Mercator - Revista de Geografia da UFC
ISSN: 1984-2201
mercator@ufc.br
Universidade Federal do Ceará
Brasil

VULNERABILITIES, RISKS AND ENVIRONMENTAL JUSTICE IN A MACRO METROPOLITAN SCALE

Canil, Katia; Baêsso Moura, Rodolfo; Nascimento Sulaiman, Samia; Henrique Campello Torres, Pedro; Luisa Abreu Netto, Anna; Roberto Jacobi, Pedro

VULNERABILITIES, RISKS AND ENVIRONMENTAL JUSTICE IN A MACRO METROPOLITAN SCALE
Mercator - Revista de Geografia da UFC, vol. 20, no. 1, 2021
Universidade Federal do Ceará, Brasil
Available in: https://www.redalyc.org/articulo.oa?id=273665153002

Artigos

VULNERABILITIES, RISKS AND ENVIRONMENTAL JUSTICE IN A MACRO METROPOLITAN SCALE

VULNERABILIDADES, RISCOS E JUSTIÇA AMBIENTAL EM ESCALA MACRO METROPOLITANA

VULNERABILIDADES, RIESGOS Y JUSTICIA AMBIENTAL EN LA ESCALA MACRO METROPOLITANA

Katia Canil
Federal University of ABC, Santos (SP), Brazil., Brasil

Rodolfo Baêsso Moura
Federal University of ABC, Santos (SP), Brazil., Brasil

Samia Nascimento Sulaiman
Alicante University, Alicante, Spain., España

Pedro Henrique Campello Torres
Pontifical Catholic University of Rio de Janeiro, Rio de Janiero (RJ), Brazil, Brasil

Anna Luisa Abreu Netto
University of São Paulo, São Paulo (SP), Brazil., Brasil

Pedro Roberto Jacobi
University of Goiás, Goiânia (GO), Brazil, Brasil

Redalyc: https://www.redalyc.org/articulo.oa?id=273665153002

Abstract:

The historical process of socio-spatial (dis)organization and the dynamics of the Paulista Macrometropolis (MMP) present a great diversity of situations of urban environmental risks, understood as "dysfunctions" with the potential to generate processes that cause loss and damage to people, surrounding goods and infrastructures. The social construction of risks, linked to the unsustainable management of the urban environment, has, on its most perverse face, the proliferation and perpetuation of vulnerable groups situations of exclusion, victims of socio-spatial segregation that restrict the poorest populations to valley floors, floodplains and the steepest slopes. Therefore, we propose a review of the relationship between the physical environment and infrastructure on urban management and the territorialization of socio-spatial conflicts related to environmental justice, considering the complexity of the MMP and the municipal disparities.

Keywords: Vulnerability, Risks, Environmental Justice, São Paulo Macrometropolis.

Resumo:

/ Resumen

VULNERABILIDADES, RISCOS E JUSTIÇA AMBIENTAL EM ESCALA MACRO METROPOLITANA

O processo histórico de (des)organização socioespacial e as dinâmicas da Macrometrópole Paulista (MMP) apresentam uma diversidade de situações de riscos ambientais urbanos, entendidos como "disfunções" com potencialidade de gerar processos causadores de perdas e danos às pessoas, bens e infraestruturas. A construção social dos riscos, relacionada à gestão insustentável do ambiente urbano, tem, na sua face mais perversa, a proliferação e perpetuação de situações de exclusão de grupos vulneráveis, vítimas da segregação socioespacial que restringe as populações mais pobres aos fundos de vale, às várzeas alagáveis e às encostas mais íngremes. Portanto, propomos uma revisão das relações entre meio físico e infraestrutura no âmbito da gestão urbana e a territorialização dos conflitos socioespaciais ligados à justiça ambiental, considerando a complexidade na MMP e as disparidades municipais.

Palavras-chave: Vulnerabilidade, Riscos, Justiça Ambiental, Macrometrópole Paulista.

Palabras clave: Vulnerabilidad, Riesgos, Justicia Ambiental, Macrometrópolis Paulista

INTRODUCTION

In the Brazilian metropolitan urban context, environmental problems have increased and worsened, and the slow pace of attempts to resolve them has contributed to the prevalence of avulnerable, unsustainable structural framework (JACOBI, 2013). Conflicts, manifested in various ways,have proliferated, and they guide the practices directing the appropriation of territories and their resources. These practices are plagued by factors that complicate progress towards the sustainable management of cities (RIBEIRO, 2005).

The conflicts transcend scale and range from the local to the regional. This case study of the São Paulo Macrometropolis (MMP) illuminates the inequalities created by the formation of a regioncomposed of five metropolitan areas and two urban agglomerations (TORRES et al., 2019). The territory with the highest gross domestic product (GDP) in the country has a heterogeneous configuration, and, until now, the policies and planning implemented by the government of the State of São Paulo have not contributed to a reduction in inequality; on the contrary, they have led to greater concentrations of it on the current developmental axes (TRAVASSOS et al., 2020; TORRES, RAMOS,and POLLACHI, 2020).

The unsustainable nature of the pattern of metropolitan urbanization is characterized by the prevalence of a process of expansion and occupation of intra-urban spaces that, in most cases, of fers alow quality of life to significant portions of the population. Cities are marked by duality, with the partsthat shelter the neediest populations neglected, having experienced much greater horizontal and vertical growth than so-called "formal" cities (ARRETCHE, 2015).

Land use and occupational planning marked by socio-spatial segregation and environmental injustice have (re)produced areas with urban socio-environmental risks (SOUZA, 2019). These risksrelate to the overlapping phenomena of natural and social contingencies that can destabilize the living conditions of urban societies and exacerbate natural (environmental) and social (cultural, political,economic, and technological) elements and factors (MENDONÇA, 2011). Therefore, problems that could be avoided, neutralized, or reduced tend to result in catastrophes and/or disasters. The construction of houses on slopes and along the edges of water ways creates areas where residents are at risk of experiencing landslides and floods, reflecting a disorderly, exclusivist, and segregationist pattern of landuse.

