

# **HISTORICAL CARTOGRAPHY OF RIO DE JANEIRO: SPATIAL AND TEMPORAL RECONSTITUTION OF DOWNTOWN**

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## **Abstract**

The history of Rio de Janeiro is full of interesting events that are intimately linked to the history of Brazil. Since before the foundation of the city, in 1565, until today, Rio de Janeiro has been the stage for important facts, such as: the various attempts of invasion; the displacement of its primary activities to the plain among the hills; the arrival of the royal family, that left Portugal to escape from Napoleon troops; the proclamation of the republic; and the great constructions and demolitions, which changed the landscape of the city. Downtown Rio has a special place in the history of the city because it has been the center of social, cultural, economic and commercial activities during the centuries. This paper deals with the analysis of historical maps of Downtown Rio de Janeiro. During the development of the work, the following main goals were pursued: a) to build maps of comparison of historical maps of Downtown Rio dating from different and significant periods, considering the features corresponding to the streets and shoreline; b) to propose a methodology for registration of those maps in pairs, even when they do not have well defined scale, projection or coordinates. In order to achieve these objectives, four maps were selected, and they have dates of publication ranging from 1769 to 2000. The first one is the Map of Roscio (1769), and it was done with the purpose of designing a fortification for the city, including the construction of a great wall. The second one dates from 1838, that is, less than two decades after the independence of Brazil, which was declared in 1822. From 1906, a map that represents improvements in Downtown Rio was selected, including the construction of the Central Avenue. The most recent map selected, published by the town hall, refers to the year 2000, and it was produced at the final scale of 1:10,000, from orthophotos at the scale 1:30,000. The methods used involved the study of the history of Rio de Janeiro, and particularly of its Center (downtown); the definition of what is meant by Center (downtown); the brief study on landscape, and its characteristics; the differentiation between antique and historical maps; the searching for control points existing both in antique and recent maps; the selection, scanning, registration, georeferencing, vectorization and comparison of maps; and the historical synchronism. As results, three

comparative maps were generated, and a flowchart was proposed as suggestion of methodology to reach the analysis of the comparative maps. The differences of scales, projection or representation were treated with different kind of transformations, by using the specific software. The points of control were meticulously chosen in order to cause minimum errors after the adjustments. Moreover, a discussion pondering quantitative and qualitative analysis is established, presenting the challenges in each approach, its advantages and disadvantages either. Finally, some applications, based on the analysis of the comparative maps, are suggested, such as the potential to diagnose infrastructure issues and to support the development of public policies of land.

## **INTRODUCTION**

The idea of this research was born from a fictional sense, as if the past were made present by walking on the streets of downtown Rio de Janeiro. Walking by downtown Rio makes it possible to notice its urban evolution, but such evolution can also be verified its urban evolution through the maps. A rich collection of historical maps of the city dated from the sixteenth century on unite both art and technique, which enables really instigating research.

The focus of research is the Center of the City of Rio de Janeiro, a scene of large, deep and significant political, social, economic and architectural transformations, or landscape transformations, for over 400 years. The Center of Rio or Downtown Rio was the heart of the city and, for a long time, of Brazil as well. For this article, maps of the Center of the City of Rio de Janeiro dating from 1700 until 2000 were compared, considering the streets and the shoreline, and showing the structure of the urban evolution of the downtown, as well as the main alterations occurred along time.

## **THE CARTOGRAPHY AND THE RIO DE JANEIRO CITY**

According to Rumsey and Williams (2002, p. 1), the maps keep the spatial information that are critical to the rebuilding of places of the past. The historical maps often keep information that is not held by any other written source, such as names of places or limits that have been modified due to progress. On the concept of ancient map versus historical map, in the context of this work, the ancient one is considered as one old map published in remote time. Meanwhile a historical map can be a document of such importance, perhaps due to the techniques used or to the period or facts represented, and therefore is considered historic.

The foundation of the city, which was called São Sebastião do Rio de Janeiro, by Estácio de Sá, was on Mar 1<sup>st</sup>, 1565, somewhere between Morro Cara de Cão and Sugar Loaf. There is mapping of that area and its neighborhood even before the foundation of the city.

