum wage (table 1).

Chart 1 - Census variables and Variables used to measure social vulnerability

Census Variables	Vulnerability Variables
Number of residents in the sector	Number of residents in the sector
Average number of residents per household	Average number of residents in the sector
Demographic density	Demographic density
% of population over 65 years old	Sum of the percentage of the population over 65 and under 12 years old
% of population under 12 years old	% of illiterate people over 12 years old
% of illiterate people over 12 years old % of responsible people with income up to 1 minimum wage	Sum of the percentage of those responsible with no income and those with income up to 1 minimum wage

Source: GOERL et al., 2012

In measuring the Vulnerability Index (IV), equation 1 was used, which includes the vulnerability variables selected in each census sector and presented in table 1

$$IV = \frac{Dd + Nm + Mm + TxD + E + R}{IDHM} \quad (1)$$

Where, Dd is the demographic density, Nm is the number of residents in the sector, Mm is the average number of residents per residence, TxD is the dependency rate (elderly and young people), E is education (illiterate people over 12 years old), R is income (responsible person without income or with up to 1 minimum wage) and IDHM is the Human Development Index of the Municipality.

Goerl et al. (2012) state that social vulnerability is inversely proportional to the support/response or repair capacity of a municipality in the face of a natural disaster. The Human Development Index - IDHM corresponds precisely to this support/response capacity of each municipality. The Iranduba IDHM, according to the United Nations Development Program – UNDP (2010), is 0.163 and the municipality is therefore classified as medium development.

After calculating the Vulnerability Index (IV) for all census sectors in the urban area of the municipality, the results were standardized based on scaling in order to facilitate the analysis of these results. For this, equation (2) proposed by Marcelino et al. was used. (2006) where the results are scaled between values 0 and 1, with 0 being the minimum value present in a universe and 1 being the maximum value.

$$Vstaggered = \frac{Vobserved - Vminimum}{Vmaximum - Vminimum} \tag{2}$$

In classifying the Vulnerability Index (IV), the Natural Breaks (Jenk) classification method available in the free software Quantum GIS (version 3.16) was used. This method identifies breaks between classes using a statistical formula (Jenk Optimization), and basically consists of minimizing the sum of variance within each class, keeping in mind the increasing order of a phenomenon. Which means that if the variance between certain values is very pronounced, they will be arranged in different classes, resulting in subsets with approximate values and a different number of elements. In the case of this research, the universe (urban region of Iranduba) was divided into four classes that were expressed in the Vulnerability Index (IV) classification as low, medium, high and very high (SILVA et al., 2019).

Hazard can be defined as a natural event (floods, landslides, etc.) characterized by a certain magnitude and probability of occurrence, with the potential to cause damage (DWYER et al. 2004; SCHMIDT-THOMÉ et al., 2006).

To determine the danger (mass movements), the risk areas mapped by CPRM in 2018, the geomorphological characteristics of the terrain, the slope of the slopes and areas of slopes occupied in each census sector were considered. The classification of hierarchical slope categories was based on the proposal by Silva et al. (2019). The extraction of slope information was carried out using Digital Elevation Model (DEM) images from data from the SRTM mission, with a spatial resolution of 30 meters, made available by USGS (2011) on the Topodata website (http://www .dsr.inpe.br/topodata/), and treated in the free software Quantum GIS (version 3.16).

The hierarchical categories of terrain slope were then classified into four intervals of 15% slope: the first interval (0 to 15%) corresponds to the "weak" intensity, supporting both housing and vehicle circulation; the following range of 15 to 30% is the maximum tolerable slope for occupation, characterizing the "medium" intensity. From the second interval onwards, any occupation is considered risky, with slopes above 45% being unviable for housing. The estimated danger (EP) was classified as low, medium, high and very high corresponding to the weak, medium, strong and very strong slope categories, respectively (table 2).

