



## **Water heritage in Macapá, Amapá: mapping of the wetlands**

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## ABSTRACT

Cities, given their complexity, are in a constant development process and changes happen in all segments. By studying the urban form it is possible to understand how the various parts of the city have ordered and interconnected themselves, integrating the larger whole. To understand the dynamics present in the relationship of the wetlands (*ressacas*) in the city of Macapá, Amapá, in this research a timeline was built from the definition of historical periods. It was considered relevant for the city the development periods that correspond to events that drove important changes in the administrative process with direct implications in the urban fabric of the city. Thus, the foundation of the Village of São José de Macapá was defined as a milestone, passing through the creation of the Federal Territory of Amapá and, finally, the creation of the Amapá State. The maps with the urban development of the city were produced attending to these events and, therefore, cover the period from the foundation in 1758 until the year 2020. For the synthesis mapping of the *ressacas* comprised in the urban environment of Macapá, a map was elaborated with the indication of each area. The disordered urbanization process, increased by migration, results in serious social problems faced by the cities. One of them, the lack of housing, results in the occupation of regions close to the urban core not yet occupied, adding new morphological regions to the city. This region presents an important set of *ressacas* (wetlands) that are contained in the urban area of the city, which are prone to profound environmental transformations, such as the landfilling process that has been taking place over the years.

**KEY WORDS:** *Ressacas*. Wetlands. Amazon.

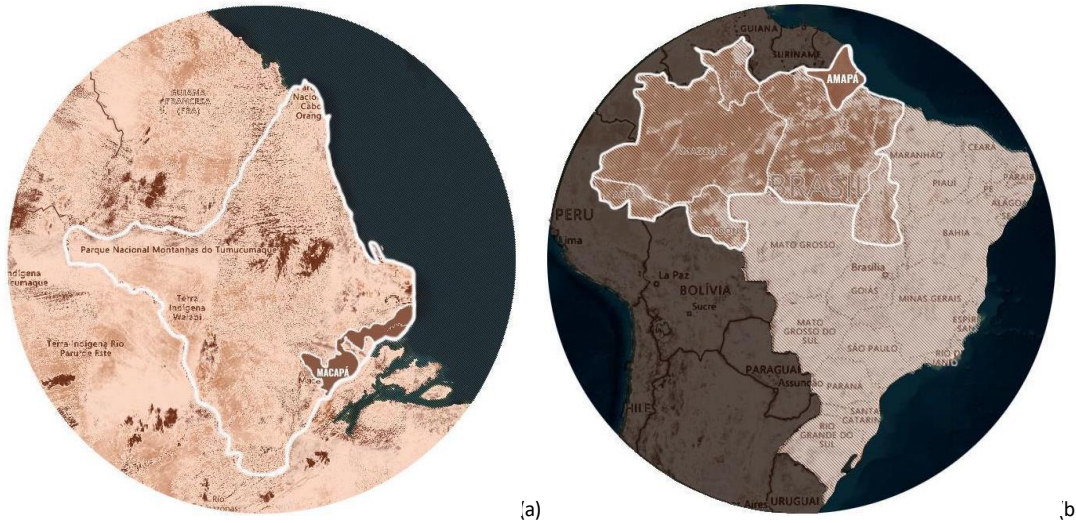
## 1 INTRODUCTION

Mapping the *ressacas* (wetlands) of the city of Macapá - Amapá is an important step towards understanding the city's water heritage and its relation to the need for housing and the climate balance that represent the region's survival systems. The study of urban form is important for understanding the transformations in *ressacas* (wetlands). For this, it is necessary to understand the diversity that the Amazon provides and the urban characteristics of the city's non-flooded areas that residents take for living on the water. The Amazon River, in addition to cutting through part of the northern region of Brazil, also borders the front of the city of Macapá. The study of urban morphology, in addition to involving the study of the urban form, with the physical part of the region, includes in its analysis the various actors and processes involved in the formation and development of the city (OLIVEIRA, 2016). Its study is an important analysis tool that enables understanding not only how the city presents itself at the moment, but also the process through which it arrived at this configuration.

The State of Amapá is located in the Brazilian Amazon and has a humid tropical climate, where the temperature does not vary greatly throughout the year, with the lowest values observed in the so-called rainy season, which takes place during the months of December to July in Macapá (TAVARES, 2014). The fauna and flora of the region show great diversity in aquatic, terrestrial and aerial specimens. Outside urban areas, important variations are observed in the microclimate and relative humidity approaches 100% throughout the year given the contribution of evapotranspiration from the forest itself, while in urban areas the percentage decreases, but presents a high humidity index relatively compared to other regions of the country.

The city of Macapá, located in the Amazon estuary, is the main access to the Atlantic Ocean, for the North region of Brazil, being, therefore, a route of great relevance for the national market and for tourism. Macapá is the capital of the State of Amapá (Figure 1a), it is located in the southeast of the State (Figure 1b), and it is intersected by the Equator Circle, where there is a monument called *Marco Zero* (Ground Zero). The city has a population of 398,204 inhabitants (IBGE, 2010) and estimates (IBGE, 2010) point to a population of 493,634 inhabitants in 2018.

Figure 1 – Location of the city of Macapá (a) and the State of Amapá (b).



Source: Bing.com base image with edits prepared by the author.

The Amazon River is part of the population's life in several ways, such as: fishing (commercialization and subsistence); means of transport with boats and ships, connecting municipalities, states and even international routes; leisure, among others.

## 2 THE RESSACAS (WETLANDS)

Wetlands, popularly known in the State of Amapá as *ressacas*, are natural spaces that are influenced by water, both rains and tides depending on their location. Some are constantly flooded, others flooded by rainfall, having vegetation species typical of these conditions: aquatic macrophytes (*mururés*, *água pés*, *alfaces d'água*) and reeds, and in some regions there is the presence of papyri. Macapá has 21 *ressacas* (wetlands) in the urban perimeter, with ramifications of bridges and stilts that land over the areas and connect to the dwellings over the water and to the infilled streets. The maps generated in this research indicate the expansion of the city of Macapá in all directions and with an intense occupation of its wetlands.