The French contribution to the historical cartography of Rio de Janeiro was the period of France Antarctica, during their attempts of invasion and colonization in the second

half of the sixteenth century. Should not pass the blank what Jacques de Vaulx did. Bardy (1965, p. 61) attributes to him the authorship of the first plan of the city, in 1579. Another important relationship to be done between the mapping and Rio de Janeiro in the sixteenth century refers to the Chart of Luiz Teixeira in 1586. According to Teixeira Filho (1975), this chart represents the beginning of human occupation of São Cristóvão and the beginning of the expansion of the city toward the meadow, between Morro do Castelo and São Bento.

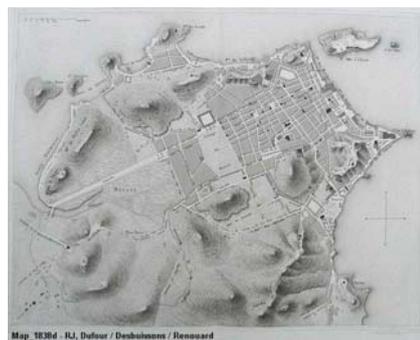
In the seventeenth century, it can be noted, initially, the Chart of Reys-Boeck in 1624. It is linked to the Dutch activity in Brazil and contains valuable information about the city.

According to Menezes et al. (2007), the eighteenth century marks the beginning of scientific mapping, when, through the use of astronomy and surveying, the mapping of geometric shapes started to seem quite close to what is known today. They also started to use an orthogonal projection. The Plan of the City of São Sebastião do Rio de Janeiro, with its fortifications, was designed in 1713 by Jean Massé, a French military engineer who was providing service to Portugal. According Ferrez (1963, p. 6), it is the first plan of Rio de Janeiro carried out in scale and it presents the results of studies of that engineer, showing how it should protect the city from the land side. Another example of map from this century is the plan of the City of Rio de Janeiro (Figure 1), prepared by Francisco José Roscio in 1769, which aimed to raise a trench of fortification in the city.

In the nineteenth century, there was the Plan of the City of São Sebastião do Rio de Janeiro in 1812, made by order of the Regent Prince. The changes caused by the influence of the arrival of the royal family (who left Portugal to escape the Napoleon troops) to Rio began to be mapped. The presence of the Royal Family raised Rio de Janeiro to a higher level of importance: being Brazil's capital since 1763, Rio became the capital of the vast domains of the Portuguese Monarchy (ROSA, 1924, p. 22). In that century, there is also the map of downtown Rio in 1838 (Figure 2). There you can see places like Morro do Castelo e Santo Antônio still intact.



**Figure 1 - Plan of Roscio (1769)**  
**1838**



**Figure 2 – Map of Downtown Rio in**

Rio de Janeiro of the twentieth century is influenced by significant reforms carried out by the public administration. In the reform of Pereira Passos, there were major changes,

which are portrayed in the Plan of Urban Improvements, 1903 to 1906, as seen in Figure 3.



**Figure 3 - Plan of Urban Improvements of Mayor Pereira Passos (1906)**

### **IMAGE OF DOWNTOWN RIO “TODAY”**

Closer to the present time, obtained through the Instituto Municipal de Urbanismo Pereira Passos (IPP), the orthophotos (Date of flight: 1999. Scale 1:30,000.) of Downtown Rio de Janeiro (Figures 4 and 5 ) provided subsidies for the generation of the plan on 1:10,000 scale, also produced by IPP and published in 2000.



**Figure 4 - Orthophoto of Downtown Rio (West Side). Source: IPP (2008a).**



**Figure 5 - Orthophoto of Downtown Rio (East Side). Source: IPP (2008a).**

### **CONCEPT OF DOWNTOWN RIO**

The Center of Rio or Downtown Rio was not always where it is today. According to João Ribeiro (apud DELGADO DE CARVALHO, 1990, p. 26): the first cities in Brazil started by the hills, only later heading to the plain, and they would never initiate their formation by the seashore or by river edges, that is, only in places where ships of long range could not - that is the wisdom of the founders in the sixteenth century. Motta (2001, p. 9) declares that various functions of urban space are not located in a powdered way, and a cluster of types within a given area may exist, and therefore a logical order.

