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Vulnerabilities in urban spots along the margins of the Capibaribe River - Pernambuco / Brazil

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Abstract
Conceiving river margins as complex and important environments for numerous socioenvironmental dynamics, this article pointed out similarities and specificities of three urban spots along the same river, detailing occupation processes, uses and vulnerabilities. The objective of this work was to investigate the influence of land occupation and land use patterns in distinct urban areas on the margins of the Capibaribe River, located in the state of Pernambuco, aiming to mitigate vulnerabilities. For that, the hypothetical deductive method, guided by the systemic reasoning line, was used. The relationship between urban spots in the local and regional economy and the margins of the Capibaribe River has made a contradictory picture of the negative signs that point to the environmental degradation and vulnerability of low income populations on the Capibaribe river margins. In order to mitigate these consequences, actions must be carried out to address local variations in the nature of river margins and social dilemmas of land use and land use, as well as to review existing policies and the role of the State in the integrated management of riverbank areas in urban spots.
Keywords: Rivers; City; Space; Capibaribe River.

Introduction

River margins are complex environments. They play an important role in various socioenvironmental processes, from those concerning the use and occupation of urban land to hydrographic basins natural environments systemic relations, in which river margins are a key element.

The understanding of river margins as a strip of land of a certain width and alongside a superficial or natural course of water, as explained by Guerra and Guerra (2006), and their constant occupation led to the need to

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use the guidelines of the Forestry Code, Law no. 12.651 of May 25, 2012 (ARAGÃO; GOMES, 2016), as a relevant support for this study.

Therefore, river margins are seen as essential spaces to life in the continents for they are related both to the biotic and hydrologic cycles. Besides, throughout history, they have been associated with different social purposes, retaining temporal-spatial marks and techniques of society's social and environmental contradictions in their spatial (re)production (ARAGÃO, 2017).

Unfortunately, these areas attract the attention of authorities only in events of urban misfortune, caused by floods impacting riverside populations (GORSKI, 2010). The occupation and use of land occur in many ways, especially when the paradoxical dynamic of urban space production and its social agents are involved (ARAGÃO; GOMES, 2016).

Because of this unrelenting picture and to its socioenvironmental consequences, the ongoing process of occupation of river margins along urban rivers requires efficient initiatives of management and of local social dynamics to mitigate existing vulnerabilities, mainly within low-income communities.

A definition for vulnerability must consider natural systems (e.g. river margins) evolution from their origin, considering society resolutions and their reflexes on these systems and socioenvironmental arrangements dialectically reconfigured and transformed into ecological support, according to Santos (2012).

With this, vulnerability is understood as a social construction (MENDONÇA, 2004; THOURET, 2007; BRASIL, 2007; PORTO, 2007; SANTOS, 2015; PNUD, 2014) whose origin is linked a) to social groups appropriation of natural systems; b) to natural systems fragility faced with different forms of land occupation and use and c) to the conditions of action in social classes paradoxical and conflicting contexts.

Based on these precepts, our main objective was to investigate the influence of various forms of urban land occupation and use along the margins of the Capibaribe River, aiming at mitigating vulnerabilities. For that purpose, we applied the hypothetic-deductive method (POPPER, 2013), guided by systemic reasoning (MONTEIRO, 2001).

According to Popper (2013), the analysis of reality is accomplished by seeking the falsification of hypotheses that are verifiable and that, if confirmed, hold a provisory truth that may be considered pertinent until its falsifiability is discovered, and another hypothesis is produced thereafter

By observing nature around urban river margins, one believes, based on Monteiro (2001), that it is possible to form hypothesis, provided that the relation between natural and social elements is considered in a systemic manner. Thus, one inquires how the occupation and use of urban river margins land, from upstream to downstream, influence the vulnerabilities in these areas.

In the study, we raised a hypothesis advocating that the State difficulty to efficiently intervene and manage, in an integrated manner, the cities along the margins of a river, contributes to reproducing the socioenvironmental vulnerabilities, especially for low-income social groups, segregated in river margins areas of greater instability.

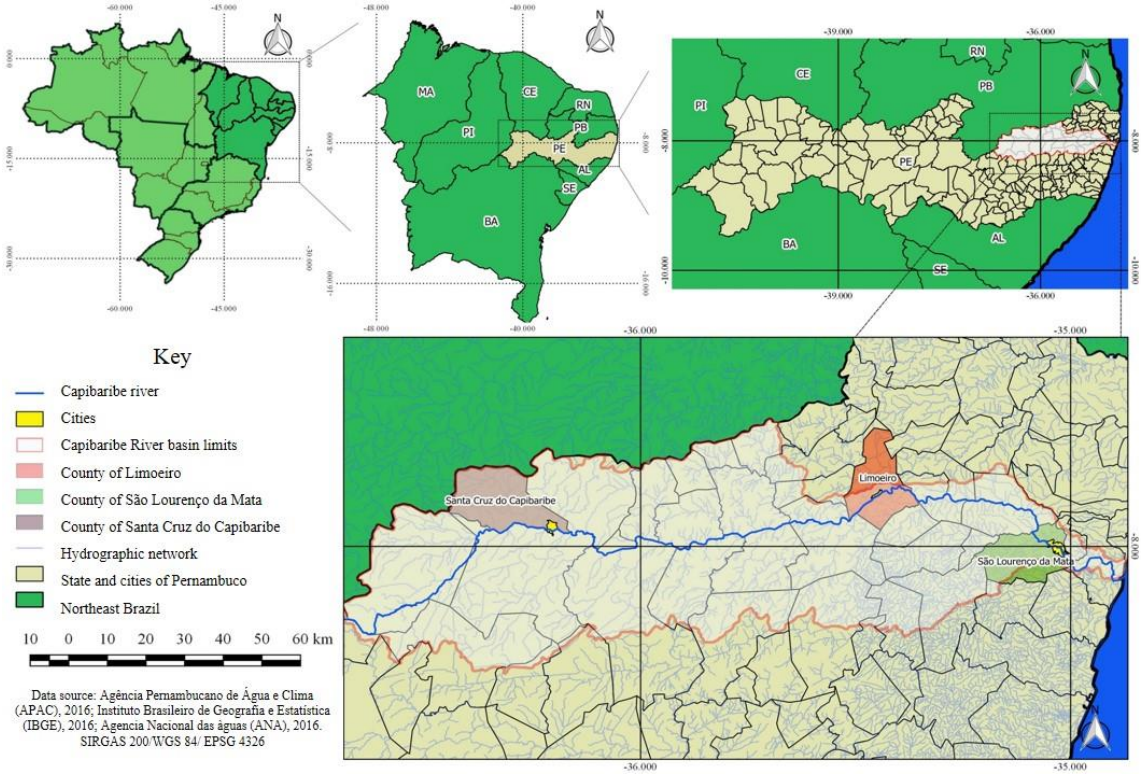
In that sense, based on Tricart (1977, 1992), Ab'Saber (1994, 1969), Sotchava (1978), Ross (1995), Bertrand (1968), it was also inferred that each subregion of a hydrographic basin, composed by different climatic and geomorphic subsystems, shows a combination of different interdependence between natural and social arrangements that are reflected in the organization of space (SANTOS, 2006; 2012).