Table 2 - Hierarchical Slope Categories and Estimated Danger

Slope	Hierarchical categories	Estimated Hazard
from 0 to 15%	Weak	Low
from 15 to 30%	Average	Average
from 30 to 45%	Strong	High
above 45%	Very strong	Very high

Source: adapted from SILVA et al., 2019

In determining risk (RI), Goerl et al. (2012) developed the equation that correlates the variables IV (Vulnerability Index) and PE (Estimated Danger) and allows their representation on a map. Vulnerability was determined for each census sector using the vulnerability index, and danger based on the estimated danger.

The Risk Index (IR) for each census sector can be calculated based on these two parameters:

$$IR = IV \cdot PE \quad (3)$$

Based on the calculated indices, maps of vulnerability, estimated danger and risk to mass movements were created for the urban area of Iranduba.

Results and discussions

Silva et al. (2019) developed a methodological proposal for mapping areas at risk for mass movements, in the municipality of Iranduba (AM), however they only presented data on social vulnerability.

The results point to precarious forms of occupation in some neighborhoods, as many houses were built in areas such as valley bottoms and steep slopes (photos 1 and 2). Most of the houses in these areas are made of masonry, a reflection of the region's pottery industry, and others are made of wood and/or on stilts. On the occupied slopes, a large amount of solid waste, ruptures in the drainage network and inappropriate discharge of domestic effluents were observed

Vulnerability

Vulnerability concerns the response/support capacity of a population in the face of an adverse environmental condition (natural disasters), and is directly related to the socioeconomic conditions of society. Thus, in constructing the vulnerability index, factors such as demography, education and economy were considered, based on the census variables selected (table 1) from the 2010 census database.

Photo 1 - Iranduba (AM): occupation of the valley floor

Source: Field research, Correa, (Sept, 2020)

Photo 2 - Iranduba (AM): residence built on a steep slope.

Source: Field research, Correa, (Sept, 2020)

Based on the vulnerability index calculated for each sector, the social vulnerability map of the urban area of the municipality of Iranduba was created (map 2). The vulnerability classes were arranged as follows (table 3):

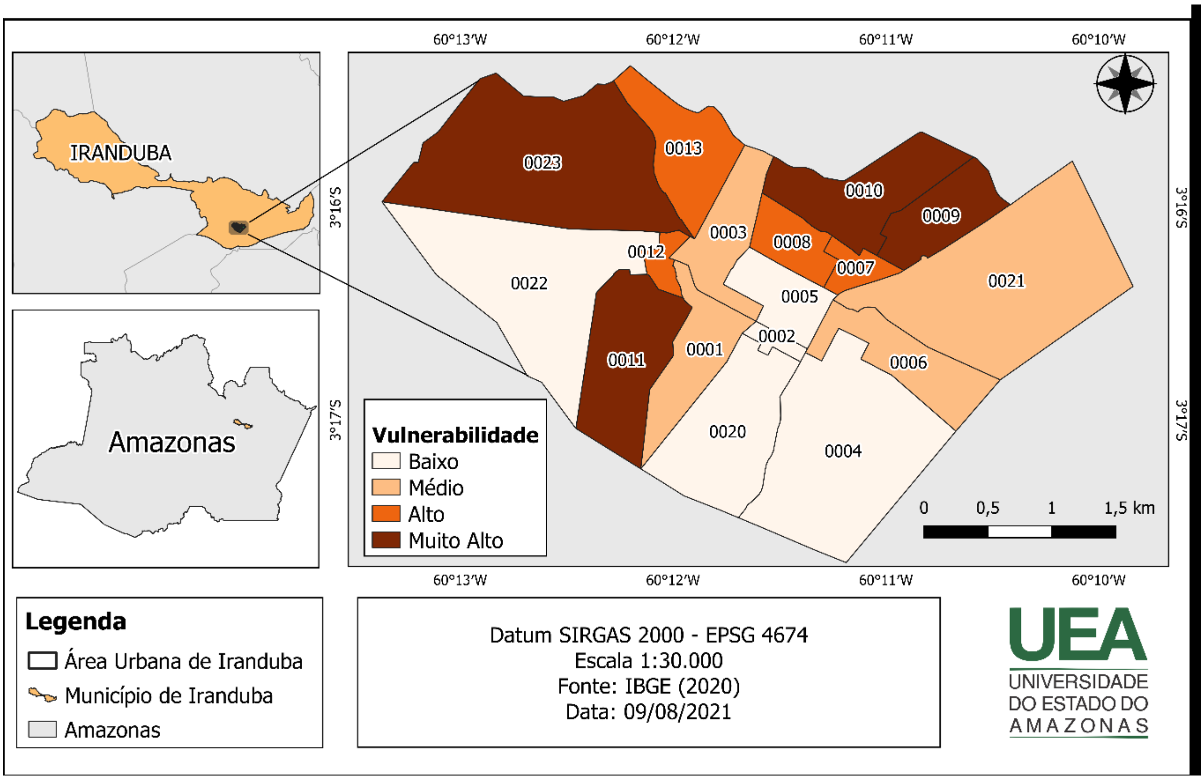
Table 3 - Hierarchical Classification of the Vulnerability Index

