




The urban hierarchy at the delta of the Amazon River and the importance of small cities

A hierarquia urbana no delta do Rio Amazonas e a importância das pequenas cidades

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Abstract

The main goal of this paper is to present an evaluation of the urban hierarchy of a sub-region of the Brazilian Amazon Region, the Delta of the Amazon River. We analyzed the Delta cities regarding their ability to provide access to basic services (infrastructure) and employment to their residents, or even the residents of adjacent towns. The results were produced using data from: census, the Annual List of Social Information (RAIS), the number of industrial establishments (Federation of Industries of the State of Pará - FIEPA), the year the cities were founded, distance from the cities to the state capitals, and the number of bank branches. A general index was created, and it allowed defining to what degree the cities were connected, and proposing an urban hierarchy at the Delta Region. Regardless of different historical processes, age, size and importance in the Regional Urban Network, the cities of the Delta can be compared in terms of infrastructure available to their population. At the same time, small cities are experiencing significant population growth, and expansion of urban areas without investment proportional to their needs.

Keywords: Urban hierarchy. Small cities. Urban growth. Delta, Amazon Region.

Resumo

O objetivo principal deste artigo é apresentar uma avaliação da hierarquia urbana de uma sub-região da Amazônia Brasileira, o Delta do rio Amazonas. A proposta é analisar as cidades do Delta que disponibilizam aos seus moradores, ou mesmo aos moradores de cidades adjacentes, acesso a serviços básicos (infraestrutura) e emprego. Os resultados foram produzidos utilizando: dados do censo, dados da Lista Anual de Informações Sociais (RAIS), número de estabelecimentos industriais (Federação das Indústrias do Estado do Pará - FIEPA), ano em que as cidades foram fundadas, distância das cidades para as capitais dos Estados e número de agências bancárias. Foi criado um índice geral que permitiu definir o grau de conexão entre as cidades e propor uma hierarquia urbana na região do Delta. Independentemente

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de diferentes processos históricos, idade, tamanho e importância na Rede Urbana Regional, as cidades do Delta podem ser comparadas em termos de infraestrutura disponível para sua população. Ao mesmo tempo, as cidades pequenas experimentam um crescimento significativo da população e uma expansão das áreas urbanas sem investimento proporcional às suas necessidades.

Palavras-chave: Hierarquia urbana. Cidades pequenas. Crescimento urbano. Delta, Região Amazônica.

Introduction

A city is an element inside the world system that stimulates development and technical improvement (Santos, 1997). Santos mentions that any city is alive and enforces its functional and symbolic values of commercial solidarity within several sectors (Santos, 1997). Some authors (Lefebvre, 1996; Harvey, 1973; Logan & Molotch, 1987; Brenner et al., 2012) discuss that cities are main founding points for the production, circulation, and consumption of provisions, and their sociospatial organization, governance systems, and forms of sociopolitical conflict have to be understood in relation to this role.

Cities are connected to each other, establishing a network of trades, jobs and commerce flows, and sometimes a network of solidarity to provide essential services, such as health and education, to people with limited access. Cities are interconnected in a very specific way, depending on local conditions of connections or, as Santos (1997) mentions, on the fixtures (or objects) present in the region in which they are located.

In the Brazilian Amazon Region, these connections show discrepancies regarding the fixtures available, producing different flows. Guedes et al. (2009) affirm that:

In the midst of this increasing urbanization, heterogeneity of urban spaces and the resulting complexity of networks, have led some authors to consider whether classical urban hierarchical models can explain the formation of the larger Amazonian urban system and contribute to understand the trajectories and consequences of regional urbanization (Guedes et al., 2009, p. 159).

Castro (2008) observes that the economic function of circulation, and the management of production from the city are key to understanding the formation of the urban network in the Amazon Region (Castro, 2008).

Becker (1990) reasons that there are five types of urbanization in the Amazon Region, which has resulted in producing different “Amazons” and an urban network. The first is termed spontaneous urbanization, as a result of state actions, and followed the economic frontier. The other is the urbanization caused by private colonization established by private companies, creating urban settlements that dominated the urban hierarchy. Rural urbanization is an additional category of urbanization defined by INCRA – the National Institute for Colonization and Agrarian Reform - based on rural settlements, and using rural workers, farmers, migrants and old inhabitants. Private Companies and Projects represented still another type of urbanization in the Amazon Region, that is, the Urbanization of Great Projects, which created company towns, structured by companies to support the process of occupation. The last category proposed by Becker (1990) is traditional urbanization, characterized by fragile economic dynamics, associated with the occupation of the Amazon Region in the distant past. The urbanization process of the Delta Region of the Amazon River was mainly conducted by economic processes of the past, and many of these cities are still characterized by a fragile economy that interferes with their establishment of a local urban network.

Flooded areas, such as the Delta, are lower and flat lands along a watercourse, intermittently flooded by river overflow. This area is one of the richest ecosystems of the Amazon Basin, considering its biological productivity, biodiversity and natural resources. More than 1.5 million local inhabitants, known as riverine (“ribeirinhos”), survive using forest and flood area resources. It also occupies more than 300,000 sq. kilometers throughout the Amazon-Solimões river channel and its main tributaries, equivalent to approximately 6% of the surface of the Brazilian Legal Amazon (Próvarzea, 2008).

According to the Brazilian Ministry of Environment (IBAMA, 2008), though the Amazonian *Várzea* has high productivity and natural resilience, the current developmental process is leading to its gradual degradation. The main reasons for this degradation include the deforestation process, rivers silting up, cattle contributing to water degradation, and the destruction of marginal lagoons by agricultural and urban expansion (Lima, 2005).

While other parts of the Brazilian Amazon have undergone significant environmental change during the past three decades, the Delta Region has seen relatively lower levels of environmental degradation. The region has experienced rapid urbanization and a growing economy based on forest products and agroforestry (Brondizio et al., 2013). Most urban areas in the region lack basic sanitation and other infrastructure, and public services, which, along with some of the highest poverty rates in Brazil, create vulnerable conditions for a significant segment of the population (Mansur et al., 2016). According to Brondizio et al. (2016, p. 605), “regional changes in infrastructure, urban growth and pollution, and growing demand for resources are putting pressures on local ecosystems and livelihoods.”