This study considered the Capibaribe River hydrographic basin (Figure 1), which is entirely located in the state of Pernambuco, in its Northeastern portion, linking the semiarid to the coastal forest zone. It covers an area of 7.454, 88km², corresponding to 7.58% of the territory of the

state of Pernambuco, with an average annual discharge of 20,05m³/s (SRHE/PE, 2010). It is located between 07º 41' 20" and 08º 19' 30" South and 34º 51' 00" and 36º 41' 58" WGr. In the north, it is limited by the Goiana and Paraíba Rivers; by the Ipojuca River in the south, in the east by the Atlantic Ocean and the Ipojuca River is its limits in the west (APAC, 2012).

From its source, located in Poção and in Jataúba, to its mouth in the Atlantic Ocean, the Capibaribe River bathes 42 cities, 15 of which are entirely located within its basin and 27 hold their main administrative office. The interaction of the basin with different climatic zones confirms the complexity of nature in the drained area. The diverse forms of human occupation established in the area make this geographic stratum even more complex.

Figure 1. Cities of Santa Cruz do Capibaribe, Limoeiro and São Lourenço da Mata – State of Pernambuco and their location in the Capibaribe hydrographic basin.



Source: Prepared by the authors, 2016.

These areas can currently be characterized by extreme artificialization, both in rural areas, where primary sector activities predominate and in urban spots, where the industry, services, commerce and a large population are concentrated. Urban spots, with different population and sizes, are partially located alongside the course of the main river and in its basin drainage area. This distribution generally occurs from the west to east of the basin, where the Capibaribe River flows into the Atlantic Ocean.

Seven cities are located in the course of the main river, from the source to the mouth of the river, in the following order: Santa Cruz do Capibaribe, Toritama, Salgadinho, Limoeiro, Paudalho, São Lourenço da Mata and Recife (SRHE/PE, 2010). Other smaller urban spots, such as urban districts, villas and urban extensions beyond urban perimeter join these cities.

This study considered the city of Santa Cruz do Capibaribe and the district of São Domingo (the upper Capibaribe), the city of Limoeiro (the middle Capibaribe) and the city of São Lourenço da Mata, including the urban extensions outside the urban boundaries (the lower Capibaribe). These three cities and the relevant urban extensions are spots of human occupation along the Capibaribe river margins and are found in different municipal territories, partially or entirely located in the hydrographic basin of the Capibaribe River (ARAGÃO; GOMES 2017).

The cities of Santa Cruz do Capibaribe and São Lourenço da Mata are almost entirely located (99,74% and 79,55%, respectively) within the Capibaribe basin. Limoeiro, in turn, has its center-south part bathed by the Capibaribe and its effluents, which is equivalent to 51,42% (SRHE/PE, 2010). All three cities investigated are located on the margin of the main river.

According to Instituto Brasileiro de Geografia e Estatística (IBGE, 2016), in Santa Cruz do Capibaribe the population corresponds to 99.232

inhabitants, 97,73% of which is urban. In Limoeiro, there were 56.536, 80% of which is urban. Finally, São Lourenço da Mata had 110.264 inhabitants, mostly urban (94,05%).) Arguably, all these cities reflect the problems and needs faced by their populations, such as in all urban agglomerations of the basin, whether in infrastructure or in socioeconomic perspectives (ARAGÃO; GOMES, 2016).

The following were used as methodological instruments: a) revision of the literature on vulnerability, margins of rivers, rivers, creation of urban space and Society-Nature relation; b) gathering of secondary information from public agencies and from field observations; c) cartographic construction, analysis of satellite images (obtained from Google Earth); and d) production of iconography and analytical charts.

Vulnerabilities in urban spots along the margins of the Capibaribe River

For the United Nations (PNUD, 2014), the concept of vulnerability is related to the susceptibility of something not desirable to happen, such as hurricanes, earthquakes, floods, economic crises bringing mass unemployment, sanitary crisis, civil conflicts, a severe epidemic, among others.

According to PNUD (2014), vulnerability is directly related to the socioeconomic reality of the population, being more visible in impoverished, communities. The vulnerability may be extreme at certain times, considering the population, political and environmental conditions. Despite the United Nations interventions, the debate on this matter is still embryonic and abounding with technocratic concepts, as pointed out by Hewitt (1983) and Aledo and Sulaiman (2014).