Hierarchical Categories	Vulnerability Index
Low	0.00 to 0.37
Average	0.38 to 0.47
High	0.48 to 0.82
Very high	0.83 to 1

Source: the authors,(2020)

The sectors that showed very high vulnerability were: 0009, 0010, 0011 and 0023; high: 0007, 0008, 0012 and 0013; average: 0001, 0003, 0006 and 0021; and low vulnerability: 0002, 0004, 0005, 0020 and 0022.

Map 2 - Distribution of Social Vulnerability in the urban area of Iranduba – AM



Source: Prepared: the authors, 2021 data from IBGE (2010)

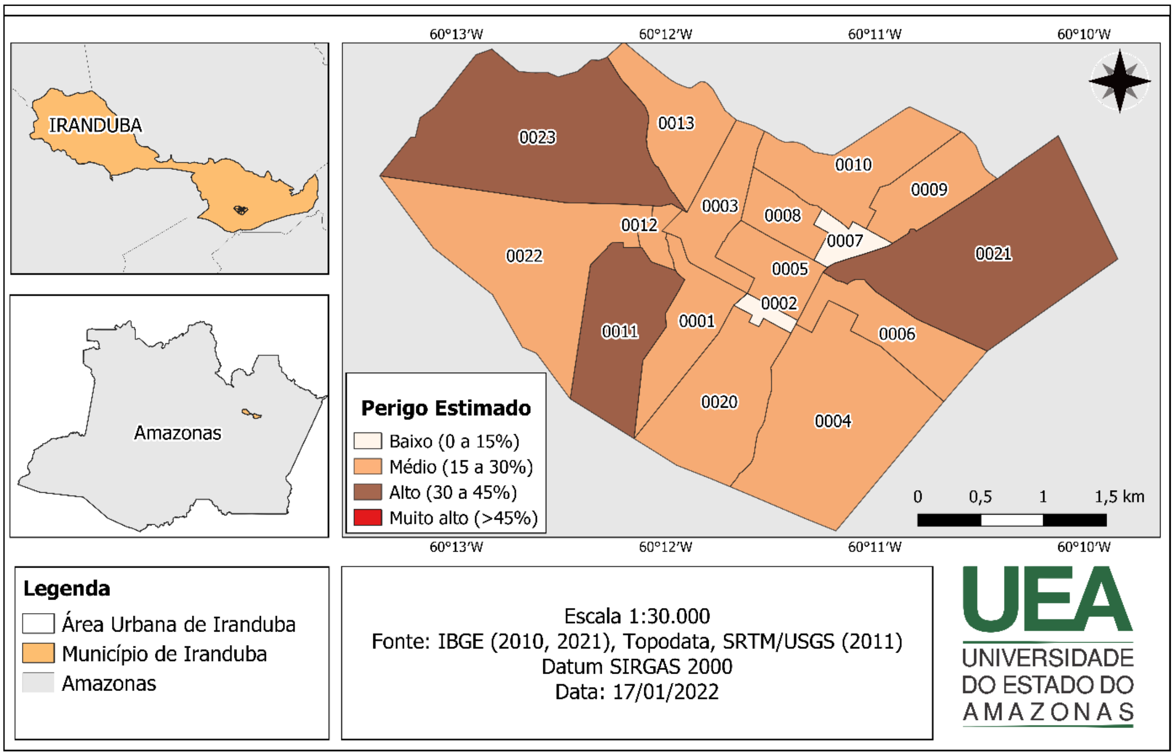
The sectors classified as high to very high vulnerability indicate priority areas for investments by the municipal public authorities aimed at improving the population's quality of life, mainly regarding social aspects such as education and income, which were considered in calculating the dimension of vulnerability. The result shows that, in the event of natural disasters, the population of these sectors does not have the support capacity to deal with the impacts and adverse situations generated.