The lack of understanding of the importance of the water system in the region can often lead to inadequate actions, such as the systematic infilling process. The 21 existing wetlands in the city are part of the local climate system, in addition to being part of the local culture, and represent an important environment for the fauna and flora of the place. The infilling process therefore alters the dynamics of the population and its cultural habits, in addition to interfering with the balance of the habitat and the local climate.

### 2.1 CLIMATE AND MICROCLIMATE

The State of Amapá is part of the North Region of Brazil, on the extreme north of the country. Located in the Brazilian Amazon, it can have its climate defined as Monsoon climate or humid tropical climate - Am, according to the Köppen-Geiger climate classification. This Am climate is characterized by having a dry season and a rainy season, indicated as summer and winter, respectively. Despite the climatic similarity along the strip immediately to the north and

south of the Equator, the detailing of the classification system enables separating the climate observed in the cities of Manaus, Amazonas (tropical forest), Tocantins (tropical savannah) and Macapá (humid tropical or monsoon).

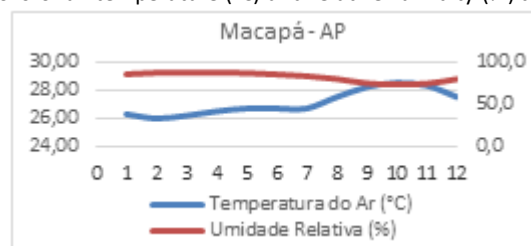
Romero (2000) points out the factors that determine the climate of a region: latitude, longitude and altitude, which together indicate the position of a point on the Earth's surface; solar radiation, which deals with the energy transmitted by the sun in the form of electromagnetic waves and will vary in intensity and quantity according to the inclination of the Earth's axis; winds, where the movement of the air flow is due to differences in pressure or temperature and, still, the masses of water and land that produce changes in the climate. These modifications are related to the dimensions of these masses, resulting in variations in the heat storage capacity and, therefore, in the processes of absorption, reflection and energy emission.

The city of Macapá (Latitude: 0° 2' 4" North, Longitude: 51° 3' 60" West) is located on the Equator, with part of its territory south and another north of it. Latitude can be pointed out as a factor directly related to climate while longitude is related to position.

The elements of climate: air temperature; air humidity; Precipitation and wind regime present themselves in a very peculiar way in the region, giving the character of the seasons, summer and winter, to the absence or presence of intense rains.

In the city, the annual temperature does not show great variations throughout the year, with the lowest values observed in the rainy season. The fauna and flora of the region show great diversity in aquatic, terrestrial and aerial specimens. The graph of the conditions of air temperature and relative humidity, measured in °C and %, respectively, throughout the year, shown in Figure 2, enables observing the variation in temperature associated with the presence of humidity.

Figure 2 - Conditions of air temperature (°C) and relative humidity (%) throughout the year.

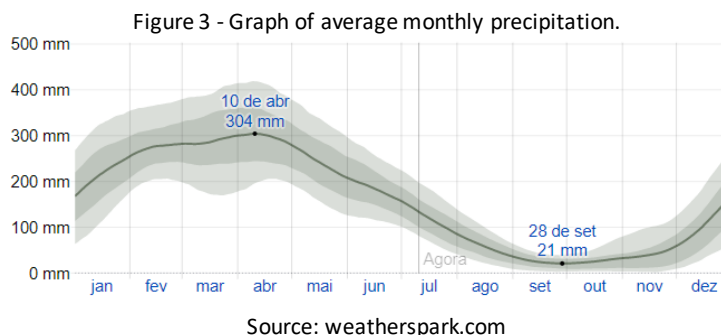


Source: Author - INMET data<sup>1</sup>

The city has an average compensated relative humidity (%) of 83.1% in the city, according to the National Institute of Meteorology – INMET<sup>2</sup> (Figure 2). Note that during the dry season (Figure 3), between the months of July and November, there is a rise in temperature.

<sup>1</sup> <http://www.inmet.gov.br/portal/index.php?r=clima/normaisClimatologicas>.

<sup>2</sup> Idem



It is possible to indicate that the average wind speed in Macapá presents small seasonal variations throughout the year. The presence of more intense winds coincides with a reduction in precipitation and with an increase in temperature in the region, that is, it can be said that it occurs in the “summer” of Macapá (INMET<sup>3</sup>).

Relative humidity values reach higher levels in measurements far from the urban area, towards the forest their values can reach 100%. These can be considered effects of the microclimate provided by a dynamic that associates the presence of vegetation, water, shading and the evapotranspiration process of the forest itself.

Microclimate is understood as the climate located in a specific point of the city, neighborhood, street, etc. Three factors locally influence changes in climate, they are topography, with all its landforms; the vegetation, of small, medium and large size; and the surface of the ground, being this natural or constructed. The microclimate is, therefore, redefined by specific elements that act at points in a region. These elements can offer shading or blockings of solar radiation and of the wind, preventing its circulation and promoting air stagnation. Urban cladding materials are usually sources of heat emission to the environment and should be used with caution, aiming for greater adaptation to the environment. In the scenario studied here, the *ressacas* (wetlands) of Macapá, attention should be paid to the infilling processes of these regions, also due to climate issues (DRACH and EMMANUEL, 2014). The removal of water bodies with their vegetation represents a direct interference in the microclimate with the possibility of promoting overheating of the urban area. These multiple scenarios can be built in the city, interfering with the quality of life of residents and the aquatic and plant species present in these water systems.

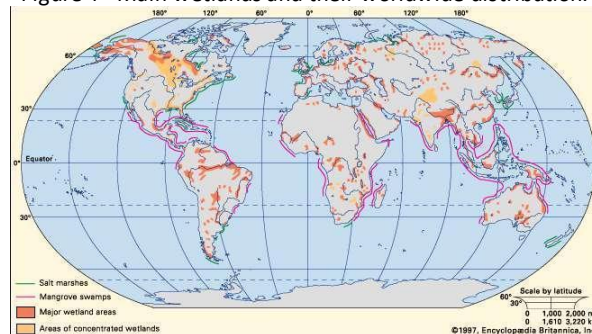
## 2.2 WETLANDS OR *RESSACAS*

The wetlands or *ressacas*, as they are known in the State of Amapá, are floodable regions that are related to rainfall, tides, the Amazon River and the *Igarapé da Fortaleza* Hydrographic Basin that borders both the municipality of Macapá and the municipality of Santana. This complex system of wetlands therefore receives influences not only from seasonal rains but also from the existing rivers of the region.