This is the oldest area in terms of the colonization process of the Amazon Region occupied during the sixteenth and seventeenth centuries. According to Brondizio et al. (2016), the Delta of the Amazon River includes fifty cities in two states: forty-one in the state of Pará and nine in the state of Amapá. An urban hierarchy was developed along the process of occupation of the Delta, with cities with over one million inhabitants leading the urban network. However, small cities with less than twenty thousand inhabitants are predominant in this area (68%), and many of them provide access to services and employment to local populations. This creates a very particular urban network.

Thus, this paper aims to present an evaluation of the urban hierarchy of this particular sub-region of the Brazilian Amazon Region, the Delta of the Amazon River. We also propose to analyze the characteristics of these cities regarding their residents, or even those of adjacent towns, access to basic services (infrastructure) and employment. We suggest a discussion of the urban hierarchy, with a very specific view of the Delta Region, complementing both classical (Browder & Godfrey, 1997; Corrêa, 1987; Machado, 1999; Sawyer, 1987) and recent academic discussion about the Amazon urban hierarchy (Castro, 2008; Guedes et al., 2009; Schor & Oliveira, 2014; Trindade, 2010).

The results presented in this paper were produced using data from: census (urban population, number of urban households, infrastructure available to urban households, commuting for employment and schooling); the Annual List of Social Information (RAIS); the number of industrial establishments (Federation of Industries of the State of Pará - FIEPA); the cities' year of foundation; distance from the cities to the state capital; and number of bank branches. These data were organized in a table, and the values were normalized using descriptive statistics. We created a general index that allowed defining the cities' degree of connection, and creating an urban hierarchy in the Delta Region.

Different approaches to the urban hierarchy of the Amazon Region

Different criteria have been used to define a city. Some countries use a quantitative approach, based on number of inhabitants, to establish the difference between city, village and community. The complexity of an urban space, considering social relations, commercial activities, and variety of services offered to citizens, makes it challenging to define.

The UNFPA (2007) considers urban settlements or localities as established by national statistical agencies. In this case, the United Nations Population Fund considers, in its statistics of the number of cities in the world, the classification of urban as defined by different countries, taking into account that cities provide a different way of life and usually a higher level of living than are found in rural areas (UN, 2001, p. 29).

The UNFPA has its own criteria to classify cities according to population size, considering the global scale of analysis used by this institution.

Clark (1998) affirms that an urban space can be considered one in which a vast number of people are clustered together in very small areas. It is frequently designed and redesigned through a persistent collision of divergent social forces oriented, respectively, in the direction of exchange-value and use-value, scopes of urban sociospatial configurations (Lefebvre, 1996; Harvey, 1973; Logan & Molotch, 1987). An urban space is essentially a reflection of society and is socially determined in its form and processes (Gottdiener, 1997; Harvey, 1973; Santos, 1997). Each city is always changing due to social movement (Santos, 1985).

Cities are related to “urban places” and to local jurisdictional institutions (Henderson, 1997). Cities can also be important in terms of providing employment, even if informal, for having infrastructure, for opportunity to access information, and for supplying educational services. At the very least, they can be important for possessing essential goods and services that can provide material and intellectual benefits to their inhabitants (Amorin & Serra, 2001). In this sense, how can we categorize cities?

According to Santos (1994), a city is a semiotic system – a way of life, a way of producing and consuming goods and information. It is a territory organized to establish communication, to turn private goods and ideological dreams into common property. The author states that during this process, the city, a living organism, imposes functional and symbolic values of commercial solidarity within several sectors (Santos, 1994).

Brenner & Schmid (2015) state out:

the contemporary urban phenomenon cannot be understood as a singular condition derived from the serial replication of a specific sociospatial condition (e.g. agglomeration) or settlement type (e.g. places with large, dense and/or heterogeneous populations) across the territory. Indeed, rather than witnessing the worldwide proliferation of a singular urban form, ‘the’ city, we are instead confronted with new processes of urbanization that are bringing forth diverse socioeconomic conditions, territorial formations and socio-metabolic transformations across the planet (Brenner & Schmid, 2015, p. 152).

Brenner (2014) argue that, because of this, urbanization process has turned into a planetary form; and there is no ‘outside’ to the urban world.

In the context of this planetary world (Brenner, 2014), cities establish relations to each other that go beyond physical boundaries. Since the 1940s, these relations have been studied according to certain theories, such as central place theory with its interpretation of a spatio-hierarchical organization of settlements.

Central Place Theory (CPT), published in 1933 by Walter Christaller, is an effort to describe the spatial arrangement, size, and number of settlements. Christaller (1966) studied community patterns in southern Germany and observed that towns of a particular size were approximately equidistant. By examining and defining the functions of the settlement’s structure and the size of the hinterland, the author found it possible to model the pattern of settlement locations using geometric shapes. Settlements, considering the different orders, arrange themselves in a hierarchy. As a rule, the lower the order, the larger the number of settlements; and the higher the order, the greater the area influenced by a city/place.

According to Guedes et al. (2009, p. 162):

Central place can be defined as a settlement that provides one or more services for its hinterland. All cities (small, median, and large) can be considered central places and all are endowed with relative central functions. Cities, in this sense, are providers of goods and services to populations living in their surrounding localities. The centrality of a town is related to the level of relative importance within an urban network, particularly in its scope and type of functions provided to residents, its area of influence, and its population size. As such, a ‘central place’ hierarchy expresses a systematic and cumulative hierarchical pattern organized into a series of functions that defines the proportional distance and quantities of central places within a given region.

Taylor et al. (2010, p. 2803) affirm that

central place hierarchies have been the traditional basis for understanding external urban relations.

According to the authors, in recent studies of these relations, “a new emphasis on urban networks has emerged” Taylor et al., 2010, p. 2804). The authors also affirm that

hierarchical relations between urban places constitute only a partial understanding of intercity relations (Taylor et al., 2010, p. 2804).

In the Amazon Region, it is not simple to define the existence of an urban hierarchy, mainly because the riverways that connect the forest and communities do not simplify the comprehension of the urban interactions characterizing the region.

The development of a regional urban system affected different parts of the region differently, despite their general similarities in terms of rates of growth and the uncontrolled expansion of urban areas. As noted by Godfrey & Browder (1996, p. 443), the Amazon Region has “multifaceted and internally varied linkages to national and global spheres” and has been marked by problematic development and characterized by a growing informal sector and imprecise rural-urban distinctions.