The discussions about vulnerability arise from the empirical and theoretical insufficiency of technocratic conceptions about natural disasters, which neglected the matter of vulnerability to understand environmental risks and their social factors. For this line of thought, natural disasters are

not directly related to social matters and are explained by extreme physical factors, being an object for management alternatives by means of using technologies (QUARANTELLI, 1998).

Based on Aledo and Sulaiman (2014), the proposed understanding of vulnerability considers disasters as socioenvironmental phenomena (society and nature combined). Therefore, it is also composed of socio-historical factors. Furthermore, the effects are spread unevenly, according to socioeconomic aspects of the population in time and in space (ARAGÃO, 2017).

The sequencing of each historical moment bears a spatial element explicitly expressed in political actions, in the form of social organization in the territory and in the economic activities that shape each place (ARAGÃO, 2017). Accordingly, one believes in a perspective of vulnerability adapted to society and to its cultural, political and economic formation (WISNER et al., 2004).

In this study, the physical delimitation of river margins should not be seen as absolute. While understood as a portion of the "space", it is not only an area measured in square meters but rather an environment appropriated in the dynamics of spatial reproduction. Such perception allows understanding how socioenvironmental vulnerabilities arise from the society-nature relation and how it is entangled in the daily fabric of social space. This reality is more dramatic in unprivileged socioeconomic contexts, mainly in environments of considerable socioenvironmental vulnerability, such as river margins. Thus, by observing reports from multiple sources, the scenario depicted is that of despair, loss and damage caused by the periodical floods of the Capibaribe River, which are amplified in the form of inundations.

In the meantime, in the 19th and 20th centuries in Pernambuco, catastrophic floods were registered, including the Capibaribe river floods in 1842,1854, 1869, 1897, 1924, 1965, 1966, 1970 and in 1975, according to the

Secretaria de Recursos Hídricos e Energéticos de Pernambuco (2010). The debates carried out by Superintendency for the Development of the Northeast (SUDENE) date back to the mid-20th century, in which technicians and scholars pointed out the need to build dams, a structural measure aiming at controlling river inundations of cities (ARAGÃO, 2017).

Despite the State efforts to build flood containment infrastructure, since 1975, flooding associated to periods of water shortage and water pollution, have been verified in the cities investigated due to the persistent and inadequate constructions on the margins of the Capibaribe River (ARAGÃO and GOMES, 2016), especially by communities of high vulnerability (Figure 2).

Figure 2. Location, relation to the Capibaribe River margins, of inadequate residential occupation in the municipalities of *Santa Cruz do Capibaribe* (a), *Limoeiro* (b and c) and São Lourenço da Mata (d).

Photos: Aragão, 2011 (c) and 2015 (a - b - d).

Although able to contain the massive amount of water during periods of heavy rainfalls with infrastructure work, especially dams, the State has failed to impose limits on the occupation of Capibaribe margins. The real estate sector dynamics coupled with the increasing demands for housing in the cities have pushed formal and informal processes of occupation of the margins of the Capibaribe River. The result of such pressure is the gradual narrowing of the riverbed due to the extraction of riparian forest and the loss of depth and width, intensifying inundations even after the construction of upstream dams.

With catastrophic results similar to the great flooding of the second half of the 20th Century, the current level of pollution of the Capibaribe waters escalates losses with public health, especially of more vulnerable social groups, during inundations and in the constants crisis of urban supply. With that, the scenario is aggravated and losses intensified as the river flows through each urban spot.

The handling of these issues in Pernambuco and in Brazil is still inefficient because of gaps in the legislation regarding the creation of urban areas, environmental protection and social justice. However, there have been advances in the legal sphere (SRHE/PE, 2010) with the creation of legal instruments such as the State of Pernambuco Water Resources Plan, created in 1988, Water Resources Master Plan for the Capibaribe River Hydrographic Basin, in 2001, the Water Resources National Plan, of 2006, and the Capibaribe River Hydrographic Basin Environmental Plan, in 2010. Contrary to these advances, we still have to deal with the insufficiency of statistical data regarding the socioenvironmental reality in each city, as shown in the chart below (Chart1).

Chart1. Aspects of city management and missing and existing instruments

Municipality	***Sta. Cruz do Capibaribe***		***Limoeiro***		***São Lourenço da Mata***	
Instruments	Missing	Existing	Missing	Existing	Missing	Existing
City Master Plan		X		X		X
Organic Law		X		X		X
Municipal Environmental Council		X	X		X	
Municipal Environmental License	X		X		X	
COBH Member		X		X		X
Environmental Services Budget – Federal Gov.		X	X			X
Contingency Plan		X	X			X
Urban Policy Council	X		X		X	
Social Relevance Specific Law	X		X			X (2006*)
Environmental Protection Zone Law	X		X			X (2006*)
Neighborhood Impact and Preemption Law	X			X (2007*)	X	
Land Use and Occupation Act	X			X (1984*)		X (2006*)
Municipal Fund for the Environment	X		X		X	
Relation with State and Federal Agencies.		X	X			X

*Year of creation.
Source: Prepared by the author based on data from MUNIC/IBGE (2012), 2016.

The chart above lists instruments whose gaps may negatively impact the management of river margins because these spaces are effectively incorporated into the economic, political and socioenvironmental dynamics of the cities. The expansion of technical systems that foster the forms of land occupation and use is not concerned with the environmental characteristics of the river margins. This creates, to low-income groups occupying these areas, a vulnerability situation that reflects the contradictions and inequalities of access to basic urban structures.

The expansion of technical systems takes place in a systematic, solidary and contradictory manner (Santos, 2006), meeting, from an economic perspective, the functionalities and needs required by each region, municipality, city and /or strategic industry in each historical time. An

illustrative example is the increasing number of applications for electric energy and water supply services, either for domestic and industrial purposes.