<sup>3</sup> <http://www.inmet.gov.br/portal/index.php?r=clima/normaisClimatologicas>.

The use of the term “*áreas de ressaca*” according to Santos et al. (2004, apud TAKIYAMA et al., 2012), or just *ressacas*, is adopted for the wetlands of the margin of the State of Amapá that is bordered by the Amazon River. In southern Brazil, more specifically in *Rio Grande do Sul* (estate), wetlands are called “*banhados*” (BURGER, 2000), a word derived from the Spanish “*bañado*”, due to their proximity to neighboring countries. Wetlands are present on all continents (Figure 4) and there are several systems for their classification, which vary according to the selected criterion, such as: types of ecosystems, physical appearance, function or through the objectives for their use (CRANDELL, 2020).

Figure 4 - Main wetlands and their worldwide distribution.

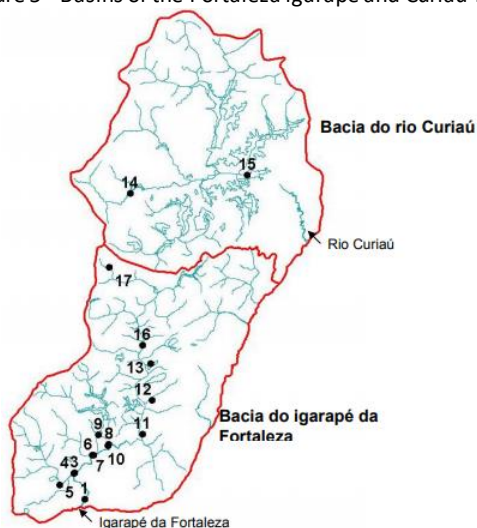


Fonte: Encyclopædia Britannica, Inc. <sup>4</sup>

It can be seen from the map (Figure 4) on the Equator over South America the extent of these wetlands. Crandell (2020) also points out the presence of mangroves, which frequently occur in river delta regions, indicating that areas in northern Brazil are home to these ecosystems. These are favorable regions due to their geographical position, that is, in the latitude range between 32° N and 38° S and because they have temperatures typical of tropical and subtropical regions. It is interesting to observe that in Malaysia and Indonesia, located in this latitude range, there is the presence of buildings on stilts in a similar way to what happens in the Amazon region, in Brazil. In addition to being part of the balance of the microclimate, as previously mentioned, the wetlands, as indicated by Silva et al. (2009), contribute to local supply, serving as “groundwater suppliers and water reservoirs”. Another important contribution is its role in reducing the risk of flooding, as it absorbs part of the rainwater. Silva et al. (2009) point out that the *ressaca* is characterized “as a humid area periodically flooded, but which harbors channels or perennial watercourses”. Figure 5 shows the complex network of watercourses in Macapá and Santana. Both cities are bordered by the Igarapé da Fortaleza Basin, and Macapá is also bordered by the Curiaú River Basin.

<sup>4</sup> Encyclopædia Britannica, Inc. <https://www.britannica.com/science/wetland/Geographic-distribution-of-wetlands>.

Figure 5 - Basins of the Fortaleza igarapé and Curiaú river.



Source: Silva et al. (2009).

In 1971, during the Convention on Wetlands, in the city of Ramsar, Iran, an intergovernmental agreement was signed, with the main objective of preserving wetlands (JUNK, 2014). Brazil only confirmed its participation in 1996.

Wetlands are permanently or temporarily waterlogged, flooded and/or awashed systems, formed in landforms and substrates that enable a greater accumulation of surface and/or subsurface water, for a sufficient time to promote physical, chemical and biological processes of environments with deficiency or absence of oxygen, commonly indicated by plant species adapted to these conditions and/or by soils with hydromorphic characteristics. Anthropogenic interference can condition its formation, such as wetlands in marginal areas of reservoirs. Depending on the scale of analysis of hydrological dynamics, wetlands may include permanently dry and/or aquatic areas, which are fundamental for their ecological maintenance<sup>5</sup> (GOMES, 2017, p. 166)

The hydrographic network of the margin of the State of Amapá, in which the *ressacas* (wetlands) are inserted, are influenced by the water level both by rainfall and by the tides.

This complex water system suffers interference from several factors detailed by Santos et al. (2004, apud TAKIYAMA et al., 2012): daily phenomena with incoming and outgoing tides; twice a month, at full moon and new moon; twice a year, when the spring tides coincide with the equinoxes (periods when the sun is closest to the earth - March and September) and also at irregular times (rare).

In the context of the city of Macapá, there are *ressacas* that are constantly flooded and others that are prone to flooding. The *ressacas* located on the edge of the city suffer the direct influence of the tides of the Amazon River and those located in the hydrographic basin of

<sup>5</sup> Áreas Úmidas (AUs) são sistemas permanentes ou temporariamente saturados, inundados e/ou alagados, formados em relevos e substratos que permitem um maior acúmulo de águas superficiais e/ou subsuperficiais, por tempo suficiente para promover processos físicos, químicos e biológicos de ambientes com deficiência ou ausência de oxigênio, indicados, comumente, por espécies vegetais adaptadas a essas condições e/ou por solos com características hidromórficas. Interferências antrópicas podem condicionar a sua formação, como as AUs em áreas marginais de reservatórios. Conforme a escala de análise da dinâmica hidrológica, as AUs podem incluir áreas permanentemente secas e/ou aquáticas, que são fundamentais para a sua manutenção ecológica.

the *Igarapé da Fortaleza*, which is in the geographic center of the capital, suffer the influences of both the tides of the Amazon River and rainfall.