Estimated Danger:

Based on the hierarchical categories of slope of natural slopes, the Estimated Danger (EP) for the urban area of Iranduba was determined, being classified as low, medium, high and very high, according to table 2.

The estimated danger map (PE) (map 3) shows the danger index of the urban area sectors and classifies sectors 0011, 0023 and 0021 as high danger; sectors 0001, 0003, 0004, 0005, 0006, 0008, 0009, 0010, 0012, 0013, 0020 and 0022 with medium danger; and sectors 0002 and 0007 of low danger.

Map 3 - Distribution of Estimated Danger in the urban area of Iranduba-AM



Source: Prepared: the authors, 2021 data from IBGE (2010)

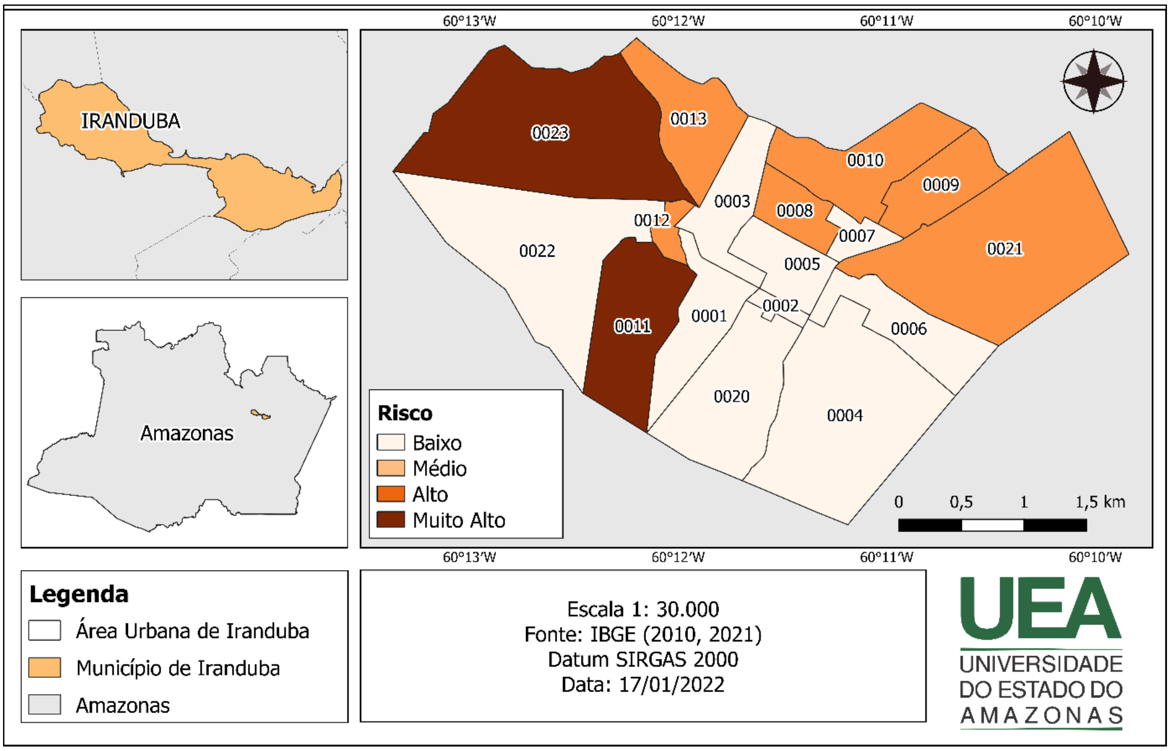
Silva (2020) carried out mapping of areas susceptible to erosion in the urban area of Iranduba and identified six gully-type erosion incisions. According to the author, geomorphological characteristics and human activities, such as soil use and coverage, drainage of rainwater and the release of domestic effluents towards the slopes are responsible for the occurrence of gullies and the acceleration of erosion processes.