Browder & Godfrey (1997) propose a “pluralistic theory of disarticulated urbanization,” which considers the non-existence of a regional urban hierarchy. This means that regional urbanization resulted in a nontraditional urban network. They assume that the processes of colonization of the Amazon Region are “disarticulated from any principle of spatial organization,” and that this is “largely asymmetrical and provides scant evidence of orderly, nested hierarchies predicted by Central-Place theory” (Browder & Godfrey, 1997, p. 95).

Supporting this theory, Corrêa (1987) states that an Amazonian urban network exists but is unrelated to the traditional models of urban hierarchy, such as the model proposed by Christaller. Correa suggests that the “rule” of order and size of cities is not a basis for considering the existence of an urban network in the Amazon. Amazon’s urban network reflects (and reinforces) the regional social and economic reality, incorporating different spaces and moments in history (Corrêa, 1987).

City development in the region has typically occurred over different economic and political periods, from missionary, military, and trading posts to private company towns and official settlements established by government agencies, to spontaneous settlements and incipient frontier villages (Corrêa, 1987; Sawyer, 1987). In each state, the urban network had a tendency to be organized, at least in part, in relation to the location of the state capital (Machado, 1999). However, these networks have increasingly been formed at longer distances and often bypass the state capital in their relationship to global markets while increasing the role of median sized cities along road corridors that serve as nodes of services and population movement.

Defining an urban hierarchy for the Delta: a methodological approach

The analytical priority of urban hierarchy follows the urban hierarchy discussion that “categorizes” Brazilian cities, using a single model for defining small, medium and large cities. The Delta is composed of two metropolitan areas (RM of Belém and Macapá) and medium and small cities, with 50 cities in total.

The analytical model was based on variables considered significant by the studies on urban hierarchy that propose hierarchical typologies of cities (Guedes et al., 2009; REGIC, 2007 apud IBGE 2008; Sathler et al., 2010). Therefore, we used variables that could express the importance of the city in make available service to their citizens and to the community around this city.

The variables used were clustered by the category in which they were compiled, as well as the levels of detail of the data according to their importance. We followed two main steps:

- 1) To propose an urban hierarchy for the Delta, we used secondary data provided by public agencies: IBGE (Brazilian Institute of Geography and Statistics), Ministry of Labor and Employment, and FEBRABAN (Brazilian Federation Banking Agencies in Brazil), and we calculated the distance of the cities located in the Delta in relation to the metropolises of Belém and Macapá.
- 2) Data grouping defined according to the urban hierarchy, by category and specificity.

The importance of the variables is noteworthy, which allow us to characterize the cities' peculiarities and their importance in offering access to urban services; and to elaborate criteria to identify the urban hierarchy of the cities of the Amazon. The variables used in this analysis allowed an understanding of the cities characteristics, considering their regional importance, as listed below:

- a) Services Establishments, Industrial and Trade - Data establishments and industrial guide, collected from secondary sources such as CAGED (General Register of employment and unemployment) and Guide of Industries (FIEPA, 2013). These data are related to the number of establishments, for commercial and industrial purposes, manufacturing, industry and local trades, and mineral extraction and agriculture;
- b) Inter-Urban Relations - Commuting data - Flow of people that move daily to work and study among the 50 cities of the Delta of the Amazon, collected in the census of 2010 - IBGE (2016). These movements can create "core" areas, which are not necessarily connected to the metropolitan region, and these areas can function as a pole that is created to supply the demands of the surrounding towns, distant from large commercial and economic centers.
- c) Banking Establishments - Number of banking establishments, collected in FEBRABAN (2017);
- d) Social-Information - Formal Employees and sector of employment. The data came from the RAIS (2015) and aggregate information related to the number of people employed in economic sectors, such as the mineral extraction and processing industry, public utility services, industry, construction, trade, services, public administration and farming, vegetal extraction, hunting and fishing.
- e) Location - Calculation of the distance from each city of the Delta to the nearest state capital, Belém or Macapá. This value was obtained by measuring the distance, using the "distance" command in ArcGis.

The name of the variables of the Industrial Guide of Pará was used as a reference to group of CAGED variables. We decided to group the industrial sectors because the indicators for establishments in the state of Amapá are not available as they were for the state of Pará (in the industry guide). The CAGED data presented this information using different terms, but they facilitated the grouping of variables.

The variable "banking establishments" was used to understand whether it is important for municipalities to be located distant from large centers that aggregate stores and banks. Some small towns have bank offices that support cities or neighboring communities' miles away from the major centers.

Variables related to infrastructure, such as access to treated water, electricity, garbage collection and sewage system, were not considered since these data equalize the cities. Infrastructure in the cities of Delta is very inefficient services, regardless of city size (Costa & Rosa, 2017).

After organizing the data in a table, we developed a general report, consisting of the sum of the relative indexes for each parameter evaluated (the maximum value adopted for each parameter was 1). The result was multiplied by the percentage of urban population of the correspondent municipality.

The following graph shows the general behavior of the data as a function of distance (in kilometers) to the nearest capital. Generally, the graph clearly indicates that the index depends on the distance from the capital, and depends on the type of "exponential decay".

We observed that for a distance of only 35 km from the nearest capital, the general index falls to 10% of the value registered in the capitals. However, a more detailed look at this type of chart (removing the capitals and changing the scale by "zooming" in the graph) reveals a peculiar behavior (Figure 1).

Despite the complexity of the graph, one can observe the following:

- i) a "valley" for distances between 90 km and 120 km (always relative to the nearest capital) – these cities are far from the capitals but do not have the characteristics to be considered "sub-regional."
- ii) for distances larger than 120 km, there is an improvement in the indexes, with some cities as far as 240 km from the nearest capital, thus characterizing possible sub-centers.