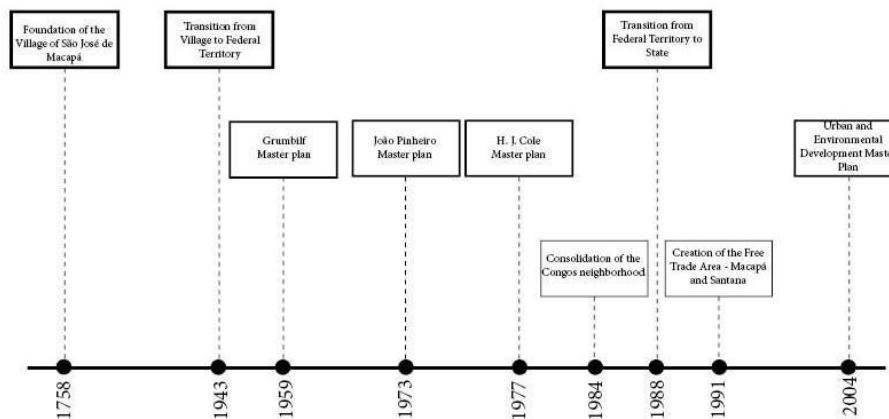
The wetlands correspond to a microclimate of the city that is constituted, mainly, by the water system and by the vegetation, typical of flooded areas - the aquatic macrophytes (*mururés, água pés, alface d'água*) and reeds and, in some localities, the papyri. The presence of water and vegetation together helps in thermal balance, with absorption of heat received through solar radiation, by vegetation, therefore, they are environments with milder temperature. The preservation of these spaces, in a region with a tropical climate, represents an ally in the production of quality spaces, in terms of climate, in the city (BARBOSA et al., 2019; DRACH and BARBOSA, 2016).

### 3 MACAPÁ URBAN DEVELOPMENT AND MAPPING OF THE WATER HERITAGE

The analysis of the urban morphology in the city of Macapá is approached here through the identification of the developmental periods capable of representing the transitions in its urban development. The developmental periods were, therefore, defined based on the dates established from the examination of historical data, facts, photos, maps and other files considered relevant from the perspective of this research.

The development of a timeline (Figure 6) that enables the understanding of the sequence of events in a visual way is interesting for a better understanding of the dynamics present in the city of Macapá.

Figure 6 - Timeline with key dates in the history of the State of Amapá and its capital Macapá.



Source: produced by the author.

The events in the highlighted rectangles at the highest level (respectively the years 1758, 1943 and 1988) concern the founding of the *Vila de São José de Macapá* (Village) and its later status changes in relation to the Federation. At the middle level, the master plans are indicated and it should be noted that three of them were developed between 1959 and 1977, that is, they occurred in a short period of time. However, these master plans promoted few changes in the city's growth dynamics, which has been expanding without applying the plans already created. In 2004, the master plan was presented, which is currently undergoing a review



process, with proposals for changing the height restriction and building setbacks even in the central region of the city.

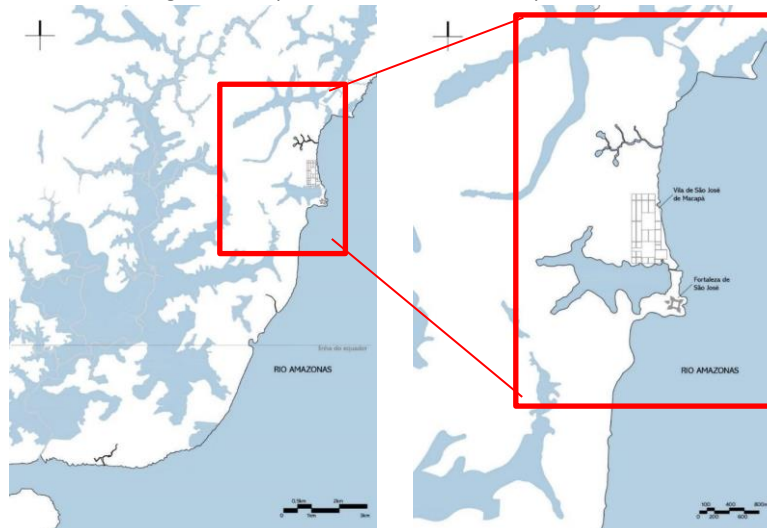
To investigate dates that presented major changes during its development, this research starting point was the moment of foundation of the city reaching the present day. For this research, *Vila de São José de Macapá* was determined as the initial period to analyze the developmental process in its installation in 1758, two centuries after 1973 onwards with data intervals of a decade or less.

Going through these periods, we seek to understand its urban development from the implantation of the initial urban network, which persists until the present day. As well as seeking to understand why the city continues to reproduce, along with the urban environment, the orthogonal grid of the original planning. Neither its four master plans (Figure 7) nor the numerous informal occupations broke with this urbanization model, even though the city's implantation land is cut by a network of rivers and canals that form the *ressacas* (wetlands). Secchi (2000) makes a pertinent statement about the relation between the isolated and the whole, indicating what could explain this repetition of the urbanization model:

The city is the place where legitimate difference is decided, but, above all, repetition is organized, eventually, in the forms of variation on a theme, and this may become an opportunity to rediscover a logic between an isolated element and the whole.<sup>6</sup> (SECCHI, 2000, pág.75-76).

The map in Figure 7, based on maps produced at the time of the installation of the *Vila de São José de Macapá*, indicates the location of the implantation of the village in relation to the location of the *Fortaleza de São José* (fortress).

Figure 7 - Map *Vila de São José de Macapá* – 1758.



Source: Prepared by the author based on maps from the time in Brito (2014).

Through Araújo (1998) it is possible to notice the intensity of the process that connected all localities and the Portuguese Crown, in the different continents.