According to Molinari (2007), the material mobilized by the mass movement can trigger quite significant erosion processes, such as laminar erosion and/or erosion concentrated in furrows, ravines and gullies, thanks to the immediate development of surface runoff over the mass of material. mobilized or on the scar itself.

Risk:

For risk analysis, this was considered as a function of vulnerability and estimated danger for each sector. The risk map (map 3) shows that sectors 0011 and 0023 were classified as Very High Risk; sectors 0008, 0009, 0010, 0012, 0013 and 0021 as High Risk; sectors 0001, 0003, 0006, 0007 and 0020 as Medium Risk and sectors 0002, 0004, 0005 and 0022 as Low Risk.

Map 3 - Risk Distribution in the urban area of Iranduba (AM)

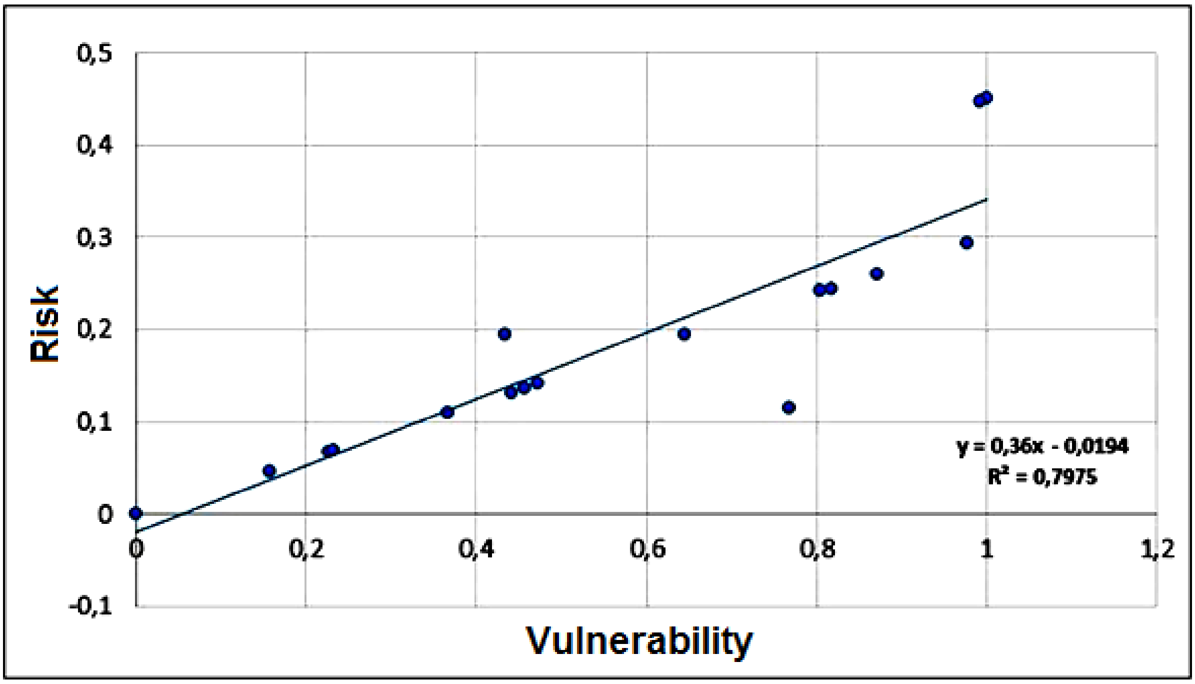


Source: Prepared: the authors, 2021 data from IBGE (2010)