In 1985, the number of electric energy consumers in the municipalities located in the investigated urban spots was 25.940. In 2015, this number was higher than 100.000, an increase of almost 300% (CELPE, 2016). Between 1984 and 2015, it was verified a similar increase in the number of applications and of economies served by the water supply network. The number jumps from 26.300 water supply points in 1984 to 55.247 in 2015, a growth of more than 100% (COMPESA, 2009).

The common historical trait in the production of urban spaces in each chosen urban spot dates back to the integration of these cities through the network of the federal roads BR101, BR232, BR104 and the state roads PE 090 and PE050. This system played an important role in allowing the expansion of services rendered in each municipality, a fact that has intensified the occupation process in these cities in the last 50 years (VILAÇA, 1973; MORA; SARABIA, 2009).

A reflex of this integration, pointed out by Aragão (2017), is the increase in the fleet of vehicles, especially trucks and buses operating between the municipalities in the region, revealing their economic-productive functionality. Between 1999 and 2015, truck and bus fleets increased more than 100% and 50%, respectively Departamento Estadual de Trânsito de Pernambuco (2015) (State Department of Transit) in Santa Cruz do Capibaribe, Limoeiro and São Lourenço da Mata. This increase confirms a decisive process of circulation of goods and workers. In the three municipalities, in1999, there were 833 trucks and 431 buses. In 2015, these numbers were 1995 trucks and 609 buses.

The recent expansion of banking services, serving an increasing number of industries, commerce, services and people in the municipalities, especially in their urban centers, indicates the orientation of technical

systems to meet the economic dynamics and the intense financialization of activities. Between 2010 and 2014, the total number of banks in the three cities increased from 13 to 17 (BANCO CENTRAL DO BRASIL, 2014).

This increase is related to the expansion of traditionally urban activities, such as the manufacturing industry, which experienced an increase from 507 units in 1998 to 1430 in 2014; the civil construction industry, which jumped from 49 units in 1998 to 148 in 2014; the commerce, which expanded units from 1462 in 1998 to 3318 in 2014; and the service industry that escalated from 510 units in 1998 to 1438 in 2014. These changes were observed in the cities of Santa Cruz do Capibaribe, Limoeiro and São Lourenço da Mata all together (MINISTÉRIO DO TRABALHO E EMPREGO, 2016).

The expansion of these systems illustrates the general growth of urban spots, mainly of the cities being investigated and their connection with the economic dynamics being consolidated in an urban network structured by the State. Inside each city, there is an intense real state dynamic that has no limits in occupying the margins of the Capibaribe River.

In the study, we did not identify any specific action regulating the occupation of the Capibaribe River margins, not to mention specific concerns with the areas of greater social vulnerability, which evidences the absence of actions targeting plans for the occupation and use of land as well as the preservation of these areas (ARAGÃO; GOMES, 2017).

This situation led to the continuous and unregulated occupation of the Capibaribe River margins. As a result, increasing negative impacts on the river and risks threatening more vulnerable social groups are observed (Chart2).

Chart2. Land use on the margins of the Capibaribe River in Santa Cruz do Capibaribe, Limoeiro and São Lourenço urban spots and current associated impacts.

Municipalities		**Santa Cruz do Capibaribe**		**Limoeiro**		**São Lourenço da Mata**	
Land use	**Impacts**						
Residential	Removal of Vegetation Cover	**X**	X	**X**	X	**X**	X
	Soil Sealing		X		X		X
	Disposal of domestic sewage to river		X		X		X
	Improper disposal of solid waste		X		X		X
Industry	Removal of Vegetation Cover	**X**	X	**X**	X	**X**	X
	Soil sealing		X		X		X
	Disposal of industrial sewage to river		X		X		X
Formal Commerce	Removal of Vegetation Cover	**X**	X	**X**	X	**X**	X
	Soil sealing		X		X		X
	Disposal of sewage		X		X		X
	Production of Solid waste for diffuse drainage		X		X		X
Informal Commerce	Removal of Vegetation Cover	**X**		**X**		**X**	
	Soil sealing		X		X		X
	Production of Solid waste for diffuse drainage		X		X		X
Services (education, health, insurance offices, workshops, accounting, etc.)	Removal of Vegetation Cover	**X**	X	**X**	X	**X**	X
	Soil sealing		X		X		X
	Disposal of sewage		X		X		X
	Production of Solid waste for diffuse drainage		X		X		X
Leisure and sports	Removal of Vegetation Cover			**X**	X	**X**	X
	Soil sealing				X		X
	Disposal of sewage				X		X
Cattle farming	Removal of Vegetation Cover	**X**	X	**X**	X		
	Exposure of soil to accelerated erosion		X		X		
Extractivism	Removal of Vegetation Cover	**X**	X				
	Exposure of soil to accelerated erosion		X				
	Pollution of river and underground waters		X				
Agriculture	Removal of Vegetation Cover	**X**	X	**X**	X	**X**	X
	Exposure of soil to accelerated erosion		X		X		X
	Disposal of sewage		X		X		X

Source: Prepared by author, 2016.

In the 80's, a major economic transition started in Santa Cruz do Capibaribe owing to "the expansion of the urban activity of clothing industry in the city [...] occurred as a result of the need to generate employment and

income for the population after the fall of the cotton cropping in the region" (MORA; SARABIA; XAVIER, 2006, p. 7).

The disorderly occupation of the Capibaribe River and of its margins promoted the growth of the São Domingos village, which, despite belonging to the municipality of Brejo da Madre de Deus, grew allied to the dynamics of the textile production in Santa Cruz do Capibaribe. When viewed from the top, the boundaries between one city and the other are blurred. However, crossing the bridge over the Capibaribe River, from one side to the other, one is actually going from one municipality to the other; from a city to a district.