A population's degree of socioeconomic vulnerability is usually associated with differential exposure to risks and indicates the greater or lesser exposure of people, places, infrastructure, and/orecosystems to some specific type of risk factor, leading to an uneven distribution of risks that are both social and spatial (CANIL, LAMPIS, and SANTOS, 2020). This leads to a discussion of the theme of environmental justice (ACSELRAD, 2002) as an approach that raises questions about the need to advance public policies focused on making cities not only better-prepared for various types of disasters but on reorienting the way that cities are being (re)produced, a factor essential to increasing their resilience. This is especially true in the context of climate change and the ensuing severe-weather events that tend to disproportionately affect the most vulnerable populations (LAMPIS et al., 2020). This issue demands that the population of an area become more aware of the risks to which it is exposed and that awareness of them be integrated into planning and decision-making processes.

Thus, the management of socio-environmental risks increasingly requires expanded publicinvolvement through initiatives that enable an increase in the population's level of environmental awareness and action and involve an intellectual exercise comprising social learning based on dialogueand interaction coupled with a constant process of recreation and reinterpretation of information,concepts, and meanings. This process originates with learning through training and education courses that improve the practices of civil society and the public authorities from the perspective of cooperation between the actors involved (SULAIMAN and JACOBI, 2018).

To facilitate an analysis of these issues, this paper is divided into three interconnected parts based on various view points of the social construction of risk and environmental justice. It includes a territorial profile

of the MMP, revealing a territory with intrinsic contradictions regarding the process of the financing of space, inequality, and social vulnerability. The first part concerns the conceptual debate proposed by the contemporary discussion on risks and vulnerabilities. The second part is meant to connect the dynamics presented in the first section to the territory under analysis. In this sense, we attempt to characterize the macrometropolitan region based on the Macrometropolis Action Plan (PAM),its main planning and governance instrument and the place where one can identify the state's vision forthe territory.

As an illustrative element in exposing and analyzing the social vulnerabilities of the MMP, we present the distortions proposed in the PAM to address social issues and regional inequalities as well as the key, defining theme of the extreme inequity that exists in terms of access to water and sanitation inthe region. The article does not take the question of water and sanitation as its central theme but ratheruses it to reinforce its argument about the social production of vulnerabilities, risks, and disasters and itsconceptual intertwining with the notion of "environmental justice."

The third, and last, part presents a characterization of susceptibility to landslides and vulnerabilityin the territory of the MMP considering the geotechnical maps of susceptibility, urban capacity, and risk.What is observed in general and confirmed by the research on the MMP is that local governments thatpromote sustainable and inclusive actions, based on premises that support innovation over repeatedideas, become examples of how cities can face strategic issues with local sustainability and resolvesocial inequalities. The challenges for these actors in articulating processes that generate decisionswithin a complex context are multiple and are strongly associated with the need to provide visibility andtransparency and to bring actors closer to addressing the questions posed by contemporary risks in society.

SOCIAL CONSTRUCTION OF RISK

The increase in inequality and socio-spatial segregation has been marked by the expansion ofurban areas subject to the occurrence of natural events (landslides, floods, storms, etc.) and hasconsequently led to environmental degradation, forming new territories of vulnerability and risk (CANIL et al., 2019). Natural phenomena have always been considered the "villains" of risk anddisaster situations, but, from the mid-1980s onward, a theoretical-methodological approach that soughtto place the focus on risks and disasters (natural and technological) from the point of view of not onlythe physical triggering factors, but also the elements at risk, i.e., the population or society exposed tothese processes, has been implemented (ALMEIDA, 2011).

This perspective gained influence with the international conferences on the theme hosted byJapan. At the 1st World Conference (1994), the Yokohama Strategy and Plan of Action for a SaferWorld was presented, calling into question the predominantly technical, scientific approach andproposing to address the vulnerabilities and risk factors of the population concerned. The 2nd WorldConference (2005) resulted in the following outcomes of the Hyogo Framework for Action 2005-2015:increasing the resilience of nations and communities and making evident the need to support thecapacity of populations to adapt to disasters and increase the resilience of governments and localcommunities. The 3rd World Conference (2015) culminated in the development of the SendaiFramework for Disaster Risk Reduction 2015-2030 and put the perspective of governance and politicalparticipation by society on the agenda (SULAIMAN, 2018).

An increase in the occurrence of disasters, the outbreak of the environmental crisis, and a gradualimprovement in living conditions contributed to the deconstruction of the belief that technical-scientificdevelopment would automatically enable the construction of a safe society, completely immune to suchrisks (SANTOS, 2015). Thus, risks are considered intrinsically connected to the predatory actions that acontemporary society performs within its territory.

According to Santos (2015), risks are part of a process of social construction, since they areproduced by the actions of a society, and it is there that they can be observed. Risks are felt byindividuals, and, when they manifest themselves, can cause damage to people, property, structures, andthe organization of a territory.

The perception, knowledge, and consideration of risk can vary dependingon a population's culture, the level of economic development of an area, and even the social groupinvolved. In an official document from the Ministry of Cities (BRASIL, 2007, p.26), a "risk area" isunderstood to be:

Therefore, urban socio-environmental vulnerability is directly associated with risk and is linked toa series of social, political, economic, cultural, and technological contingencies that explain variousconditions of the exposure and vulnerability of social groups to risks. In other words, urbansocio-environmental vulnerability shows the heterogeneity of impacts arising from the risks that affect agiven population in which both urban risk and vulnerability form a highly complex area for urbanunderstanding and management (MENDONÇA, 2011).

It is precisely the degree of vulnerability of the affected social groups that determines theircapacity for reconstruction after the occurrence of a disaster, which, in a way, reflects the socioeconomicconditions of the population and its socio-spatial relationships (SANTOS, 2015). Therefore, a society'slevel of risk exposure and responsiveness are directly connected to the socioeconomic conditions of theaffected social groups.

The current hegemonic view of contemporary risks, whether coming from the media, "commonsense," or academia (BOURDIEU, 2001; BECK, 1992), in a context of climatic variability and itsinterface with environmental inequalities (ACSELRAD, 2002), must be problematized and givenvisibility in terms of environmental justice. Thus, Acselrad (2009) explained that it is the poorestpopulations that are the most prone to environmental risks and that the

In this context, the concept of systemic risk--the risk to which all social groups are prone--isdifferentiated from the risks of socio-natural disasters, whose impact specifically falls mostly onvulnerable socioeconomic/ sociodemographic groups. This process occurs due to a decision-makingprocess that shifts the risk from the most privileged groups/regions to the most vulnerable ones and can,over time, shift the environmental impact to future generations (SULAIMAN and ALEDO, 2016). Thus,through the decisions of the elites, whether in planning or urban investment, an uneven distribution ofrisk is perceived in different territories.