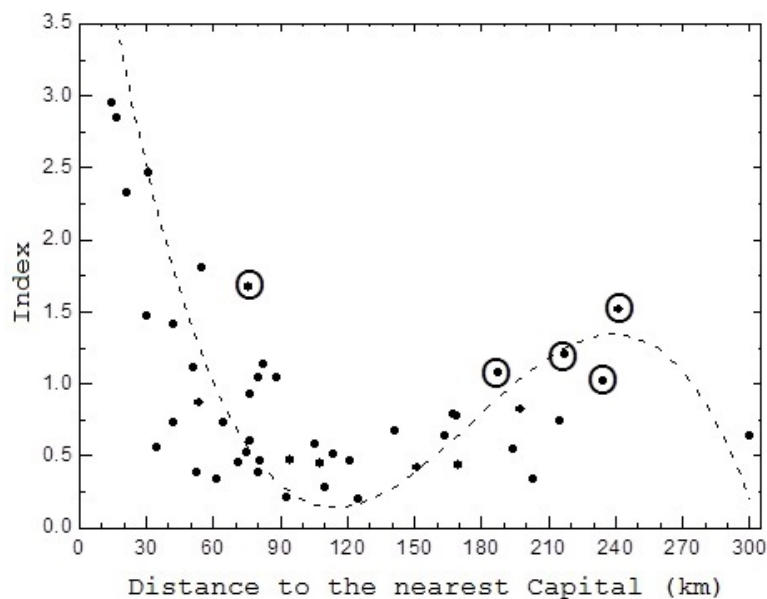


Figure 1 - Distance to the nearest capital, using an adjusted curve. Source: Elaborated by the Authors (2017).

The adjusted curve of the zoomed graph is cubic, showing a point of minimum for distance at approximately 110 km and a point of maximum at approximately 240 km.

Considering this, the final table permitted us to define a hierarchy of the Delta cities, after creating the INDEX of the city's importance (urban hierarchy). Using the results, we produced a map establishing an urban hierarchy. To define the classes of urban hierarchy, we followed the classification of cities proposed by the IBGE study, "Regions of Influence of Cities", or REGIC - 2007, (IBGE, 2008). The goal of this study was to assess the Brazilian Urban Network, based on the flow of information, goods and services. We used the main classes of cities defined by IBGE (2008) and adapted them to the Delta reality:

- I. Metropolis - most important urban center in the Delta. The main feature is the territorial extension and its direct influence over other cities (for instance, Belém, the prime city), which polarizes the flow of people and economic activities;
- II. Regional Capitals - urban centers whose area of influence is at the regional level (in this case, Macapá, capital of state of Amapá);
- III. Regional Center - within a metropolitan area, those cities that had a large number of relationships directly with the metropolitan center were identified, and the cities that were considered at the top of the hierarchy within the areas of metropolitan influence were called regional centers;
- IV. Sub-Regional Centers - characterized by the presence of low complexity management activities. Cities with urban population > 20,000 and < 100,000;
- V. Zone Centers - small cities whose urban network is delimited by the neighboring cities, with basic management activities. Subdivided into A and B, according to their importance to the zone and physical distance from the Metropolis or Regional Capital;
- VI. Local Centers - with an urban population of less than 10,000 inhabitants, whose importance of intra-urban activities is limited to the municipality itself.

The results of this classification permitted us to understand the main connections between cities in the region and the urban hierarchy of the Delta.

Process of urbanization of the Amazon Region and the urban hierarchy in the Delta

An Amazonian urban network began to show signs of organization after the 18th Century, with economic, social, and administrative policies defined by Marques of Pombal supporting, in particular, cities such as Belém and Manaus (Valla, 2015). During the colonial and imperial period of Brazil, until 1889, 58% of the cities of the Delta (Figure 2) were created. Because of the Enlightenment and the logic of spatial occupation brought by the colonizer overseas, the colonial baroque city of the Amazon Region was constructed, following an urban design that originated from the control of absolutist states (Vicentini, 2004).

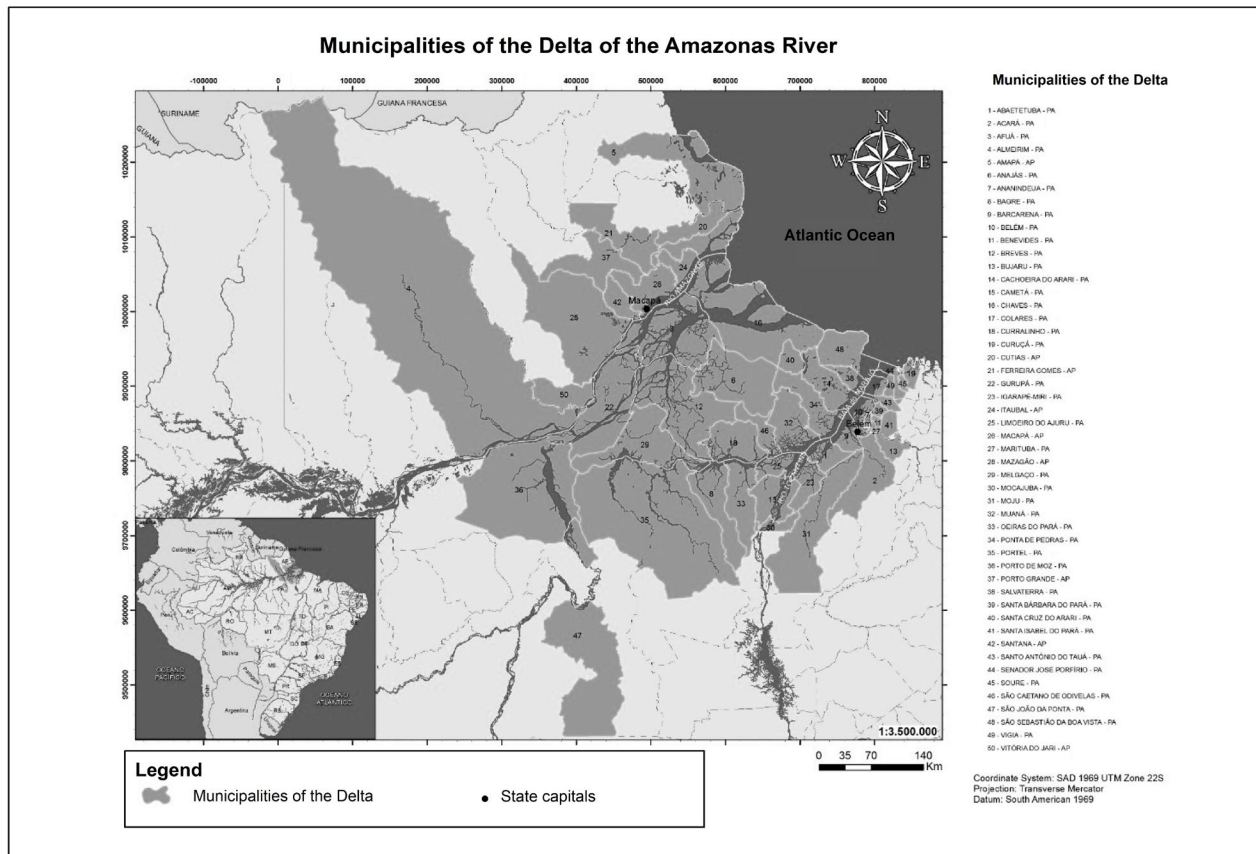


Figure 2 - Location of the Delta Region. Source: Elaborated by the Authors (2017).