The accelerated growth boosted by the capital of the textile industry, consorted with the State, provider of operational structures, shape the occupation of the margins of the Capibaribe, with the production of plots of land being occupied by residences, shoe stores, churches, small grocery stores and other small undertakings, in which the working class is settled.

The absence of sanitary structure and the disposal of waste into the River and on its margins guarantee an aspect of abandonment, which reflects not only the State precarious assistance, but also the lack of prioritization of environmental preservation and of the social groups residing in the area, not to mention the companies that have promoted the economic development in the region.

This picture is aggravated by the climatic conditions in the region. Located in the semiarid, the city of Santa Cruz do Capibaribe and the district of São Domingos, endure a shortage of water supply and frequent inundation. Also, the possibility of extracting water from the dry river bed is, in many parts, not possible due to the substantial contamination of the Capibaribe River.

The global neo-liberal economy, guided by the spatial selectivity of companies and mediated by the State, grants significant commercial undertakings, in addition to tax incentives, the capacity to induce labor, as

well as financial resources, transportation, communication and supply infrastructure, organized in different sizes networks, but visibly temporary.

This process has capillarity in Brazil, but it outstands only in some centers, promoting fast employment saturation and, as a consequence, an increase in the informal sector and in the real estate market, due to the escalation of demographic flow into these urban centers. The city of Limoeiro has been a good example of this process since 1970 (VILAÇA, 1973).

As a result the lack of land in the center of the city and of the inefficient urban structure connecting distant land from and to the commercial center of Limoeiro, the construction of small allotments on the margins of the Capibaribe River has been observed, not to mention other interventions, such as landfilling tributary rivers, improper disposal of litter, of *in natura* domestic and urban sewage to the river, among other.

At the same time, the problems of vulnerability in the city of Limoeiro are not addressed. A fact that reinforces the possibility of risks whenever new flooding strikes, causing amplified inundation, as observed in 2011, when the Capibaribe River waters stroke communities such as Barriguda, located on the left margin of the Capibaribe.

In the lower Capibaribe, agglutinating the largest population among the three investigated cities, the urban spot of São Lourenço da Mata has gradually become a commuter town. It guarantees Recife, the state capital, labo and new areas of economic dynamism located in the north and south coast of Pernambuco (ARAGÃO; GOMES, 2016).The cities of Goiana (a pharmaceutical, automotive and glass pole) and Ipojuca (Suape industry harbor) are the most evident examples.

The (re)production of this urban space is integrated into the repercussions of technical systems, which are concentrated in the capital city or in areas previously defined by the capital. The increasing offer of

labor in Recife Metropolitan Area and the evident socioenvironmental impacts registered in the Capibaribe River landscape compose this process.

Within this framework, São Lourenço da Mata Organic Law, like many others, is based on the Brazilian Constitution to rule in its Section XI, Article 102-B that "the right to an ecologically balanced environment, a common use property of the people is essential to a healthy standard of living, the Municipality and the community is responsible for its defense and preservation for current and future generations" (PREFEITURA MUNICIPAL DE SÃO LOURENÇO DA MATA, 2008).

Although the Federative Constitution of Brazil guarantees environmental rights, it is outstandingly evident that public authorities (not only in São Lourenço da Mata) have failed in finding the means to guarantee these rights to Brazilian citizens in the interest of the precepts to integrate the movement of modernization of the productive structures, considered a priority by the capital and by the State itself.

Encouraged by the economic forces, the occupation of the Capibaribe river margins have been occurring intensively in the last five decades, without concerns of the State regarding damages caused to the cities, even when faced with the increasing number of state and federal environmental laws and, in a less systematically manner, at the city level.

In all the examined realities, risks, such as floods in densely occupied areas, contaminated water diseases, proliferation of vectors, devaluation of river margins land, socioeconomic losses to formal and informal activities, collapse of buildings, shortage of supply associated to flooding of densely populated areas, deterioration of the cultural material heritage (historical buildings), reduction of riparian forest and loss of biodiversity, are common

Yet, the peculiar sub-regional organization between natural, environmental and social factors requires revising policies and instruments of urban and environmental management as well as of existing water resources in each municipality, considering the peculiarities of each local

reality, as supposed by Aragão and Gomes (2016; 2017) and Aragão (2017). These authors' analysis of the urban spots centralized by the municipalities of Santa Cruz do Capibaribe, Limoeiro and São Lourenço da Mata allowed the identification of three groups of socioenvironmental vulnerability factors, namely: social, natural and environmental (Chart 3).

Chart3. Factors and socioenvironmental vulnerability levels in urban river margins

Factors	Factors endangerment levels in urban rivers margins	Socioenvironmental vulnerability
A. SOCIAL	3. Low income socioeconomic structure, precarious basic sanitary conditions and absence or low power of community representation;	**9 HIGH** A.3; B3; C3
	2. Low and average income socioeconomic structure, precarious basic sanitary conditions and absence or low power of community representation;	**8 HIGH** "X".3; "Y". 3; "Z".2
	1. Upper and medium income socioeconomic structure and absence or low power of community representation.	**7 HIGH** "X".3; "Y".2; "Z".2
B. NATURAL	3. Area of water shortfall, subject to intense rains and floods with inundation of urban area;	**6 MEDIUM** "X".3; "Y".2; "Z".1
	2. Area free of water shortfall, subject to intense rains and floods with inundation of urban area;	**5 MEDIUM** "X".3; "Y".1; "Z".1
	1. Area free of water shortfall and temporarily free of flood and inundation.	**4 MEDIUM** A.2; B.2; C.2
C. ENVIRONMENTAL	3. Population residing or working in areas of hydro-morphological instability, subject to disappropriation, landslide, structural damage and diseases due to contact with contaminated water and/or vectors;	**3 LOW** "X".2; "Y".2; "Z".1
	2. Population residing or working in areas of hydro-morphological instability, subject to structural damage and to diseases due to contact with contaminated water and/or vectors;	**2 LOW** "X".2; "Y".1; "Z".1
	1. Population residing or working in areas of hydro-morphological instability, subject to diseases due to contact with contaminated water and/or vectors.	**1 LOW** A.1; B.1;C.1

Source: Prepared by author, 2015.