When analyzing the correlation between risk, danger and vulnerability, it is observed that vulnerability is the factor that determines the risk in the area. In graph 1 it is possible to observe the strong correlation (R2 = 0.79) between risk and vulnerability. In the correlation between risk and danger and vulnerability and danger (graphs 2 and 3), these are weak. Thus, what most influenced the risk was vulnerability, that is, the population's ability to respond to disasters associated with mass movements in the municipality.

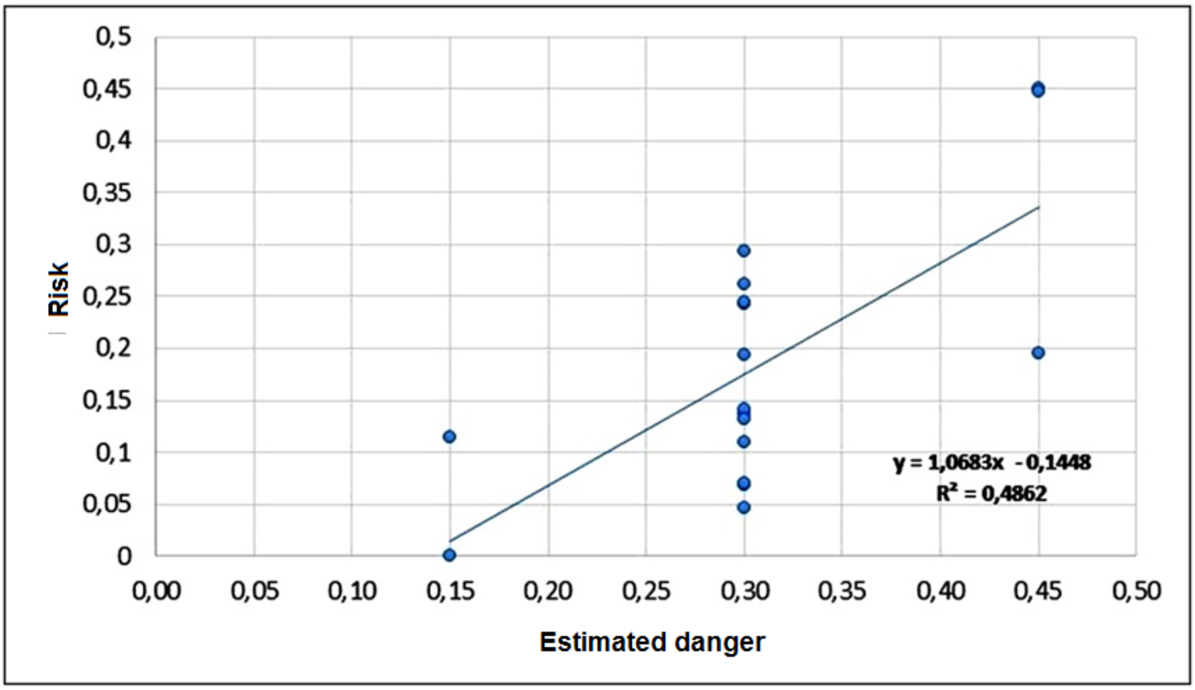
In the specific analysis of the sectors, it is observed that low risk sectors correspond to low vulnerability sectors; In sectors classified as medium risk, vulnerabilities range from high to very high and the danger is medium, here too vulnerability was the determining factor of risk.