<sup>6</sup> “A cidade é lugar onde se decide a diferença legítima, mas, sobretudo, se organiza a repetição, eventualmente, nas formas da variação sobre um tema, e isso pode vir a ser uma ocasião para reencontrar uma lógica entre um elemento isolado e o todo.”(SECCHI, 2000, pág.75-76)

At any and every moment of the colonization of the overseas territories, the Portuguese Crown intended to be present. And the foundations of expansion urbanism were never disconnected from a central meaning of the Crown, even when this is apparently not detectable.<sup>7</sup> (ARAÚJO, 1998)

From the detail in Figure 7, it is possible to observe the dynamics adopted by the Portuguese Crown and indicated by Araújo (1998). This territorial domain was continuously present throughout the 16th, 17th and 18th centuries, the latter being the moment of implementation of the set in Macapá, however, the author states that this process is not necessarily interrupted in the 18th century, as this “inserts unequivocally in full Modernity” (ARAÚJO, 1998). On the map in Figure 7, now from the point of view explained by Araújo (1998), it is possible to visualize how the implementation of the Fortaleza and urban settlement complex worked. In the detail of Figure 7, one can see how the “*Lago do Macapá*” (lake), as it was called at the time, was formed. Located between the village and the *Fortaleza de São José* (fortress), it was used as a port for small boats. The Village had a linear orthogonal implantation with empty spaces between blocks for the location of the squares. Spirn (1995) in her publication “The Granite Garden” addresses the theme of urban water, emphasizing that:

all the streams and watercourses of the pre-urban landscape disappear from modern maps. Covered and forgotten, ancient waterways still flow through the city, buried underground in large pipes, primary channels of an underground drainage system<sup>8</sup> (SPIRN, 1995, p. 146).

In Macapá, the process did not happen differently, thus, the existing lake in the vicinity of *Fortaleza de São José* (fortress) at the time of *Vila de São José* (village) now is reduced to a channel located on *Avenida Mendonça Júnior*, a street in the commercial center of the city. This observation was made possible by the survey of data and images that provided subsidies for the production of maps and identification of the channel. It should be noted that the lake, even though it has become a channel, still suffers the daily influence of the tides of the Amazon River, an influence similar to that which the lake suffered when it had been occupied a larger area.

During this research, indications were observed that the Master Plans for the city did not have a reading of the water masses as part of the urban form, dealing with them as areas prone to infilling.

In the forecast for expansion suggested by the road planning of the Urban Development Plan of Macapá (Figure 8) designed by the *Fundação João Pinheiro* (foundation) in 1973, is noted the intention to expand beyond the area where the Congós neighborhood is located today. The Plan developed by the company HJ Cole (1977) continued the expansion project towards the south and southwest of the city.

<sup>7</sup> “Em todo e qualquer momento da colonização dos territórios ultramarinos a Coroa portuguesa pretendeu estar presentes. E os fundamentos do urbanismo de expansão jamais estiveram desligados de uma aceção central da Coroa, mesmo quando isto aparentemente não é detectável.” (ARAÚJO, 1998)

<sup>8</sup> “todos os córregos e cursos d’água da paisagem anterior à urbanização desaparecem dos mapas modernos. Cobertos e esquecidos, antigos cursos d’água ainda correm através da cidade, enterrados sob o solo em grandes tubulações, canais primários de um sistema de drenagem subterrâneo” (SPIRN, 1995, p. 146)

Figure 8 – Urban Development Plan of Macapá by the *Fundação João Pinheiro* - 1973.

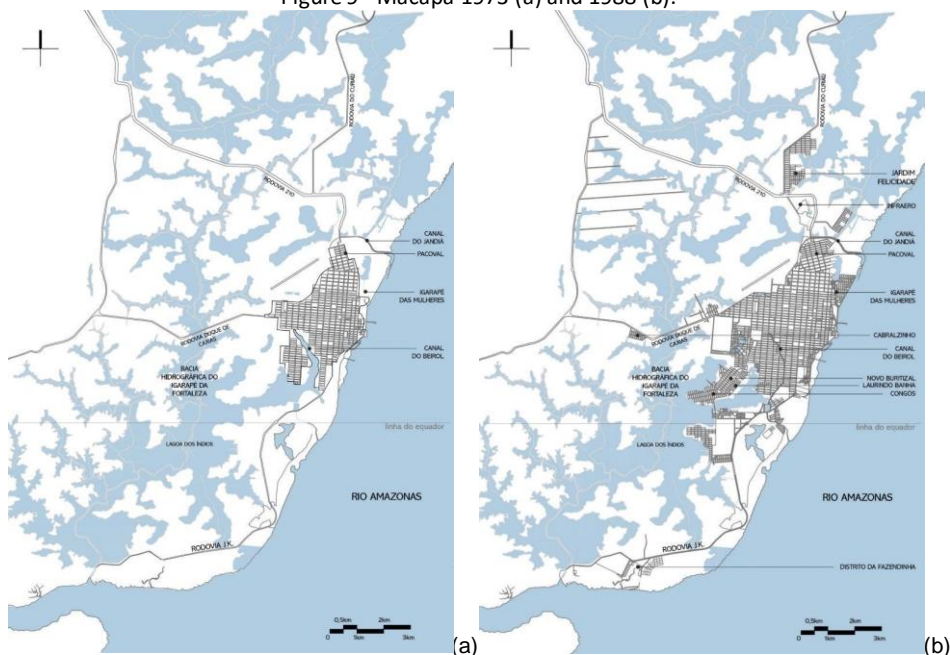


Source: Adapted from *Fundação João Pinheiro's* map (1973).

The urban plans proposed, both by *Fundação João Pinheiro* (1973) and by the company HJ Cole (1977), show the emphasis on expansion to the south and southwest, promoting more connections with the municipality of Santana, and also inducing urban growth for these regions. In the urban plan of the *Fundação João Pinheiro* (1973) there was provision for a road connection through the roads already built (*Rodovia Juscelino Kubitschek* and *Rodovia Duque de Caxias*) and a new road that in the project would cross the *Igarapé da Fortaleza* hydrographic basin and their respective *ressacas* (wetlands). In 1973 (Figure 8) the city expanded through the dry natural site, to the north of the city with the creation of the *Pacoval* neighborhood. Towards the south and west, the urban fabric expands, occupying one of the arms of the dry natural site, to the south, starting the implantation of the *Beiro!* neighborhood. In this same period, the city already presents a well-consolidated linear orthogonal grid, composed by a set of blocks with similar dimensions in the central region that replicates to the south and west. To the north, this fabric undergoes variations in the dimensions of its blocks, even if the main roads are preserved, the grid adapts itself to the arterial route of the *Rodovia 210* (highway).

In the transition from the 1970s to the 1980s (Figures 9a-b) one of the branches of the *Igarapé da Fortaleza* hydrographic basin was channeled, transformed into the *Canal do Beiro!* (channel), through a infilling process, even in the regions where there were stilt houses. With the advancement of the urban fabric in the 1980s, the emergence of the Congós neighborhood and other neighborhoods further south could be noted.