As stated by Acselrad (2002), in addition to questioning the unequal distribution of the effects ofenvironmental risks, another collective action against socio-environmental injustices occurs at the levelof discourse. There is a discourse on the legitimacy of the unequal distribution of environmentalresources that is being contested by the social movements fighting against environmental injustice,"evidencing the social logic that associates the dynamics of capitalist accumulation with thediscriminatory distribution of environmental risks" (ACSELRAD, 2002, p.52).

When the concept of environmental injustice is associated with the issue of climate change inurban areas, it occurs in the context of scenarios involving severe climatic situations in which people inprecarious settlements are subjected to the negative impacts of dangerous events, such as floods andlandslides. It is within this context that it is necessary to democratize not only technoscientificknowledge, but also decision-making processes, and integrate them into the sphere of urban planning (JACOBI and SULAIMAN, 2016).

In the context of the notion of a territory as an area of power disputes and, therefore, conflicts,vulnerability must be seen as a historical construction or process. In this sense, the vulnerability of aterritory is defined not only by technical data on infrastructure (or the absence of it), by the means ofcalculating risks, or by an unfortunate circumstance to which a location is susceptible, but by the set offactors, within a historical context, that have established the specific conditions determining whether alocality exhibits social injustice and possesses natural resources of interest in the appropriation andreproduction of capital, and, at the same time, can serve it with a minimum infrastructure for theoperation of this engineering.

In addition to examining the vulnerability of groups of individuals living in municipalities, it is also necessary to reflect on the institutional fragility of smaller municipalities, which often do not havethe means to implement risk-management policies on their own. Therefore, Nogueira, Oliveira, andCanil (2014) have argued for the consortium model of risk management, which was successful in thecase of the São Paulo Greater ABC's (an industrial region in Greater São Paulo, Brazil) intermunicipalcooperation because it

allows for smaller municipalities to communicate with more-qualified,better-equipped municipalities in the region, optimizing the acquisition of material, technical, human,and logistical resources at a regional level (without the need for this structure at the local level) andenabling the analysis of physical processes at the regional level. The Metropolitan Region of São Paulo(RMSP) has other partnerships, but it is still in the process of forming and consolidating them toapproach a structure similar to that of the ABC, namely, the Intermunicipal Consortium ofMunicipalities in the Juqueri Basin (CIMBAJU); Development Consortium of Alto Tietê Municipalities(CONDEMAT); and Intermunicipal Consortium of the Western Metropolitan Region of São Paulo (CIOESTE).

ENVIRONMENTAL INJUSTICE IN THE CONTEXT OFTHE MMP

The São Paulo Macrometropolis is one of the largest urban agglomerations in the southernhemisphere. It includes the Metropolitan Region of São Paulo (RMSP) and those of Baixada Santista(RBS), Campinas (RMC), Sorocaba, and Vale do Paraíba and Litoral Norte (RMVPLN) and the urbanagglomerations of Jundiaí (AUJ) and Piracicaba (AUP) as well as the Bragantina Regional Unit (URB),which has not yet been institutionalized (Figure 1).

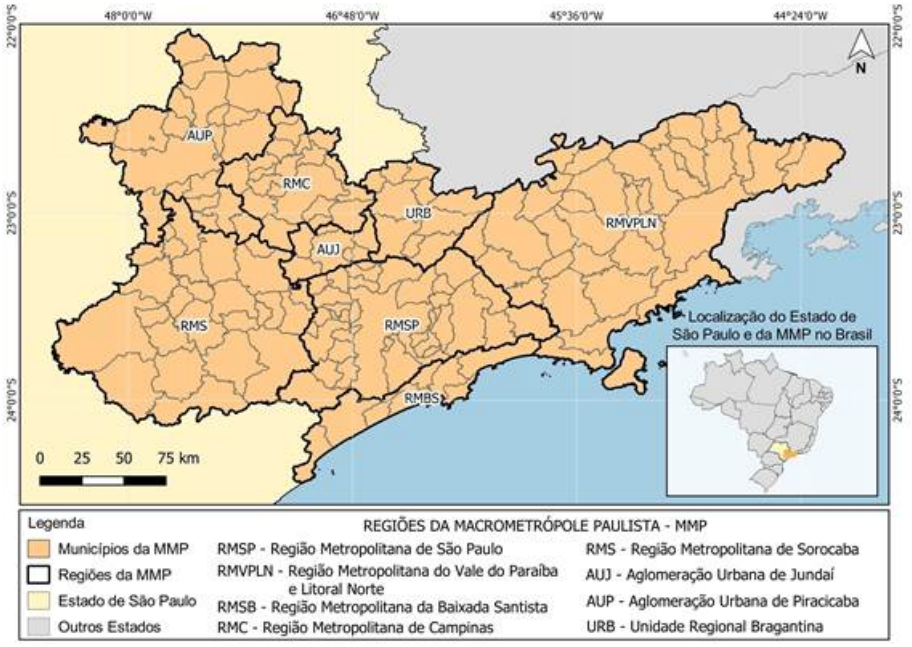

FIGURE 1
São Paulo Macrometropolis and its regions.
Adapted from IBGE, 2015 and IGC,2016.

According to data from the Paulista Metropolitan Planning Company SA (EMPLASA), whichrecently became defunct (under Law No. 17.056/2019), the MMP occupies an area of 3.4 thousand km2(21.5% of the State of São Paulo), with a concentration of high-tech industries, diversified trade sectors, complex services, and productive agribusinesses. It includes important ports (such as the Port of Santos,which saw 29% of the country's export and import movement in 2019) and airports (such as GuarulhosInternational Airport, which saw 42 million passengers in 2019), large road systems, and prominentknowledge and innovation centers.1 It includes 174 municipalities (50% of the state's urban areas) andgenerated 81.9% of the state's GDP in 2016. It accounted for 74.7% of the state's population in 2018and 2.68 million people in subnormal settlements (2010 Census). In addition, it represented 20% of theprotected natural heritage areas of the state. The socioeconomic importance of the region has grownexponentially, as have the social

disparities evident in it and the uneven distribution of risks andenvironmental injustices that we will address in this paper.