Considering how vulnerability manifests itself in the different contexts of each city, on the margins of the Capibaribe River, the group of factors mentioned is carefully considered to propose a schematic organization of statistical data that can characterize socioenvironmental vulnerability factors in the municipalities along the margins of the Capibaribe River. The combination of each factor variables generates different levels of vulnerability. In that sense, each local reality must be

seen as specific, differently from what has been proposed by government programs and projects (ARAGÃO, 2017).

Chart 3 above presents a proposal for actions to mitigate vulnerabilities in urban areas (ARAGÃO, 2017). Although it does not include numerical indicators, the chart points out social, natural and environmental factors, contrary to mechanisms of hermetic analysis, based on previously established statistical parameters that are applicable to any reality.

The "socioenvironmental vulnerability" column indicates possible combinations between Social (A), Natural (B) and Environmental (C) factors. Each fact shows three levels of implication: level "1" (less susceptible) to level "3" (more susceptible). Thus, the level of socioenvironmental vulnerability of an area will be extreme if level 3 is identified in all factors A3, B3 and C3). If all factors show level 2 (A2, B2 and C2), there will be a medium level of vulnerability. Factors characterized as level of susceptibility 1 (A1, B1 and C1) show a low level of vulnerability.

In short, the socioenvironmental vulnerability of an area is the result of a combination of the implication levels identified in each factor. The variations in the extreme, medium and low levels of vulnerability are represented in the chart by the letters "X", "Y" and "Z". They indicate the possibility of intermediate situations, when one or two of the three factors show level 2, for example. These cases are highlighted by underlining them ("X".3, "Y".2, "Z".2).

In this proposal, the socioenvironmental vulnerability is considered high when a certain area, sector or territorial portion of the city shows at least one of the factors (A, B or C) at level 3 and the other factors at level 2. The medium socioenvironmental vulnerability will be observed when all factors are at level 2 or are combinations of a factor at level 3 and the others at level 2 and 1 or at levels 1 and 1. As for low vulnerability, all factors show

a level 1 or a level 2 combined with two factors at level 2 and 1 or 1 and 1 (blue color in the chart).

The proposals that indicate a single analysis pattern do not consider the variables that might arise from place to place, becoming rigid possibilities of prevention, diagnose and/or planning. Considering the lack of statistical data on the local socioenvironmental realities and the importance of indicators, the proposal in the chart above shows a possible path regarding the level of endangerment of river margins.

Fixing the socioenvironmental limits of vulnerability in urban spots along the same river requires integrated planning, aiming at improving the living standards of the population in situations of vulnerability. In that sense, careful examination of the numbers composing the levels of endangerment of each factor must be carried out within the inter-municipal management of the river and of its margins.

For that reason, the planning, occupation and use of river margins must take into account the peculiarities of each urban spot, especially the interactions arising from the upstream/downstream occupation in each city. In each investigated city, it was possible to identify high vulnerability occupations, namely the Compesa occupation in Santa Cruz do Capibaribe, the occupation on Rua da Barriguda in Limoeiro, and stretches of Nova Tiúma, in São Lourenço da Mata (Figure 4).

The challenges imposed by the management of river margins in urban spots and the mitigation of vulnerabilities in these areas are not settled with the creation and/or maintenance of infrastructure work. However, considering initiatives in countries such as the United States, Canada, (GORSKI, 2010), Germany (CUNHA, 2009) and even in Brazil, the theme of river parks is suggested as a line of study and alternative to continue the reflections and questionings raised in this work.

Figure 4. Location of high vulnerability areas on the margins of the Capibaribe River in the cities investigated.

Factors	Factors endangerment levels in urban rivers margins	Socioenvironmental vulnerability
A. Sociais	3. Low income socioeconomic structure, precarious basic sanitary conditions and absence or low power of community representation;	A3
B. Naturais	3. Area WITH (or WITHOUT) water shortfall, subject to intense rains and flood with inundation of urban area;	B3 / B2
C. Environmental	3. Population residing or working in areas of hydro-morphological instability, subject to disappropriation, landslide, structural damage and diseases due to contact with contaminated water and/or vectors;	C3

Santa Cruz do Capibaribe – Compesa Occupation (A3/B3/C3)

Limoeiro – Barriguda Street (A3/B2/C3)

São Lourenço da Mata – Stretch of Nova Tiúma neighborhood (A3/B2/C3)

Source: Google Earth – adapted, 2016.

The outcomes of this experience points to the reversibility of environmental problems (such as river pollution and high vulnerability), to the recovery of the aesthetic beauty of the river margins environment as well as to valuing neighboring areas. Also, it includes the relations with tourism as well as the use of river courses and their margins when the creation of parks is associated with investments in basic sanitation, in housing and in the environment, among others.

Applying this type of intervention requires a previous diagnose of the urban space to be impacted by the construction of the park. It also calls for identifying the different types of land occupation and use; the conflicts associated with irregular occupation, land tenure and infrastructure in

addition to existing environmental problems. Denying these conditions promotes the shattering of proposals or the aggravation of conflicts because the actions in this hypothesis would be measures alien to and disconnected from existing conflicts.

In countries like Brazil, with historical formation marked by wealth accumulation processes (especially by using the land), the time required for discussions and actions to solve conflicts tends to be procrastinatory, although this does not serve as denial, given the undisputable need to improve life and to mitigate vulnerabilities in Brazilian cities river margins.