Figure 9 - Macapá 1973 (a) and 1988 (b).



Source: Prepared by the author.

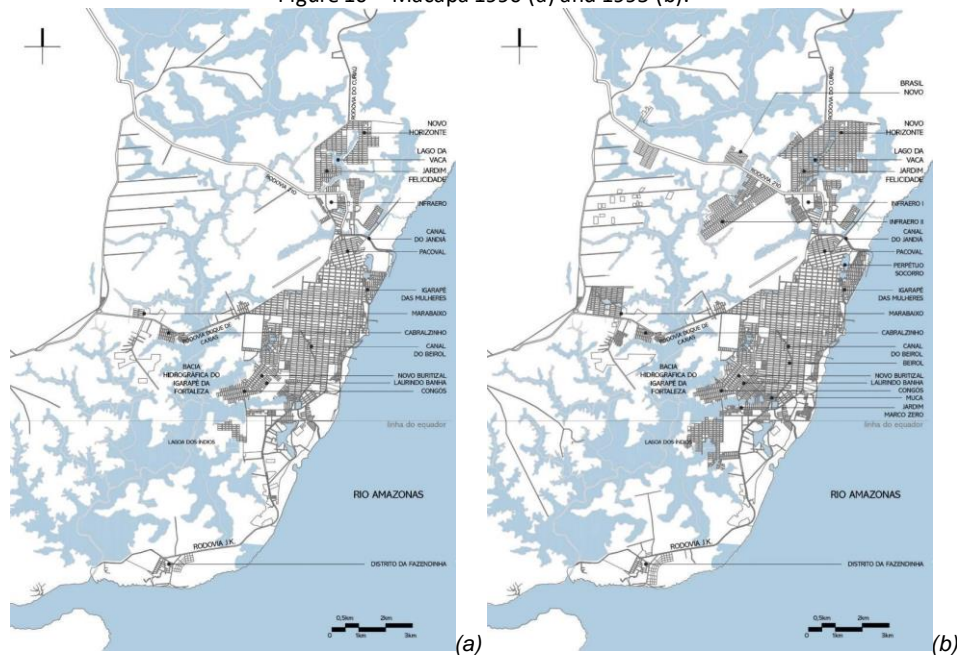
It is also observed that the growth towards the north (Figures 9a-b) crosses the *Canal do Jandiá* (channel) and continues around the intercity highways. There is the emergence of the *Jardim Felicidade* neighborhood, on the edge of the *Rodovia do Curiaú* (highway), maintaining the linear orthogonal grid, even far from the city center. This neighborhood grows between the highway and the wetlands (*ressacas*).

This expansion to the north also results in the creation of new neighborhoods from streams (*igarapés*), as is the case of *Igarapé das Mulheres*, located near *Canal do Jandiá* (channel), which presents the continuity of the expansion of the urban fabric, repressing water bodies again. To the extreme south of the territory in Figure 10a, one can also note the growth of neighborhoods that are more distant from the center of Macapá, but which appeared on the banks of *Rodovia J.K.*, the road that connects the municipalities of Macapá and Santana. This district has an irregular road network, made up of main and secondary roads shaped more by the local topography than by a pre-established regular design.

Figure 10a shows the period of 1990 in which the city already demonstrates a more accentuated urban development to the south, following the *Rodovia J.K.*, towards the municipality of Santana. Continuing with the densification of the neighborhoods adjacent to *Congós* neighborhood, which had previously expanded around the then *Canal do Beírol* (channel), and also moving towards other *ressacas*. The mesh presents several adaptations, but even changing direction to follow the system of the main roads, it adapts and maintains its linear orthogonal grid.

In the urban development maps, significant changes can be seen in the city's fabric in the 1990s. Figure 10b shows Macapá in 1995, that is, after a five-year interval in relation to the map in Figure 10a, which could draw attention to the emergence of several neighborhoods and for the horizontal expansion of the city.

Figure 10 – Macapá 1990 (a) and 1995 (b).



Source: Prepared by the author.

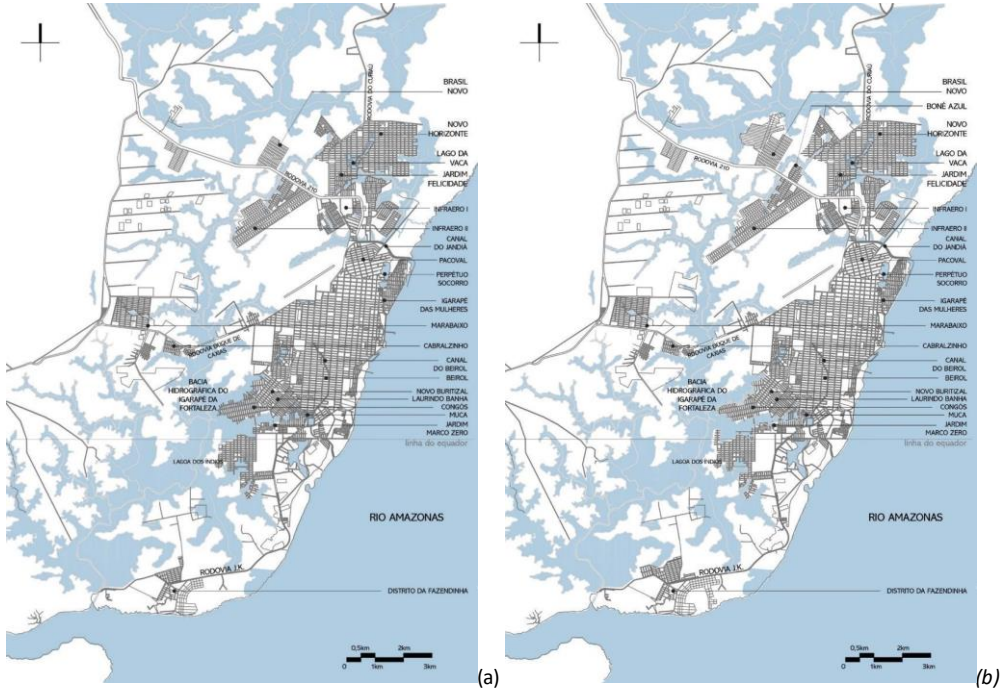
During the 1990s, the process of integrating Amapá into the national context continued, with the creation of the state of Amapá as a federative unit and the creation of the Free Trade Area (1991). One of the consequences of these processes was the creation of state development projects that attracted workers from other regions, contributing to the expansion of the urban fabric. These factors were relevant and explain the differences observed between the 1990 and 1995 maps.