Since the formation of the MMP (TAVARES, 2018), the official narrative of the government ofSão Paulo has reinforced the idea that the creation of this city-region (LENCIONI, 2015; FREY, 2019; TORRES, RAMOS, and POLLACHI, 2020), because of its unique characteristics from the point of viewof its borders and size, can resolve regional distortions, especially outside the hubs of São Paulo,Campinas, São José dos Campos, and Santos.

This preoccupation was recorded in the planning instrument published in 2014 by EMPLASA: theSão Paulo Macrometropolis Action Plan (PAM) (2013-2040), which has served as a guide for planningand governance in the region. However, the plan itself (EMPLASA, 2014), structured around prioritizedaxes and a business portfolio, appears to contain contradictions that become evident if we criticallyanalyze the planned projects. The projects reinforce the development of the existing axes-poles, not thepolycentric development of the other regions, agglomerations, and micro-regions.

Table 1 contains the details of the projects prioritized by the MMP, separating them by the axesproposed by the state government. The maintenance of inequalities in investments and priorities byregion, as well as the fact that the RMSP has established itself as a radiating axis for attracting andcirculating capital within the territory, is eviden

Development Vector	Number of projects	Area of influence	Estimated investment in millions of reais - BRL (R $)			
			2025	2035	2040	Total
RMSP	13 projects	RMSP	68,930.0	97,340.0	3,800.0	170,070.0
Bandeirantes	10 projects	Covers the connection between São Paulo/Jundiaí/Campinas/Rio Claro/Piracicaba.	14,001.3	10,016.7	-	24,018.0
Vale do Paraíba	13 projects	Covers the connection between São Paulo/São José dos Campos/Taubaté.	7,419.3	9,416.7	250.0	17,086.0
Caminho do Mar	11 projects	Covers the connections between the logistics centers, roads, and transposition modes of the Serra do Mar for cargo and passengers directed towards the Port of Santos.	3,188.0	13,016.7	-	16,204.7
Sorocaba	9 projects	Covers the region to the west of the MMP along the Castelo Branco and Raposo Tavares axis.	8,115.3	7,556.7	-	15,672.0
Perimeter of the MMP	10 projects	Covers a territorial strip formed from the Port of São Sebastião/São José dos Campos/Jacareí/Campinas and Sorocaba.	7,228.0	3,727.0	-	10,955.0
Total	**66 projects**	-	**108,881.9**	**141,073.8**	**4,050.0**	**254,005.7**

TABLE 1
Quantity of projects and estimated investment (in millions of reais) by territorial vector of theSão Paulo Macrometropolis
PAM Project Portfolio, EMPLASA, 2014. Adapted from Torres,Ramos, and Pollachi, 2020.

The proposed regional development, which is directly linked to transport and logistics projects, ispresented in the PAM without problematizing its objectives, impacts, or alternatives or even reflectingon how these projects would, in fact, resolve the regional distortions and enormous contrasts in theMMP (TRAVASSOS, MOMM, and TORRES, 2019). If, on the one hand, the region producedapproximately 82% of the state's GDP (EMPLASA, 2016) on 21.5% (53.4 thousand km2) of its area, onthe other hand, the remaining 78.5% of the territory would only produce 18% of the GDP, representingan extremely low per capita contribution

and showing the fragmentation, heterogeneity, and inequalitycharacteristic of the MMP (TRAVASSOS et al., 2020).

Another contrast, which appears perverse from the point of view of public health and quality oflife, is reflected in the unequal distribution of urban socio-environmental risks and can be seen in thepublic water supply and sewage treatment indexes of the territory. The service access index for thepublic water supply, when considering the entire territory of the MMP, is considered good, with 90%service coverage in all metropolitan regions. 2 For sewage collection, the overall rate is 86%; however,for the treatment of the collected sewage, the rates are quite low, reaching only 31% (EMPLASA, 2014,p.201). When examining the specific water supply and sewage-collection/treatment indexes, observingthe service rates by municipality and the metropolitan region, there are wide gaps in the sanitationinfrastructure in the cities that comprise the macrometropolitan territory, especially in relation to theseservices.

Providing an illustration of the inequalities in the coverage of basic sanitation services in theMMP, Table 2 shows the lowest rates of water-supply access and sewage collection/treatment amongthe municipalities of the São Paulo metropolitan region, Baixada Santista, Campinas, Sorocaba, andVale do Paraíba and Litoral Norte as well as the urban agglomerations of Jundiaí and Piracicaba.

WATER-SUPPLY AND SEWAGE COLLECTION/TREATMENT INDEXES OF THE MR AND UA IN THE SÃO PAULO MACROMETROPOLIS (2018)				
Metropolitan Region or Urban Agglomeration	**Urban Water Service Index below 90%**	**Sewage Collection Index below 50%**	**Total Absence of Sewage Treatment**	**Municipalities Without Information**
UA of Jundiaí, including 7 municipalities	Campo Limpo Paulista (79.4%); Jarinu (85.2%); Cabreúva (87.2%)	Jarinu (30.6%)	-	-
UA of Piracicaba, including 23 municipalities	-	-	Araras; Cordeirópolis; Rafard; Rio das Pedras	Analândia
MR of Baixada Santista, including 9 municipalities	Bertioga (74.4%); Guarujá (82.4%); Cubatão (85.4%)	-	-	-
MR of Campinas, including 20 municipalities	-	-	Cosmópolis	-
MR of São Paulo, including 39 municipalities	São Lourenço da Serra (52.8%); Juquitiba (57.6%); Mairiporã (62.6%); Biritiba Mirim (64.5%); Pirapora do Bom Jesus (82.4%); Santa Isabel (83.1%); Guararema (83.9%); Rio Grande da Serra (84.9%); Embu-Guaçu (86%)	Vargem Grande Paulista (25.5%); Itapecerica da Serra (27.4%); Santana de Parnaíba (32.5%); Mairiporã (33.2%); Juquitiba (34.1%); Francisco Morato (35%); Cotia (37.4%); Embu-Guaçu (37.8%); Pirapora do Bom Jesus (49.2%); Arujá (49.4%)	Caieiras; Cajamar; Francisco Morato; Franco da Rocha	-
MR of Sorocaba, including 27 municipalities	Araçariguama (60.3%); São Roque (74.4%); Aluminum (84.8%); Boituva (89.4%)	Araçoiaba da Serra (33.2%); Ibiúna (36.1%)	Mairinque; Sarapui	-
MR of Vale do Paraíba and Litoral Norte, including 39 municipalities	Campos do Jordão (65.2%); Ilhabela (69.2%); Igaratá (70.5%); Santa Branca (72.7%); São Sebastião (74.5%); Ubatuba (75.9%); Redenção da Serra (81%); Caraguatatuba (83.8%)	Areias (18.3%); Ubatuba (39.5%); Cunha (40.5%); Igaratá (44.6%)	Aparecida; Areias; Cruzeiro; Paraibuna; Piquete; Potim; São José do Barreiro	-

TABLE 2

Municipalities with low water-supply access and sewage collection/treatment rates in themetropolitan areas of São Paulo, Baixada Santista, Campinas, Sorocaba, and Vale do Paraíba and LitoralNorte as well as the urban agglomerations (UA) of Jundiaí and Piracicaba.