Final remarks

In the local and regional economic dynamism, urban spots relation with the margins of the Capibaribe has revealed a paradoxical scenario, given the environmental degradation and vulnerability of low income population settled on the margins of the river. Therefore, the accumulation of environmental damages, imposed by local and extra-local factors in accordance with each urban texture, is witnessed along the margins of the river.

In the analyzed urban spots, the margins of the river bear marks of diverse urban and rural forms. Jointly with the remains of vegetal cover, it was possible to see the complexity and diversity of the universal relations between society and nature, developed throughout history.

In fact, these areas have been created according to the spatial-commodity logics, in which the degradation of river waters and the risks of scarcity and flooding are combined with the shortage of space and (re)production of areas constricted between the river margins and the dynamic center of the local economy.

The guidelines for the preservation of natural resources and for

socioeconomic development, controlled at higher management spheres, have not been efficient in addressing occupation, uses and socioenvironmental vulnerability problems of the low income populations settled on river margins. In order to mitigate these problems, actions must be taken to consider the local nature diversity on the margins of the river, the social dilemmas of land occupation and use. These must be implemented by revising existing policies and the role of the State in the integrated management of rivers margins in urban spots.

As a result, the first hypothesis was revised to include the understanding that, in addition to the difficulties of effective intervention by the State, social agents' diverse intentions express a multitude of interests and of forms of urban land occupation and use. This also results in the procrastination of environmental preservation and social justice precepts. This has impacted the reproducibility of socioenvironmental vulnerability conditions, mainly in the lower income groups operating on the margins of the Capibaribe River.

This scenario often implies a process of environmental degradation and of social-spatial segregation of the unprivileged population in the cities, expressing, at all levels, the disarticulation of the public administration of rivers and their margins. Over time, this process contributes to the disorderly growth of cities that, without proper attention to the process of occupation and use of land, fosters the dynamics of degradation of river margins, spaces currently used at the mercy of their weaknesses and potentials.

Furthermore, any change in the natural systems of river margins or in the communities living in these environments will unfailingly impact the logical reorganization of space constitutive elements. This fact triggers the reconfiguration of the exchanges of matter and energy in the systems, whether they are natural or social.

Given the mitigation of the existing socioenvironmental vulnerability on the margins of the Capibaribe River, based on the proposed social, natural and environmental factors and on the relevant role public agents play in this process, it is necessary to advance towards developing vulnerability indicators, establishing quantitative parameters. Indeed, something not explored in this study, but very much encouraged.

Finally, it is important to call attention to the possibility of reflecting on other complex realities in Latin America, given the fact that the factors identified in this study are not restricted to the cases analyzed. Similar scenarios, especially in Brazil, abound without an equivalent study, which could corroborate, revise or deny the findings, since they are an inconclusive and necessary theme.

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References

AB'SABER, A. N. Bases conceptuais e papel do conhecimento na previsão de impactos. In: MULLER-PLANTENBERG, C.; AB'SABER, A. N. (Orgs.). **Previsão de Impactos**: o estudo de impacto ambiental no leste, oeste e sul. São Paulo: Edusp, 1994. p. 27 – 49.

_____. Um conceito de Geomorfologia a Serviço das Pesquisas Sobre o Quaternário. **Geomorfologia**. GEOG/USP. São Paulo, n. 18, p. 1 – 23, 1969.

ALEDO, A.; SULAIMAN, S. La incuestionabilidad Del riesgo. **Ambiente & Sociedade**. São Paulo v. 17, n. 4, p. 9-16, out.-dez., 2014. https://doi.org/10.1590/1809-4422ASOCEx01V1742014

APAC – Agência Pernambucana de Águas e Climas. **Bacias hidrográficas**: rio Capibaribe. Disponível em: <http:/z/www.apac.pe.gov.br/pagina.php?page_id=5&subpage_id=14>. Acesso em: 12 de maio de 2012.

ARAGÃO, J. P. G. de V.; GOMES, E. T. A. Margens do rio Capibaribe na (re)produção do urbano em cidades pequenas: vulnerabilidades e formas de ocupação e uso. In: ENCONTRO NACIONAL DE GEÓGRAFOS. 2016. São Luís. **Anais**[...]**.** São Luís: UFMA, 2016. p. 1 – 12.

_____**.** Paradoxos do uso dos solos nas margens do rio Capibaribe: vulnerabilidades socioambientais em áreas urbanas. **Revista Brasileira de Agrotecnologia**. v. 7, n. 3, p. 148 – 166, 2017**.**

ARAGÃO, J. P. G. de V. **Uso e ocupação das margens do rio Capibaribe**: vulnerabilidades socioambientais m áreas urbanas. 2017. 294 f. Tese (Doutorado em Desenvolvimento e Meio Ambiente) - Recife: Universidade Federal de Pernambuco, 2017.

BANCO CENTRAL DO BRASIL. **Número de agências bancárias entre 2010 e 2014**. Available in: <http://www.bde.pe.gov.br/estruturacaogeral/conteudo_site2.aspx>. Access in**:** January 15, 2016.

BERTRAND, G. Paysage ET Geographie Phisique Globale: equisse méthodologique. **Rev. Géogr. Des Pyrenées ET Du Sud-ouest** (Toulouse), v.39, n.3, p. 249-272, 1968. https://doi.org/10.3406/rgpso.1968.4553

BRASIL. Ministério das Cidades / Instituto de Pesquisas Tecnológicas. **Mapeamento de riscos em encostas e margens de rios**. Brasília: Instituto de Pesquisas Tecnológicas – IPT, 2007.

_____. **Lei Nº 12.651, de 25 de maio de 2012**. Dispõe sobre a proteção da vegetação nativa; altera as Leis nº 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis nº 4.771, de 15 de setembro de 1965, e 7.754, de 14 de abril de 1989, e a Medida Provisória nº 2.166-67, de 24 de agosto de 2001; e dá outras providências. Available in: <http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm>. Access in: March 12, 2016.