The year 2000 map in Figure 11a, shows the consolidation of the neighborhoods already installed and the advance of the occupation in the dry sites of the neighborhood, and also, the advance onto the two *ressacas* (wetlands) already established there. It is also possible to perceive the continuous expansion of the neighborhoods of the north zone, *Jardim Felicidade* and *Novo Horizonte*, which maintain and extend their orthogonal blocks around the boundaries of the *Ressaca Lago da Vaca* (wetland). Figure 11b shows Macapá in 2008, with its consolidated expansions. The city presents small modifications to expand the urban fabric of some neighborhoods.

Figure 12 shows the city of Macapá in 2020 (SPINDOLA, 2020). At this time, it is remarkable the occupation between neighborhoods in the northern part of the city. Subdivisions made for condominiums that no longer follow a linear orthogonal grid, previously reproduced in most of the city, exceed the boundaries of the same *ressaca* with which the *Brasil Novo* neighborhood was delimited.

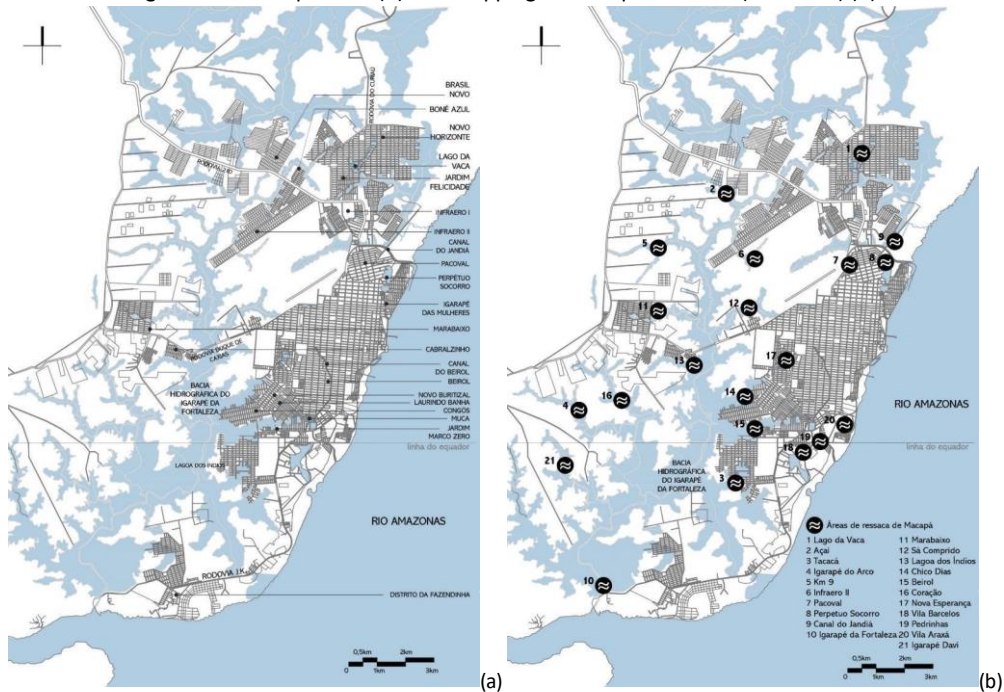
In the south zone of the city, subdivisions also present expansions onto the boundaries of the *ressacas* (wetlands) existing there. However, in 2020 (Figure 12a) several regions show continuity with an irregular grid, starting from dirt roads that advance towards the *ressacas*. In the west zone of the city there are also subdivisions that already delimit future areas built on the *ressacas*. It is an expansion process that repeats itself in all directions, occupying the *ressacas*, leveling and subdividing the land.

Figure 11 – Macapá 2000 (a) and 2008 (b).



Source: Prepared by the author.

Figure 12 – Macapá 2020 (a) and mapping of Macapá *ressacas* (wetlands) (b).



Source: Prepared by the author (a)(b) based on data collected at ANA (National Agency for Water and Basic Sanitation).

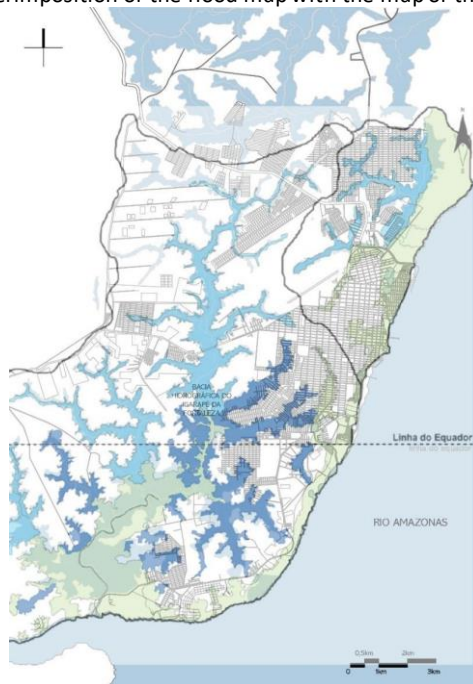
With the development of maps of urban development of Macapá, it was possible to understand and locate the existing wetlands in the city. Takiyama et al. (2012) indicate the

presence of nine *ressacas* systems located on the left bank of the *Igarapé da Fortaleza*, the main river of the *Igarapé da Fortaleza* (basin) (Figure 5). In Figure 5, it was possible to observe the network of channels and small drainage rivers “interconnecting the *ressaca* systems, other small channels are arranged perpendicularly to the coastline and drain the areas of floodplain forests of the Amazon River.” (TAKIYAMA et al., 2012, p. 49). The authors indicate that these *ressaca* systems total an area of 28.94 km<sup>2</sup>, representing 17.11% of the drainage basin. Within these nine *ressacas* systems pointed out by (TAKIYAMA et al., 2012) as present in the *Igarapé da Fortaleza* basin, 21 different *ressacas* were identified in this research in the municipality of Macapá, which can be seen on the map in Figure 12b (SPINDOLA, 2020).