Through the historical review conducted, it seems that a location of the center, not as well defined, is near the Carioca River. Originally the center of Rio was at the site of the foundation of the city, between the hills Sugar Loaf and Morro Cara de Cão. Then, for reasons of security/defense, the Center moved to Morro do Castelo. Finally, it occupied a plain among the hills Morro do Castelo, São Bento, Conceição and Santo Antônio.

In this paper, the limits of the Center are considered as part of a clear cut, which is presented by the IPP (Figure 6). The date of the decree, with the description and delimitation of the center, is Jul 23<sup>rd</sup>, 1981 (IPP, 2008B).

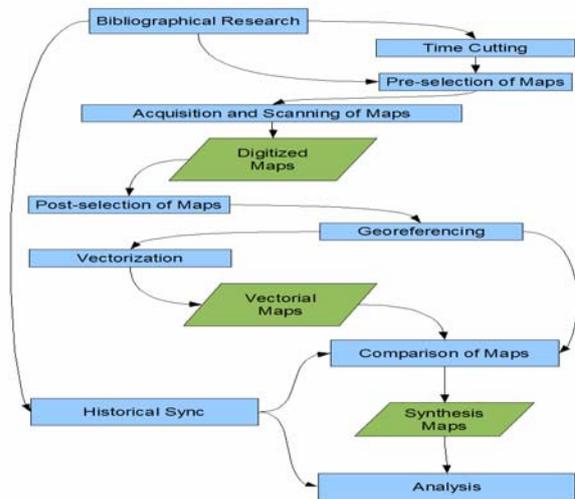


**Figure 6 – Downtown Rio and Adjacent Neighborhoods.**  
**Source: Adapted from IPP (2008a).**

According to Santos (1988), what we see, what our vision reaches, is the landscape. You can make a connection with the observation of the cartographer, who understands the landscape and reflects on their maps, with representations of geographic phenomena. The geographical landscape is a generalization derived from observation of individual scenes (SAUER, 1925). The Center of Rio went through many transformations in its landscape, involving construction and demolition over time.

## **METHODOLOGICAL PROCEDURES**

The methodological procedures were implemented during the following phases: bibliographical research, time cutting, pre-selection of maps; acquisition and scanning of maps, post-selection of maps, georeferencing, vectorization, comparison of maps, historical sync, generation of synthesis maps, and analysis (Figure 7). To implement the work, we chose to use the Arcgis.



**Figure 7 – Flowchart of the Stages of Work**

Within the idea of time cutting and, consequently, the relevance of events in selected periods, the maps were initially selected (Table 1). Aligned with the objective of the study, which compared the set of maps in the period from 1700 until 2000, it is emphasized, in Table 1, the lines that contain the post-selected maps. By considering the maps from 1700, the criteria had to be refined in order to facilitate comparisons that are part of the objective of the work. Accordingly, properties and minimum elements of the maps were prioritized: top vision or orthogonal projection, geometric shapes and well defined relative positioning between the features, presence well defined streets and shoreline; scale compatible with the detailed features of the Center of Rio.

**Table 1 – Pre-selected Maps**  
(the gray lines correspond to the post-selected maps)

Image/Map	Year	Scale	Resolution (dpi)	Observations
1. Chart of Jacques de Vaulx	1579	-	72	-
2. Chart of Luiz Teixeira	1586	-	600	-
3. Chart of Reys-Boeck	1624	-	110	-
4. Plan of Massé	1713	Fathoms	96	-
5. Plan of Roscio	1769	Fathoms	96	Figure 1
6. Plan ordered by Regent Prince	1812	Fathoms	96	-
7. Map of Downtown Rio	1838	Fathoms	72	Figure 2
8. Plan of Urban Improvements of the Mayor Pereira Passos	1906	1:10,000	72	Figure 3

Image/Map	Year	Scale	Resolution (dpi)	Observations
9. Plan of IPP	2000	1:10,000	- Not applied (vector) - Orthophotos correspondence: 300 dpi	- Ortofotos: Fig 4 e 5 - From the orthophotos, in 2000, IPP edited the plans in 1:10,000

For the georeferencing, the initial reference image was the vector of Plan of IPP, year 2000, since it was the most recent map and was already georeferenced. The procedure adopted went from the most recent to oldest map. Based on the assumption that the more recent maps have most accurate position than the older maps, it was expected that the errors propagated in the process were minimized. For georeferencing, two options for transformations were tested: affine and adjust. The control points were chosen from features that existed in at least two consecutive maps.