Ministry of RegionalDevelopment, National Sanitation Information System – SNIS, 2020. Compiled by the authors.

Regarding public water-supply access, even though the overall MMP rate is around 90%, thereare cities with a much lower coverage rate. For sewage collection, although there are locations with anindex of 100%, in some municipalities, the rate is quite low, as in the case of São Lourenço da Serra,with 51% coverage; Juquitiba, with 59.4%; Itanhaém, with 30%; Itapecerica da Serra, with 18%; andVargem Grande Paulista, with 24%. Regarding sewage treatment, the overall MMP sewage-treatmentindex is considered poor. For example, the RMSP treats 53.1% of its sewage, and the RMBS only treats16.4% (EMPLASA, 2014, p.201). There are also some MMP cities that do not have any type of sewagetreatment, such as Caieiras, Franco da Rocha, Praia Grande, and Santos.

The continuous release of wastewater directly onto slopes or through leaks from cesspools, besides causing health risks and other negative environmental impacts, is an important indicator of, andcontributor to, the prevalence of landslides in areas with precarious settlements. Such situations areevidenced in the various mappings of risks and municipal risk-reduction plans prepared formunicipalities in the RMSP, such as Franco da Rocha (Figures 2 and 3).

FIGURE 2,3
Figure 2 - Release of wastewater and rainwater on a hillside – Vila Josefina, Franco da Rocha. Source:LabGRis, 2018. Figure 3 - Poor wastewater collection infrastructure – Vila Josefina, Franco da Rocha. Source: LabGRis,2018.

SUSCEPTIBILITY TO LANDSLIDES ANDVULNERABILITY IN THE MMP TERRITORY

Law No. 12.608/2012 of the National Civil Protection and Defense Policy includes a set ofinstruments and mechanisms for planning and territorial organization, requiring municipalities to adopt aseries of measures to protect their inhabitants and infrastructure, with support from geotechnical chartswith various scales and objectives.

In general, the term "geotechnical cartography" can be conceptualized as the cartographicrepresentation of the characteristics of the physical environment (soil, relief patterns, and rock) in anintegrated manner. It also includes the associated geological-geomorphological and hydrologicalprocesses, such as erosion, landslides, floods, and collapses, among others, and the various behaviors ofthe land in relation to the types of interventions and land-use and occupation patterns. Thus, to complywith Law No. 12.608/2012, three types of geotechnical maps are considered in assessing risks (BITTAR, 2014; SOUZA and SOBREIRA, 2014; CANIL et al., 2018):

A "susceptibility map" that shows the degree of susceptibility of the terrain (high, medium, orlow) to geodynamic processes (mass gravitational movements, such as landslides and related processes)and hydrodynamics (inundations and floods) on a scale of 1:25,000;

An "urbanization capacity map" that explains the potential uses and limitations of land given theoccurrence of geodynamic and hydrodynamic processes and indicates guidelines for safely constructingsettlements on a scale of 1:10,000; and

A "risk map" that represents the sectorization of the degree of risk (very high, high, medium, orlow) considering the occurrence of geodynamic processes on a scale greater than 1:2,000 (detail scale).

Due to the size of the MMP, we will present a reading of the integration of various maps showingsusceptibility to the landslide processes that have affected the municipalities. These were mapped basedon cooperative work between the Geological Service of Brazil (CPRM) and the Institute ofTechnological Research of the State of São Paulo (IPT), and the work was carried out from 2013 to2018 (MOURA, CANIL, and SULAIMAN, 2019). In this work, susceptibility maps were preparedindividually for each municipality; however, spatial data were available on the CPRM website3, which enabled the integration of information.

Furthermore, susceptibility maps present, through the integration of various physicalenvironmental conditions, a municipality's degree of susceptibility to landslides and their relatedprocesses and to inundations and floods. Of the 157 susceptibility maps from the State of São Paulo, 125correspond to

municipalities in the MMP. When assessing risks, susceptibility maps indicate afundamental issue, threat/danger, which can be translated as the probability of a given phenomenonoccurring in an area.

Figure 4 shows the integration of the susceptibility maps indicating areas of low, medium, and high susceptibility; from it, it is possible to observe that areas of high susceptibility to landslides andtheir related processes are present in a strip that extends from the north of the municipalities in theRMSP (Serra da Cantareira) to the limits of Serra da Mantiqueira, which includes municipalities in partof the Vale do Paraíba region. To the south, a significant part of the stretch that limits the plateau regionand the coast (south and north) by the Serra do Mar, including the municipalities of the Baixada Santista(Santos, São Vicente, Cubatão, and Guarujá) and the Litoral Norte (São Sebastião, Ilhabela,Caraguatatuba, and Ubatuba), falls into the high-susceptibility class, with an elevated potential forexperiencing risk-generating situations.