## CONCLUSION

The possibility of implementing a sanitation program, even in *ressacas* (wetlands), would enable the reduction or extinction of the infilling dynamics. This process brings as important consequences the vulnerability of the city to flooding and the rise in temperatures due to changes in the microclimate of the city of Macapá. Figure 13 shows the superimposition of the flood system map produced by Takiyama et al. (2012) on the map in Figure 12a (Macapá in 2020).

Figure 13 - Superimposition of the flood map with the map of the city of Macapá.



Source: Takiyama et al., 2012 adapted by the author.

In the studies developed for the *ressacas* (wetlands) of Macapá, Takiyama et al. (2012) point out that these areas are vulnerable “to flooding processes” because they are in low-relief regions and are “susceptible to fluvial and tidal flooding dynamics” (TAKIYAMA et al., 2012, p. 50). Takiyama et al. (2012) point out that the continuous embankments along the “*ressaca* systems and river channels decrease the space available for the accumulation of water and natural sediments, increasing the susceptibility to flooding in previously non-flooding areas”

(TAKIYAMA et al., 2012, p. 50). It is notable from the map (Figure 13) that the flooding process indicated by the author is capable of reaching several occupied regions of the city, with emphasis on the commercial center close to *Fortaleza de São José* (fortress) and on the neighborhoods of *Beírol* and *Muca*, which presented an advanced infilling process.

## References

- ARAÚJO, R. M. **As Cidades da Amazônia no Século XVIII** - Belém, Macapá e Mazagão. FAUP - Faculdade de Arquitetura da Universidade Porto, 1998.
- BARBOSA, G. S.; DRACH, P. R. C.; CORBELL, O. D. *Intraurban Temperature Variations: Urban Morphologies of the Densification Process of Copacabana Neighborhood, Brazil*. *Climate*. v.7, p.1 - 17, 2019.
- BRITO, J. F. L. **A Fortaleza de Macapá como monumento e a cidade como documento histórico**. Dissertação Mestrado Profissional. Instituto do Patrimônio Histórico e Artístico Nacional. Rio de Janeiro. 2014 .
- BURGER, M. I. **Situação e Ações Prioritárias para a Conservação de Banhados e Áreas Úmidas da Zona Costeira**. Base de Dados Tropical. Porto Seguro, 2000. Disponível em: <[http://filesrodadas.anp.gov.br/round6/arquivos\\_r6/guias/PERFURACAO/PERFURACAO\\_R6/refere/Banhados.pdf](http://filesrodadas.anp.gov.br/round6/arquivos_r6/guias/PERFURACAO/PERFURACAO_R6/refere/Banhados.pdf)>.
- CRANDELL, C. J. *Wetland. Encyclopædia Britannica. Encyclopædia Britannica. inc.* 2020. Disponível em: <<https://www.britannica.com/science/wetland>>. Acessado em: 11 jul. 2020.
- DRACH, P. R. C.; BARBOSA, G. S. Estudos da variação da temperatura intra-urbana no centro da cidade do Rio de Janeiro: influência da morfologia e da vegetação. **Cadernos do PROARQ** (UFRJ). v.26, p.71 - 86, 2016.
- DRACH, P. R. C.; EMMANUEL, R. Interferências da forma urbana na dinâmica da temperatura intra-urbana. **Revista de Morfologia Urbana**. v.2, p. 55 - 70, 2014. Rede Lusófona de Morfologia Urbana.
- JUNK, W. J.; PIEDADE, M. T. F.; LOURIVAL, R.; WITTMANN, F.; KANDUS, P.; LACERDA, L. D.; BOZELLI, R. L.; ESTEVES, F. A.; NUNES DA CUNHA, C.; MALTCHIK, L.; SCHÖNGART, J.; SCHAEFFERNOVELLI, Y.; AGOSTINHO, A. A.; Brazilian wetlands: their definition, delineation, and classification for research, sustainable management, and protection. *Aquatic Conservation: Aquatic Conservation: Marine and Freshwater Ecosystems.*, v. 24, p. 5-22, 2014.
- OLIVEIRA, V. Morfologia urbana. Uma introdução ao estudo da forma física das cidades. **Revista de Morfologia Urbana**. 4(2), p. 65-84, 2016. Rede Lusófona de Morfologia Urbana.
- ROMERO, M. A. B. **Princípios Bioclimáticos para o Desenho Urbano**. 2.ed. São Paulo: ProEditores, 2000.
- SECCHI, B. **Primeira lição de urbanismo**. Tradução de Marisa Barda e Pedro M. R. Sales. São Paulo, Perspectiva, 2007.
- SPIRN, A. W. **O jardim de granito**. São Paulo: EdUSP, 1995.
- SILVA, A. Q. [et. al]. Valoração ambiental das unidades fitoecológicas remanescentes da bacia hidrográfica do Igarapé Fortaleza. **OLAM – Ciência & Tecnologia**. Rio Claro – SP. Ano IX, jan.-jul. 2009, Vol. 9, n. 2, p. 354. ISSN: 1982-7784. Disponível em: <<http://cecemca.rc.unesp.br/ojs/index.php/olam/index>>.
- TAKIYAMA, L. R. [et al.]. Qualidade das Águas das Ressacas das Bacias do Igarapé da Fortaleza e do Rio Curiaú. In: TAKIYAMA, L. R.; SILVA, A. Q. da (orgs.). **Diagnóstico das Ressacas do Estado do Amapá: Bacias do Igarapé da Fortaleza e Rio Curiaú, Macapá-AP**. Macapá: CPAQ/IEPA e DGEO/SEMA, 2003. p.81-104.
- \_\_\_\_\_. **Projeto zoneamento ecológico econômico urbano das áreas de ressacas de Macapá e Santana, estado do Amapá: relatório técnico final**. Macapá: IEPA, 2012.
- TAVARES, J. P. N. **Características da climatologia de Macapá-AP**. Caminhos de Geografia, Uberlândia, vol. 15, n. 50, p.138-151, jun., 2014.