Twenty five cities, 50% of the cities located in the Delta, were founded during the 19th century, most of them located along the south channel of the Amazon River Delta. One explanation for this is the offloading of the rubber production during the rubber boom. Belém, where most export enterprises were concentrated, was the most important city during the rubber boom period. Following the crash of the rubber economy, cities in the Amazon Region lost their economic strength and influence, although several new towns were created with poor infrastructure, limited political organization and resources.

Figure 3 provides a schematic sketch of establishment of the urban network of the Delta. Many cities, despite their size, were defined by an economic relationship with the main cities of the Delta (first Belém and then Macapá). A proto urban network was already designed at the end of the 1700s. An intense urban network existed at the beginning of the 1900s, reflective of economic relations between cities and the rubber boom. Belém became the Metropolis during this period.

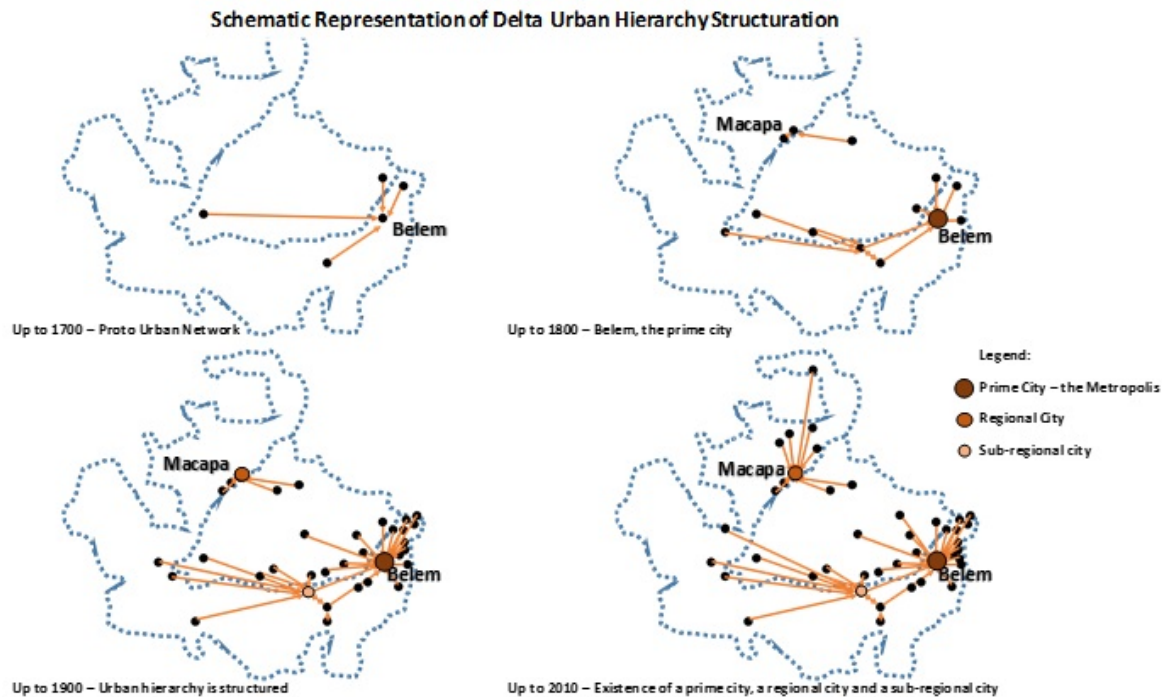


Figure 3 - Schematic representation of the urban hierarchy of the Delta. Source: Elaborated by the Authors (2017).

After the Second World War, the cities located in the Delta experienced a period of economic decline, reflecting the loss of importance of the Amazon Region in the Brazilian economic context. However, throughout their development cycles, these cities received waves of small farmers leaving agrarian settlements for urban areas, and groups of migrants attracted by a tertiary sector in development and in many cases public institutions (Sawyer & Carvalho, 1986). Costa & Brondízio (2011) noted, however, that there is high intra-regional variability in urban population growth, as between the Solimões basin and the Amazon River Delta where colonial capitals were established at the same time.

The Brazilian Amazon Region has been characterized as an urbanized forest since 1980, when the urban population surpassed the rural population (Becker, 1985). Although it is still considered an “agricultural frontier,” researchers have emphasized that cities are increasing very rapidly (Becker, 2005; Browder, 2002; Browder & Godfrey, 1990, 1997; Corrêa, 1987; Machado, 1994; Sawyer, 1987). According to Costa & Brondízio (2011, p. 84), “the intensity of the urbanization process in the Amazon Region, however, has not been followed by proportional investments in urban infrastructure”.

As a result, Amazonian cities are deficient in infrastructure and services, as well as employment. These cities are an “El Dorado” for many immigrants, a protection against landlessness and a support for families to access urban services and employment opportunities that are less available in rural areas (Padoch et al., 2008).

The Delta Region can be considered “urbanized” since at least 1960, and from 1970 to 2010, the urban population in the region has increased by 300% (IBGE, 2010). It is clear that the urbanization process in the Delta was mainly driven by economic booms and established since the 18th century, despite authors affirming that the process of urbanization of the Amazon was intensified by the politics of migration after the 1970s (Becker, 1978, 1985, 2005; Browder & Godfrey, 1997; Corrêa, 1987; Godfrey, 1990; Machado, 1988, 1994, 1999; Sawyer, 1987). The municipalities located at the floodplain of the region were urbanized before the region as a whole. As the Delta is also a part of the floodplain (“várzea”), it encompasses most of the oldest cities of the region. The Delta is one of

the oldest areas in Brazil in terms of occupation, with most cities (78%) established in or before the 19th century. Before 1940, 90% of the Delta cities were towns or already cities.