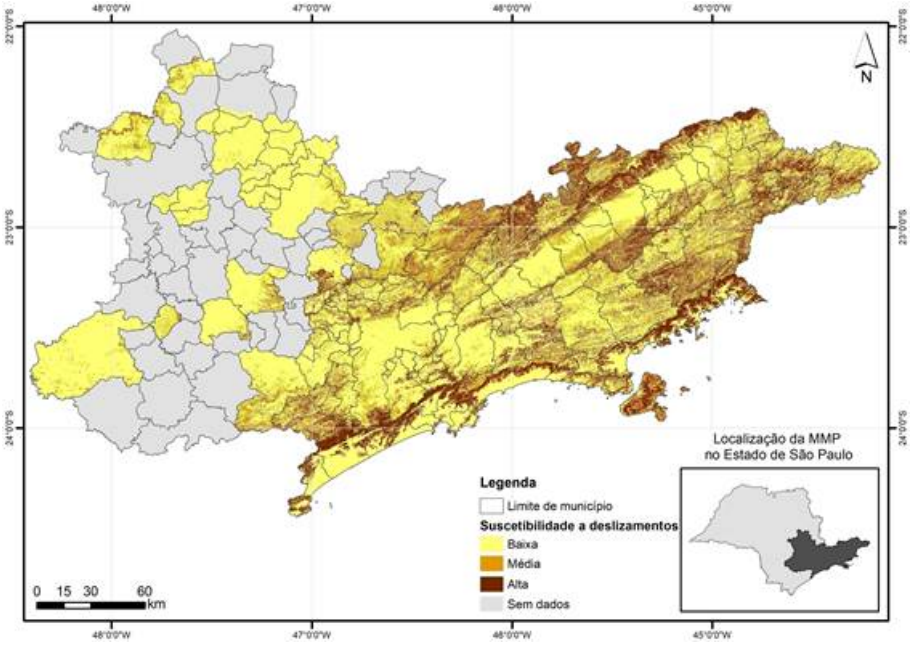

FIGURE 4
Map of susceptibility to geodynamic processes (landslides and related processes) for theMMP.
Adapted from the CPRM and IPT, 2014 and 2015.

In addition to this aspect of the susceptibility analysis, there are other factors that can lead to thediscovery of high-risk areas in terms of vulnerability on another dimension and scale of analysis. Thus,it is understood that the "vulnerability" component of the social, economic, and environmentalconditions of land use and occupation defines risk as a factor of social construction. Vulnerabilityinfluences the socioeconomic losses related to the consequences of a disaster; this is the factorassociated with the selective severity of the negative impact of such processes on the population and theamount of infrastructure exposed to the risk. Thus, it is necessary to go beyond the discussion of theareas exposed to threats (susceptibility) when guiding regional risk-management policies, assessing theweaknesses and fragility (vulnerability) of the people and communities that are exposed to physicalenvironmental processes that can intensify such vulnerabilities.

The São Paulo Social Vulnerability Index (IPVS) assesses a territory's spatial vulnerability basedon socioeconomic and demographic data from the 2010 Census. Given its scope, this instrument can beused to obtain a regional reading in the sense that it can spatially depict the areas of greatest socialvulnerability in the MMP and offer a means of providing support to decision-makers in implementingintegrated public policies; considering risk, housing, and social development; and prioritizing the areasof risk that, perversely, tend to accumulate in precarious settlements (MOURA, CANIL, and SULAIMAN, 2019).

Through a combination of variables, both socioeconomic and demographic, the IPVS classifiessocial vulnerability into seven groups (Table 3). It even considers the type of location (urban/rural) andthe form of territorial occupation (precarious/ normal/non-precarious settlements). The socioeconomiccondition of an area is translated into high, medium, and low categories, and family composition,understood as a demographic factor, is divided into elderly, adult, and/or young categories (SOUZA,OLIVEIRA, and MINERVINO, 2013).

DETAILS OF THE SÃO PAULO SOCIAL VULNERABILITY INDEX		
Vulnerability Classification	**Vulnerability Dimensions and Variables**	
Groups	Socioeconomic	Demographic
1 - Extremely low vulnerability; 2 - Very low vulnerability; 3 - Low vulnerability; 4 - Medium vulnerability; 5 - High vulnerability (urban); 6 - Very high vulnerability (subnormal clusters); 7 - High vulnerability (rural).	- Per capita household income; - Average income of the female head of household; -% of households with per capita household income up to 1/2 of the minimum wage; -% of households with per capita household income up to 1/4 of the minimum wage; -% of literate heads of household.	- % of heads of household aged between 10 and 29 years; - % of heads of household who are women and aged between 10 and 29 years; - Average age of heads of household; - % of children between 0 and 5 years of age.

TABLE 3
Components of the São Paulo Social Vulnerability Index.
Adapted from the SEADE (2013). Compiled by the authors.

The number of classes of social vulnerability is determined by the census data, according towidely varied dimensions (from a single condominium to an area of a few kilometers), which on themacrometropolitan scale, presents a challenge for representation and interpretation. Thus, it was decidedto aggregate specific groups based on a reinterpretation of the data and considering the originalcomposition of the IPVS proposed by Souza, Oliveira, and Minervino (2013), who were also the authorsof the IPVS. Thus, the Social Vulnerability Map for the MMP (Figure 5) was composed of the followingclasses:

Low (Groups 1, 2, and 3): Medium to very-high socioeconomic status; young, adult, and/orelderly families;

Medium (Group 4): Low socioeconomic status; adult and elderly families;

High (Groups 5, 6 and 7): Low socioeconomic status; young families in urban areas andprecarious settlements and young, adult, and elderly families in rural areas.

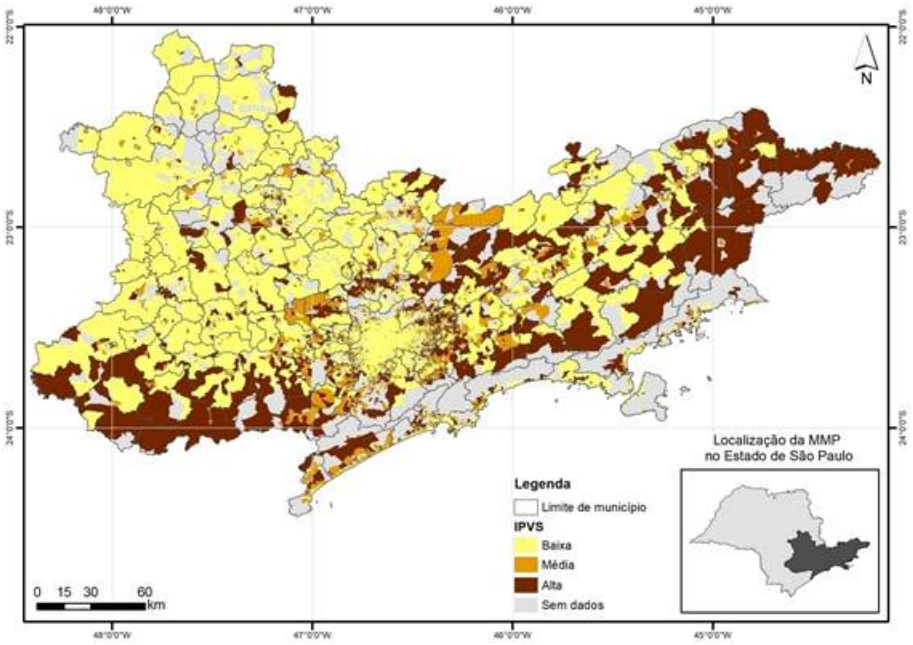

FIGURE 5
Social Vulnerability Map for the MMP.
Adapted from the IPVS, 2010. (MOURA,CANIL, and SULAIMAN, 2019)