Graph 1- Correlation between Risk and Vulnerability



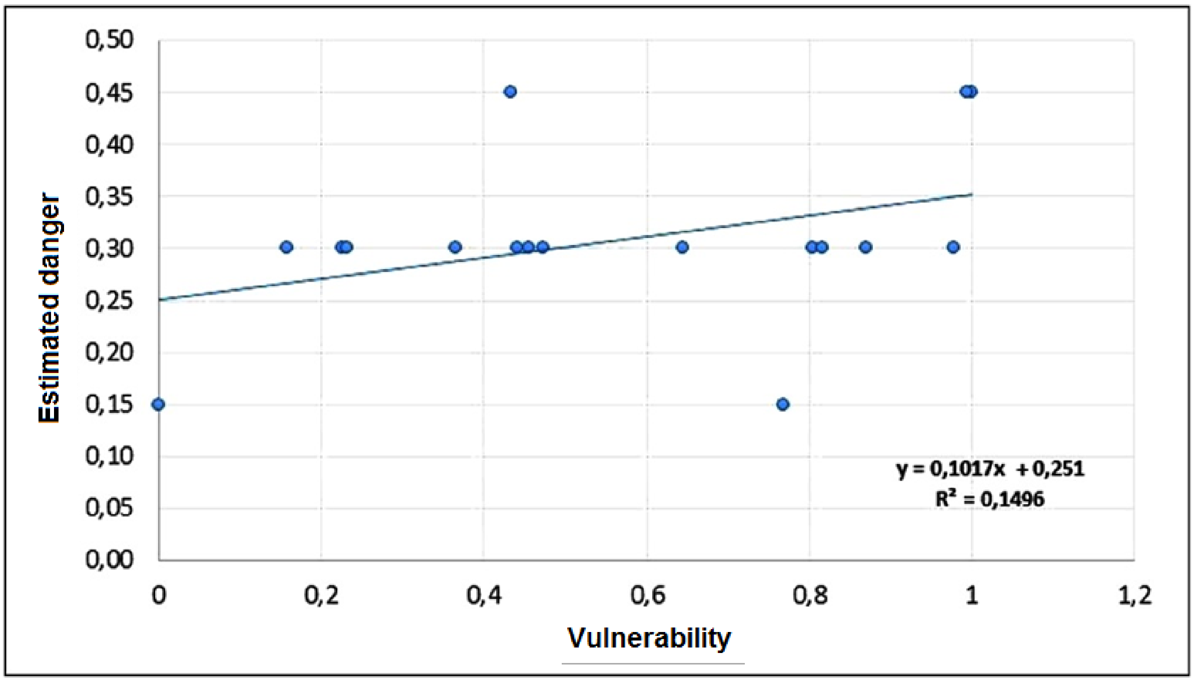
Source: Prepared: the authors, 2021

Graph 2 - Correlation between Risk and Estimated Danger



Source: Prepared: the authors, 2021

Graph 3 - Estimated Danger and Vulnerability Correlation



Source: Prepared: the authors, 2021

Considerações Finais

In analyzing the risk of mass movements occurring in the municipality of Iranduba (AM), the results indicate that vulnerability is the factor that most influenced the danger. This result corroborates the premise that natural phenomena have their effects enhanced when they affect low-income populations and those with conditions of high vulnerability, that is, the risk is the result of a social construction.

Thus, risk cannot be addressed without considering the socioeconomic conditions of the population, a fact that points to the urgent need for municipal managers to work on the territorial planning process, especially in urban areas, through available legal instruments such as the Master Plan Municipal and the Municipal Environmental Code, aiming at not occupying areas susceptible to mass movements and, if possible, removing the population in situations of high social vulnerability.

In addition, actions aimed at improving the quality of life of the local population, increasing the number of jobs, reducing poverty and illiteracy rates, improving health, housing conditions and increasing the HDIM, which encompasses the three dimensions of development human: longevity, education and income. These joint actions will prevent, in the future, the occurrence of natural disasters in the region and the creation of new risk areas.

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Thanks

The University of Amazonas for granting Academic Productivity Bonus

Authors' contributions:
Author 1: Guidance, discussion and final analysis of results, text review
Author 2: Preparation of maps and graphs, methodology, text review
Author 3: Bibliographic review, methodology, analysis of results