The process of urbanization is not the same for all Amazon cities, and it is because there are different processes in the region, even though the main actor responsible for both processes (old and new frontier) is the same: the state and the necessity to include Brazil in the capitalist system.

From the 1970s to 1991, this process decelerated in the Delta, due to migration directed towards large cities such as Belém and Macapá. After 1991, the urban growth of the Delta was more intense than the growth of small cities in the Amazon Region, as well as large cities. The period of the most intense urban growth was 1991 to 2000, as a result of mostly rural-urban migration processes. This urbanization process in the Delta is also directly reflected in a reduction of the regional rural population.

The predominance of small cities creates an articulation between these cities that not can be explained by traditional urban hierarchy theory, such as Central Place Theory. We mentioned before that Browder & Godfrey (1997) propose a theory of disarticulated urbanization, considering the non-existence of a regional urban hierarchy at the Amazon Region. The urban reality of the Delta can also be explained by this theory, since the number of small cities, and the physical distances between them, permits the existence of an urban network related to the regional social and economic reality (Corrêa, 1987). Cities are connected to each other, and the local level permits small cities to be connected to each other, the metropolis, regional capitals, such as Belém and Macapá, or even to the world system, such as Vila dos Cabanos, in Barcarena, due to the existence of complex industrial production.

At the macro regional level, it is a disarticulated urbanization, with an articulation of sub-regional networks characterized by service center cities of medium and large sizes. The complexity of network tiers emerges at this sub-regional level in one way in rural/rural and rural/urban areas and in another way predominantly between small and medium cities.

Urban hierarchy in the Delta

The urban network is defined by the interaction between the functions performed by different cities, meaning relationships and exchanges made between various urban spaces. The greater the number and importance of functions of a city in a region, the greater the importance of the city within a specific hierarchy. For instance, when we evaluate commuting, it is possible to verify its importance to understanding urban dynamics and hierarchy. It is used to study the functional organization of regional spaces and to delimit and characterize the flows generated between cities from the study and work requirements of residents.

According to Lima et al. (2016), understanding the dynamics of the interactions between development and flows of capital and labor is essential to analyze the growth trajectories of particular regions and/or countries. The authors state that networks emphasize the complexity of the spatial interactions existing in the country, and its focal points are the cities that primarily perform a territorial management function.

Therefore, produced as a result of the index of importance of a city, allowed us to define a hierarchy for the Delta cities. Using the results, a map (Figure 4) was produced, establishing an urban hierarchy. As mentioned before, we followed the classification of cities in terms of urban hierarchy proposed by the study of IBGE, REGIC - 2007 (IBGE, 2008). The results of this classification permitted us to understand the main connections between cities in the region and the Delta urban hierarchy. Table 1 summarizes the results of the number of cities in each urban hierarchy category in the Delta. There is a predominance of Zone Centers, small cities whose urban network is delimited by the neighboring cities with basic management activities. The difference between a Zone Center and a Local Center is the number of services offered to local and zonal residents (the ones that live around the zone center), such as the number of post offices, primary health care services and bank branches.

Table 1 - Distribution of cities by urban hierarchy (category)

Level	Category	No. of cities	%
I	Metropolis	1	2
II	Regional Capitals	1	2
III	Regional Center	3	6
IV	Sub-Regional Centers	11	22
V	Zone Centers	21	42
VI	Local Centers	13	26

Source: Elaborated by the Authors (2017).

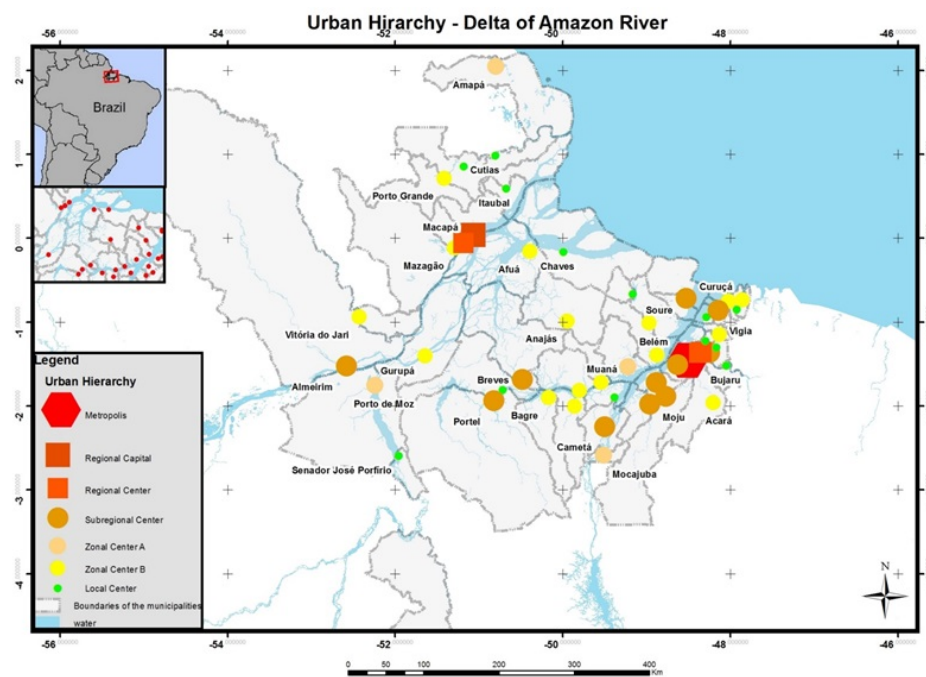


Figure 4 - Mapping of urban hierarchy in the Delta. Source: Elaborated by the Authors (2017).

According to the map produced, it is possible to verify that there is one primary city in the Delta, Belém, from which a large volume of economic interactions and population dynamics (commuting movement) occur. This prime city is a fine example of a regional metropolis that is strongly connected to its surroundings and establishes its influence as a polarizing center. According to the 2010 Census (IBGE, 2016), Belém received 121,821 thousand commuters working or studying in the state capital, which represents 67% of the total such movement in the entire state of Pará.