The highest vulnerability indexes are concentrated in the municipalities to the south of the regionof Sorocaba in the municipalities of the region of Vale do Paraíba (bordering the Planalto Atlântico),Vale Histórico, and the municipalities bordering the State of Rio de Janeiro. Areas with a mediumvulnerability index predominate in the peripheral municipalities of the RMSP, indicating a context ofurban segregation, where the most socially vulnerable populations are distant from the center.

It should be noted that the two aforementioned instruments, susceptibility maps and the IPVS,when applied to the MMP, (home to 174 municipalities and 33 million people) and when correlated andconsidered in addition to other aspects, can guide the prioritization of risk-management actions relatedto socio-environmental issues. These tools display the need for political articulation and governancebetween municipalities and metropolitan regions to address this issue. In this way, they can be used toaddress the situations that lead to the formation of high-risk areas through interventions to improveliving conditions and security, especially in peripheral territories.

The application of these mappings must, above all, be integrated into the context of efforts toaddress other infrastructure deficiencies, such as issues with the water supply and sewage treatment, aswe have previously mentioned, as these factors are also involved in the socio-environmental risks in theterritory. Most of these scenarios show that such issues are largely inseparable, and their effectivetreatment depends on implementing integrated interventions and addressing technical, urban, legislative,and community-related questions.

CONCLUSION

By integrating the reading of maps of the areas susceptible to geodynamic processes (landslidesand related issues) with those of social vulnerability and analyzing various aspects of sanitation (rates ofwater-supply access and sewage collection/treatment), we observed that the areas where precariousinfrastructure related to water and sewage predominates correspond to those of the greatestenvironmental vulnerability. The susceptibility component indicates the probability of a phenomenon occurring within a specific

territory, and, although the area is predominantly classified as medium-risk,the external factors that lead to precariousness, inequality, and socio-spatial segregation can create areaswith high-risk tendencies.

In the context of the MMP, vulnerability is extremely evident when addressing the peripheralterritories, which, from the perspective of the physical environment, are more fragile and susceptible toprocesses like landslides and floods. From an environmental perspective, we are responsible for themaintenance of ecosystem services, guided by environmental-protection laws, which leads to a conflictbetween the need for environmental protection and the population's right to housing and use of the city'samenities.

Understanding risk as a social construction linked to a process of environmental injustice andsocio-spatial segregation is a fundamental premise for local and regional diagnosis of such issues,especially in view of the territorial complexity of the MMP. Understanding the concept of risk from thisperspective also aids in the articulation of issues related to the design of territorial planning, urbandevelopment, health policies, the environment, climate change, water-resource management, geology,infrastructure, education, science, and technology, all with the purpose of promoting sustainabledevelopment, as provided for in Art. 3 of Law No. 12.608/2012.

Thus, many municipalities must be considered in relation to various socio-environmental risks,and, in order to mitigate them, actions must be taken at the local level (dealing with unsafe housingconditions and precarious settlements in areas at risk of landslides and floods) and at the regional level(in consideration of the role of planning as fundamental to solving the mapped problems). This is thekey to building a public-policy agenda for effective governance and risk-management. The dissolutionof the EMPLASA, as well as the approval of the new regulatory framework for sanitation (Law No.14.026 of July 15, 2020), leaves the direction and the complex problems pointed out in this paper in aneven more uncertain position. Thus, it will become even more imperative to encourage participatoryprocesses and active citizenship, aiming at constructing territories that are more resilient to the effects ofclimate change that affect the area's most vulnerable populations most severely.

ACKNOWLEDGEMENT

This research was developed as part of the FAPESP Thematic Project 2015/03804-9, processes2019/05644-0 and 2018/06685-9.

REFERENCES

ACSELRAD, H. Justiça Ambiental e Construção Social do Risco. Desenvolvimento e Meio Ambiente, Ed. UFPR, Curitiba, v. 5, p. 49-60, 2002.

ACSERALD, H.; CAMPELLO, C.; BEZERRA, G. (orgs). O que é Justiça Ambiental? 1º. Ed. Rio de Janeiro: Garamond, 2009.

ALMEIDA, L. Q. Por uma ciência dos riscos e vulnerabilidades na geografia (a science of the risks and vulnerabilities to geography). Mercator, Fortaleza, v. 10, n. 23, p. 83 a 99, nov. 2011.

ARRETCHE, M. Trajetórias das Desigualdades: como o Brasil mudou nos últimos 50 anos. 1. ed. São Paulo: UNESP, 2015.

BECK, U. Risk Society: Towards a New Modernity, Londres, Sage, 1992.

BITAR, O. Y. (coord). Cartas de suscetibilidade a movimentos gravitacionais de massa e inundações: 1:25.000: nota técnica explicativa. São Paulo: IPT; Brasília: CPRM, 2014.

BOURDIEU, P. Meditações pascalianas. Rio de Janeiro: Bertrand Brasil, 2001.

BRASIL. Ministério das Cidades; Instituto de Pesquisas Tecnológicas. Mapeamento de riscos em encostas e margem de rios. Brasília: MC/IPT, 2007.

CANIL, K.; FREITAS, C. G. L.; SOBREIRA, F. G.; COLLARES, E. G. Cartografia Geotécnica e Geoambiental. Geologia de Engenharia e Ambiental. 1ed.São Paulo: ABGE, 2018.

CANIL, K.; MYAMOTO, M. M.; FIGUEIRA, R. M.; TOMBETA, L. R. Gestão de riscos e desastres e a articulação com o Plano de Desenvolvimento Urbano Integrado: ações para uma governança da Região Metropolitana de São Paulo. In: Encontro Nacional Anpur, 18., 2019, Natal. Anais..., Natal: Anpur, 2019.