With the control points defined, the first Georeferencing could be initiated: raster image of the map of 1906 (slave image) to the image of the vector map of 2000 (master image). Using the affine transformation, which was the one with the smallest errors, after the adjustment, the total rms (root mean square) was of approximately 4.8 m. That is, less than the Class A planimetric standard accuracy of the mapping (adopted in Brazil), which is 0.5 mm on the scale of the map. The PEC (Standard of Cartographic Accuracy) is defined in Brazil (1984). In the case of Class A: 0.5 mm on the scale of 1:10,000 = 5 m.

By georeferencing the raster image of the map of 1838, using the map of 1906 as reference, there were hard difficulties to locate and identify points of control in the image of 1838, which probably caused the high value for the total rms (about 14.3 m).

About the points used for georeferencing the map of 1769, it was decided for the adjust transformation, which showed better results. As the total rms was less than 10 m, it is comparable to the PEC Class C (1 mm on the scale of 1:10,000).

After georeferencing the images of maps of 1906, 1838 and 1769, the vector digitalization was carried out.

The procedure adopted for the comparison of maps occurred as follows: comparison in pairs between vectorial subsequent maps, from the most recent to the oldest one. To make the comparisons and to generate synthesis maps, there was a continuous accompaniment of the bibliography in a process that was called Historical Sync.

### **Synthesis Map [1906 x 2000]**

The Synthesis Map [2000 x 1906] appears in Figure 8 and enables the comparison, through their cartographic representations, which are separated 94 years time. While the map of 1906 carries significant transformations captained by Mayor Pereira Passos, the

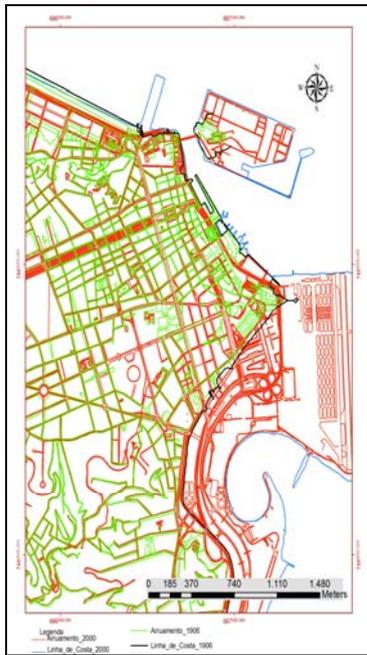
map of 2000 contains information of profound changes, which passed through the period of government of Mayor Carlos Sampaio, where it happened, for example, the dismantling of the Morro do Castelo and preparations for the celebrations of the centenary of independence in 1922. The aperture of Avenida Central and other events also occurred in this transition between 1906 and 2000. There was the landfill in the region where Santos Dumont Airport was later installed, the connection from Ilha das Cobras to the mainland, and the increase of streets density in the old Morro do Castelo region. A great amount of streets in 2000 could be observed. Through the analysis to the shoreline, there is the regular ground Santos Dumont Airport in 2000, the regular formation (by landfilling) of Ilha das Cobras and its connection to Ilha Fiscal.