The metropolitan region of Belém presents heterogeneous characteristics that make these intra-metropolitan spaces very different from each other. Some authors, such as Trindade (2010), Vicentini (2004), and Cruz et al. (2010), relate this metropolis to the notion of misery due to socio-spatial inequality. As a result, the main city, the metropolis, concentrates much of the metropolitan region – RM services, urban equipment, best availability of infrastructure, shopping centers, etc., while the “fringe” of the RM expands without control, in clear view of the public sector. Belém concentrates 81% of economic activities of the RM of Belém (IBGE, 2016). Figure 5 demonstrates some examples of commuting in the Delta, the flow of people to work. Belém leads the process in the Delta, and Macapá attracts people from the cities of the immediate surroundings, as a Regional Capital, an urban center whose area of influence is regionally intense. The city of Santana is a good example of a Regional Center because it has a large number of relationships directly with the metropolitan center and cities of the highest hierarchy.

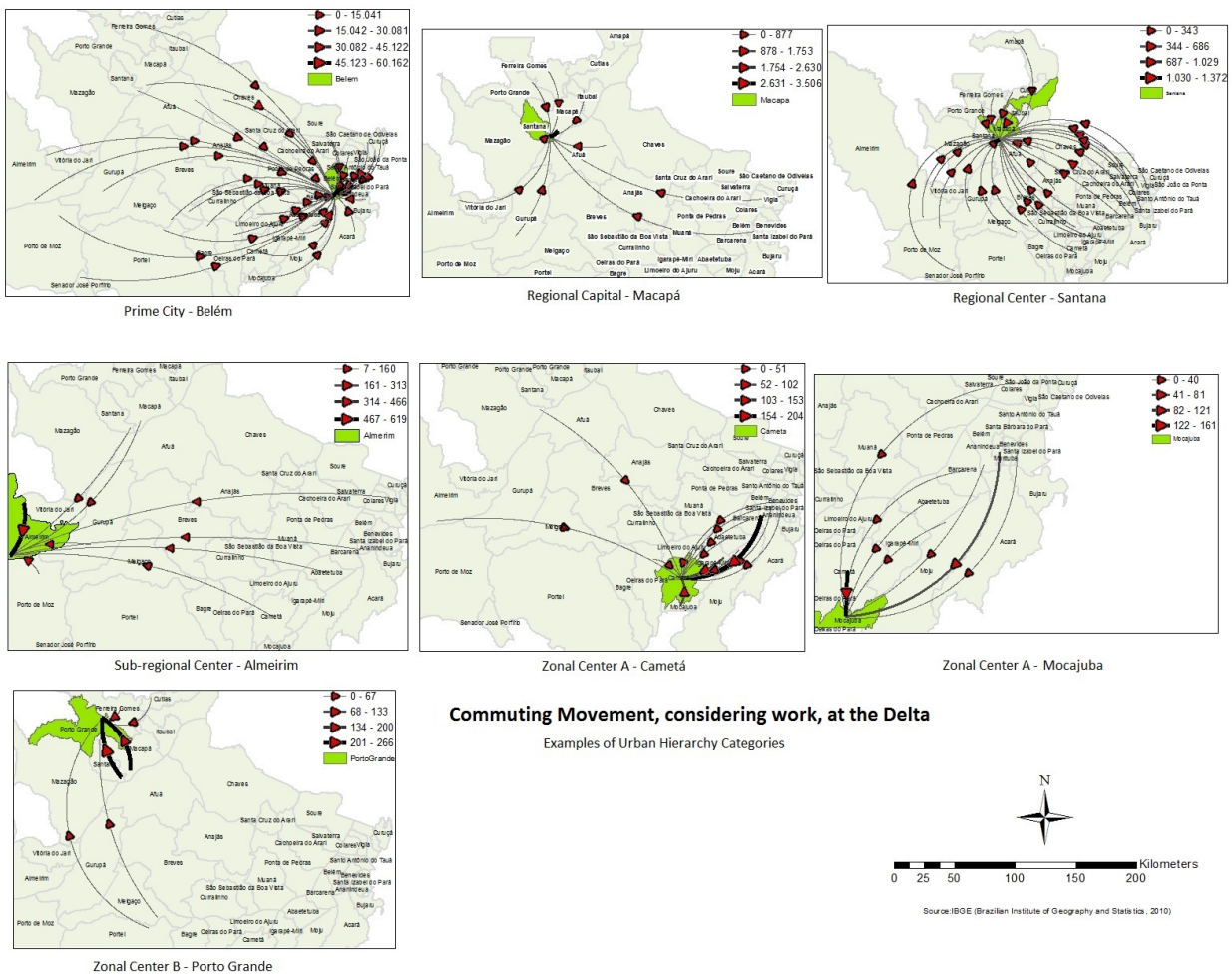


Figure 5 - Examples of commuting in the Delta Region. Source: Elaborated by the Authors (2017).

The city of Almeirim, a sub-regional center, is characterized by the presence of low complexity management activities. The predominance of Zonal and Local Centers in the Delta, representing 68% of the total, demonstrates the singular characteristic of the urban hierarchy of the Delta. All the cities classified in one or another category are small cities with less than 20,000 inhabitants whose urban network is delimited by the neighboring cities with basic management activities (Zonal Centers), or the importance of the intra-urban activities of these cities are limited to the municipality itself (Local Centers). This means that despite poor infrastructure and services, we can verify a population movement to the small cities. These areas offer a protection against landlessness and a base for rural families to access urban services and employment opportunities (Costa & Brondízio, 2009).

Therefore, cities in the Delta have inadequate infrastructure and urban services. However, they attract population in part because cities in the Delta and the Amazon Region have developed with strong links to the surrounding rural environment in terms of social relations and economic activities. In the entire region of the Amazon, even though the urban population is concentrated in cities that do not offer enough services to their population, such as water service, they are cities (Becker, 2005). Small, medium or large, these cities function as possibilities for the people of the rural areas to access employment, information, educational services, and essential goods and services.

In the Amazon Region, according to Costa & Brondízio (2009, p. 216)

small cities have, in general, fragile and weak transformative economies, high dependency on federal subsidies, jobs located predominantly in public service.

The tendency in the Delta is similar. The municipalities with an urban population of less than 50,000 inhabitants have approximately 50% of their formal jobs from the public sector, and the smaller the population, the greater the reliance and the higher the dependency. Urban conditions and infrastructure in this area are non-selective, affecting cities despite their age, size, and location.