CANIL, K.; LAMPIS, A.; SANTOS, K. L. Vulnerabilidade e a construção social do risco: uma contribuição para o planejamento na Macrometrópole Paulista. CADERNOS METRÓPOLE, v. 22, p. 397-416, 2020.

EMPLASA. Rede urbana e regionalização do Estado de São Paulo. São Paulo, 2011.

EMPLASA. Plano de Ação da Macrometrópole Paulista. São Paulo, 2014.

EMPLASA - Empresa Paulista de Planejamento Metropolitano S.A. Macrometrópole Paulista, 2016. Disponível em: . Acesso em: 11/09/2020.

FREY, K. Global city-region. The Wiley Blackwell Encyclopedia of Urban and Regional Studies. Edited by Anthony Orum. JohnWiley & Sons Ltd, 2019.

JACOBI, P. R. São Paulo metrópole insustentável- como superar esta realidade. CADERNOS METRÓPOLE (PUCSP), v. 15, p. 219-239, 2013.

JACOBI, P. R.; SULAIMAN, S. N. Governança ambiental urbana em face das mudanças climáticas. Revista USP, n. 109, p. 133-142, 22 nov. 2016.

LAMPIS, A.; CAMPELLO, P. T.; JACOBI, P. R.; LEONEL, A. L. A produção de riscos e desastres na América Latina em um contexto de emergência climática. O Social em Questão, Vol. 48: 75-92. 2020.

LENCIONI, S. Urbanização difusa e a constituição de megarregiões. O caso de São Paulo-Rio de Janeiro. E-metropolis, 22, (6-15), 2015.

MENDONÇA, F. A. Riscos e vulnerabilidades socioambientais urbanos: a contingência climática. Mercator, Fortaleza, v. 9, n. 1, p. 153 a 163, jan. 2011.

MOURA, R. B.; CANIL, K.; SULAIMAN, S. N. Vulnerabilidade social, suscetibilidade e riscos de deslizamentos: Um estudo sobre a Macrometrópole Paulista. In: Encontro Nacional da ANPEGE, 13., 2019, São Paulo. Anais..., São Paulo: ANPEGE, 2019.

NOGUEIRA, F. R.; OLIVEIRA, V. E.; CANIL, K. Políticas públicas regionais para gestão de riscos: o processo de implementação no ABC, SP. Ambiente & Sociedade, São Paulo, v. 17, n. 4, p. 177-194, dez. 2014.

RIBEIRO, A. C. T. Território usado e humanismo concreto: o mercado socialmente necessário. In: X Encontro de Geógrafos da América Latina, 2005, São Paulo. X Encontro de Geógrafos da América Latina, 2005.

SANTOS, J. O. Relações entre fragilidade ambiental e vulnerabilidade social na susceptibilidade aos riscos. Mercator, Fortaleza, v. 14, n. 2, p. 75 - 90, sep. 2015.

SEADE. Índice Paulista de Vulnerabilidade Social. São Paulo, 2013.

SOUZA, G. O. C.; OLIVEIRA, F. M.; MINERVINO, L. S. Primeira Análise: Retrato socioterritorial da metrópole, São Paulo à luz do IPVS. São Paulo: SEADE, nov., 2013.

SOUZA, L. A.; SOBREIRA, F. G. Guia para elaboração de cartas geotécnicas de aptidão à urbanização frente aos desastres naturais: Estudo de caso de Ouro Preto - 2013. Brasília, 2014

SOUZA, M. L. Ambientes e territórios: Uma introdução à Ecologia Política. 1. ed. Rio de Janeiro: Bertrand Brasil, 2019.

SULAIMAN, S. N.; ALEDO, A. Desastres naturais: convivência com o risco. Estud. av., São Paulo, v. 30, n. 88, p. 11-23, dez. 2016.

SULAIMAN, S. N.; JACOBI, P. R. (orgs). Melhor prevenir: olhares e saberes para a redução de risco de desastre. 1. ed. São Paulo: IEE-USP, 2018.

SULAIMAN, S. N. Reflexão e ação: educar para uma cultura preventiva. In: SULAIMAN, S. N.; JACOBI, P. R. (orgs). Melhor prevenir: olhares e saberes para a redução de risco de desastre. São Paulo, IEE-USP, 2018.

TAVARES, J. Formação da macrometrópole no Brasil: Construção teórica e conceitual de uma região de planejamento. EURE, v.44, n.133, pp. 115-134, 2018.

TORRES, P. H. C.; RAMOS, R. F.; REGINA, L. G. Conflitos Ambientais na Macrometrópole Paulista: Paranapiacaba e São Sebastião. Ambiente & Sociedade., São Paulo, v. 22, e0101, 2019.

TORRES, P. H. C.; RAMOS, R. F.; POLLACHI, A. A Macro metropolização em São Paulo:

TRAVASSOS, L.; MOMM, S.; TORRES, P. Apontamentos sobre Urbanização, Adaptação e Vulnerabilidades na MMP. In: TORRES, P.; JACOBI, P.; GONÇALVES, L.; BARBI, F. Governança e planejamento ambiental: adaptação e políticas públicas na Macrometrópole Paulista. Rio de Janeiro: Editora Letra Capital, 2019.

TRAVASSOS, L. R. F. C.; TORRES, P. H. C.; ZIONI, S.; FERNANDES, B.; MACHADO, G. Heterogeneidade e fragmentação espacial na Macrometrópole Paulista: a produção social de fronteiras e buracos. Ambiente & Sociedade, vol 23, 2020.

Notes

1 For more data on ports, see “Waterway Statistics,” available at:http://web.antaq.gov.br/ANUARIO/ and accessed on August 31, 2020. For more data on the Guarulhosairport, see , which was accessed on August 31, 2020.

2 According to the PAM, a water-supply index above 90% is considered “good”; between 50%and 90% “regular”; and under 50% “poor.” For sewage collection, over 90% is considered “good”;between 50% and 90%, "bad"; and under 50%, "very bad" (EMPLASA, 2014). Compiled by theauthors.

3 http://www.cprm.gov.br/publique/Gestao-Territorial/Prevencao-de-Desastres/Produtos-por-Estado---Cartas-de-Suscetibilidade-a-Movimentos-Gravitacionais-de-Massa-e-Inundacoes-5384.html