CELPE – Companhia Energética de Pernambuco. **Consumo e consumidores de energia elétrica entre 1985 e 2015**. Disponível em: <http://www.bde.pe.gov.br/estruturacaogeral/conteudo_site2.aspx>. Acesso em: 15 de janeiro de 2016.

COMPESA – Companhia Pernambucana de Saneamento. **Bacia Hidrográfica do rio Capibaribe.** Recife: Monitoramento dos reservatórios, 2009.

CUNHA, S. B. Canais fluviais e a questão ambiental. In: CUNHA, Sandra Baptista; GUERRA A. J. T. **A questão ambiental**: diferentes abordagens. Rio de Janeiro: Bertrand Brasil, 2009. p. 219 – 237.

DETRAN – Departamento Estadual de Trânsito de Pernambuco. **Frota de veículos, por tipo**. Disponível em: <http://www.bde.pe.gov.br/estruturacaogeral/conteudo_site2.aspx>. Acesso em: 15 de janeiro de 2016.

GORSKI, M. C. B. **Rios e cidades**: ruptura e reconciliação. São Paulo: Edidota Senac São Paulo, 2010.

GUERRA, A. T.; GUERRA, A. J. T. **Novo Dicionário Geológico Geomorfológico**. Rio de Janeiro: Bertrand Brasil, 2006.

HEWITT, K. **The Idea of calamity in a technocratic age**. Boston: Allen and unwin, 1983.

IBGE – Instituto Brasileiro de Geografia e Estatística. **Sinopse dos censos demográficos 2000 e 2010**: domicílios particulares ocupados, localizados por área. Disponível em: <http://www.bde.pe.gov.br/estruturacaogeral/conteudo_site2.aspx>. Acesso em: 15 de janeiro de 2016.

_____. **Pesquisa de Informações Básicas Municipais**. Available in: <http://www.ibge.gov.br/home/estatistica/economia/perfilmunic/>. Access in: April 12, 2015.

MENDONÇA, F. de A. Riscos, vulnerabilidade e abordagem socioambiental urbana: uma reflexão a partir da RMC e de Curitiba. **Revista Desenvolvimento e Meio Ambiente**. Editora UFPR. n. 10, p. 139-148, jul./dez., 2004. https://doi.org/10.5380/dma.v10i0.3102

MINISTÉRIO DO TRABALHO E EMPREGO. **Estabelecimentos por setor de atividades entre 1998 e 2015**. Available in: <http://www.bde.pe.gov.br/estruturacaogeral/conteudo_site2.aspx>. Access in: January 15, 2016.

MONTEIRO, C. A. de F. **Geossistemas a história de uma procura**. São Paulo: Contexto, 2001.
MORA, L. D. L.; XAVIER, M. G. P.; SARABIA, M. L. A cidade de Santa Cruz do Capibaribe e seu dinâmico desenvolvimento local: em foco as mudanças. In: 5ÈME COLLOQUE DE l'IFBAE**.** 2009. Grenoble**.** Anais[...].Grenoble: IFBAE. 2009. p. 1 – 17.
PORTO, M. F. de S.. **Uma Ecologia Política dos Riscos**: princípios para integramos o local e o global na promoção da saúde e da justiça ambiental. Rio de Janeiro: Fiocruz, 2007. https://doi.org/10.7476/9788575413777
POPPER, K. R. **A lógica da pesquisa científica.** São Paulo: Cultrix, 2013.
PREFEITURA MUNICIPAL DE SÃO LOURENÇO DA MATA. **Lei Orgânica Municipal**. São Lourenço da Mata: Sala da Seções, 2008.
PROGRAMA DAS NAÇÕES UNIDAS PARA O DESENVOLVIMENTO (PNUD). **Sostener El progresso humano**: reducir vulnerabilidades e construir resiliencia. Nova York: ONU/PNUD, 2014.
QUARANTELLI, E. L. **What is disaster?** London: Routledge, 1998.
ROSS, J. L. S. Análises e Sínteses na Abordagem Geográfica da Pesquisa para o Planejamento Ambiental. **Revista do Departamento de Geografia da USP**. São Paulo. n.9, p.65-75, 1995. https://doi.org/10.7154/RDG.1995.0009.0006
SANTOS, M. **Espaço e método.** São Paulo: Editora da Universidade de São Paulo, 2012.
_____. **A natureza do espaço**. Edusp: São Paulo, 2006.
SANTOS, J. de O. Relações entre fragilidade ambiental e vulnerabilidade social na susceptibilidade aos riscos. **Mercator**, Fortaleza, v. 14, n. 2, p. 75-90, mai./ago., 2015. https://doi.org/10.4215/RM2015.1402.0005
SRHE/PE – Secretaria de Recursos Hídricos e Energéticos do Estado de Pernambuco. **Plano Hidroambiental da Bacia Hidrográfica do Rio Capibaribe**. Recife: Governo do Estado de Pernambuco, 2010.
SOTCHAVA, V. B. Por uma teoria de classificação de geossistemas da vida terrestre. São Paulo**: IGEOG-USP**, 1978.
THOURET, J. Os riscos nos países em desenvolvimento. In: VEYRET, Yvette (Org.) **Os riscos**: o homem como agressor e vítima do meio ambiente. São Paulo: Contexto, 2007. p. 83 – 85.
TRICART, J. **Ecogeography and rural management**: a contribuiton to the international geosphere-biosphere Programme. Paris: Longmam Scientific & Technical, 1992.
_____. **Ecodinâmica**. Rio de Janeiro: IBGE, 1977.
VILAÇA, A. **À sombra de dois pinheiros**. Rio de Janeiro: Arquimedes, 1973.
WISNER, B; BLAIKIE, P.; CANNON, T. e DAVIS, I. **At risk**: natural hazards, people's vulnerability and disasters. London: Routledge, 2004.