This situation is not specific to the Delta. Perz (2000) compared indicators of environmental quality of urban populations in 1980 and 1991 and shows, as expected, that these indicators tend to deteriorate proportionally to the pace of urban growth. According to the author, the literature on urbanization suggests that cities can differ considerably from one part of the region to another. This study detected that households in the new urban areas have considerably fewer resources and services, such as waste collection and water supply, and are more exposed to environmental hazards than the older urban areas.

Despite this condition, the majority of the cities, large and small, have insufficient infrastructure for their populations, such as water and sewage systems. According to the IBGE Census data, by 2000, more than 96% of Delta cities had less than 10% of households connected to public sewage systems, and approximately 38% offered limited access to treated water. The number of urban households increased 68% between 2000 and 2010 in this region. Regardless of the number of households with increased access to basic infrastructure, the distribution of these services among the Delta cities is not the same.

When we analyze the results by groups of cities, we observe significant differences. We grouped the cities in different population sizes (small towns with urban population less than 50,000 inhabitants, medium-sized cities with populations between 50,000 and 300,000, and large cities with more than 300,000 inhabitants). We used the Census 2010 data on the number of urban households with access to sewer and water (IBGE, 2010), and we tabulated the data, which can be seen in Figure 6.

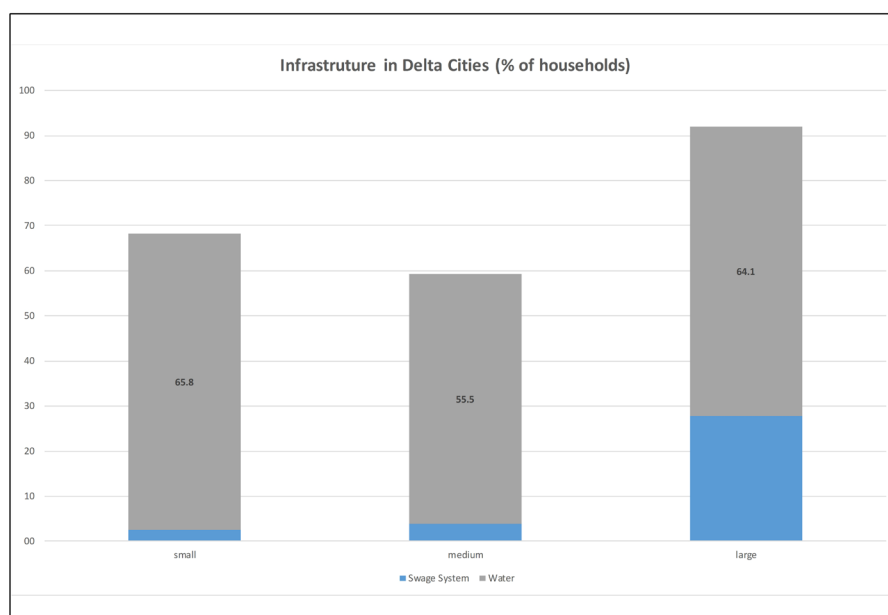


Figure 6 - Percentage of households connected to swage system and water pipes. Source: Census data (IBGE, 2010).

This information permits us to note that at least 50% of urban households have access to piped water, for any group of cities. This scenario is not the same when considering access to the sewage system. The larger the city, the greater the number of households that access the sewer system. The problem is more serious for small cities, which are usually deprived of infrastructure, services and the capacity to generate resources to invest in improving the quality of life of their populations. The smaller the population, the greater the environmental problems.

Another important point is that the level of access to public services and urban infrastructure does not correlate with age, size and location of cities. All the cities of the Delta are growing, but the investments in infrastructure do not correspond to this urbanization process.

Mansur et al. (2016) developed a study of approximately 41 cities located in the Delta. According to the authors, the results of their research indicate the insufficiency of urban infrastructure in the study area, especially in the small cities. The authors state that

[...] lack of public services and infrastructure such as drinking water, sewage, proper waste collection and disposal increases the health risks of the population, posing additional challenges to advancing social and economic progress (Mansur et al., 2016, p. 637).

The impacts of urbanization equally affect ecosystem services, urban pollution, and accelerated riparian deforestation. Growing demand for resources is exerting increasing pressures on local ecosystem services. According to Guenni et al. apud Mansur et al. (2016, p. 628),

[...] a significant portion of the rural and urban populations of the Delta depend directly on local ecosystem goods and services, including the provision of water for home consumption and personal hygiene, fishing, and transportation.

Final remarks

The paper contributes to debates on urban hierarchy, commuting, the importance of small cities in the Delta, and how these cities exert influence on the region's urban network. We historically trace the structuring of the Delta urban space and how it led to the hierarchy of cities and the primacy of Belem.

The mobility of people is an important aspect of the urban hierarchy context, and is a necessity to provide residents with opportunities and access to services that can improve their lives. The Delta urbanized and continues to do so rapidly and with a concentration of industrialization in the core cities, with poor structural transformation.

We understand that from the urban perspective, an extensive approach as presented in this article cannot establish a theoretical line that supports the analysis of this urban complexity. However, this was not the objective of the present research; instead, it was to examine the possibility of understanding the following: 1) the difficulty of studying the urban space in the Delta; 2) the complexity introduced by urban diversity (Trindade, 2010); and 3) the necessity for small cities to be able to communicate their needs. This last, relating especially to their situation in terms of access to urban services and their inability to generate resources and reinvest locally to improve the population quality of life is not visible to the policy makers.

The urban diversity (*urbanodiversidade*) is revealed not only by various forms of cities and the existence of multiple types of urbanization usually deriving from processes from outside the region, but also by complex forms of spaces that indicate the hybridization of relations defined by contacts and resistance in face of these different movements that arrive in the region (Trindade, 2013, p. 18). Thus, understanding how cities have been structured and the intensification of the urbanization process, in all its dimensions, is a fundamental aspect of the broader "social and environmental equation", that is, the quality of life conditions of the inhabitants of the Amazon River Delta.

Despite the different historical processes, time of existence, size and importance in the Regional Urban Network, the cities of the Delta have similar availability of adequate infrastructure, such as water and sewage systems, for their populations. At the same time, small cities are experiencing significant population growth and expansion of urban areas. This shows us that we still need to understand what role the small urban centers of the Delta play in regional and national economies, and any attempt to understand and contribute to the future of the region requires special attention to these processes.

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