### **Synthesis Map [1838 x 1906]**

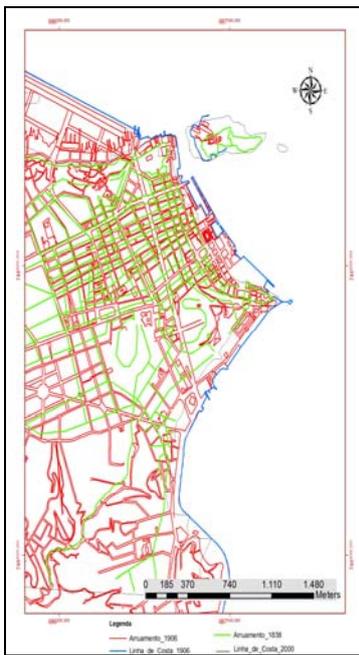
In this comparison, the center of Rio de Janeiro was the scenery for the great and profound changes taking place in Brazil, from Empire to Republic. The period separating the two maps is 68 years. Figure 9 shows a tangled network of streets denser. From the port zone to Gloria neighborhood, Avenida Central arises, constructed at the expense of demolition, which left as legacy the current Avenida Rio Branco. Significant changes are perceived in the shoreline, with respect to the port zone to the north, and some landfills to the east. Ilha das Cobras was not yet connected to the mainland or to Ilha Fiscal. Immediately northern to Campo de Santana, one can see where, around that time, the new headquarters of the Army was constructed. In the region of hills Morro do Castelo e Santo Antônio, the streets are still rare.

### **Synthesis Map [1769 x 1838]**

The Map Overview [1769 x 1838] is showed in Figure 10. The map of 1769 shows the urban concentration in the region between the hills Morro do Castelo, Conceição, Santo Antônio e São Bento. It can be also verified, by observing characteristic shapes, the presence of at least two fortress (Conceição and Castelo) and the design of the big wall that would serve to fortification of the city. The place where there was a fortress, to the southeast on the map, had no buildings around it, that is, Morro do Castelo is still imposing in the region. In 1838, an expansion to the west is already perceived, probably strongly influenced by the arrival of the Royal Family in 1808, to Brazil. There is also the continuation of the parallel streets, maintaining the existing order in 1769. The urban occupation is shown to set a direction and following a land use. Some representations of features from the map of 1838 could not be well converted into vectors due to the difficulty in identifying them in the raster image. Although the vectors are not well integrated, it is perceived that the shoreline has not changed significantly in that period. It is important for these two dates, the significant transitional period in which Brazil was. While in 1769 there was great concern about the protection due to threats of invasion by pirates or enemy nations, in 1838, the Brazilian Colony lived under the influence of the Portuguese Royalty, and then, the country experienced little more than a decade of independence.



**Figure 8**  
**Synthesis Map [1906 x 2000]**



**Figure 9**  
**Synthesis Map [1838 x 1906]**



**Figure 10**  
**Synthesis Map [1769 x 1838]**

From the synthesis maps, together with their analysis, a brief survey of the distances between the control points on vectorial maps was prepared and exposed in Table 2.

**Table 2 – Distances Between Control Points in Synthesis Maps**

	Point	Distance (m) 1906 x 2000	Distance (m) 1838 x 1906	Distance (m) 1769 1838 x
1	Mosteiro de São Bento	0.9	47.5	47.7
2	Igreja Nossa Senhora do Bonsucesso	1.3	94.9	-
3	Palácio Episcopal	0.6	-	-
4	Igreja Santa Cruz dos Militares	0.3	-	-
5	Capela São Francisco da Prainha	0.7	24.7	14.3
6	Ermida Igreja de Santa Luzia	5.8	206.0	145.0
7	Convento de Santo Antônio	3.3	-	-
8	Igreja Nossa Senhora do Carmo	2.7	-	-
10	Colégio Pedro II	8.4	15.0	18.0
11	Campo de Santana	0.2	24.6	189.0
12	Ponta do Calabouço	-	4.0	-

The necessity of scanning maps to be converted into vector in a resolution higher than 96 dpi was confirmed. Less than this, the location of control points is impaired, as well as the identification and vectorial digitalization of the features represented.

## CONCLUSION

From the history of Rio here reported, it can be highlighted from the text: the French invasions, the construction of fortifications to protect the city, the passage of the royal family in Brazil, the aperture of Avenida Central, the demolition of the Morro do Castelo, among others. But the paper did not threat only about recovering history of Downtown Rio from literature. It was concerned in large part about overcoming the challenges when dealing with maps of the most varied periods. Among the challenges, there is a lack of definition of scale, coordinate system, projection system and the low resolution of the scanning of some selected maps.

Even with the obstacles, we tried to achieve the objectives outlined initially. Thus, three synthesis maps were mounted, resulted from the comparison of the four maps selected. For the generation of synthesis maps, we chose to use the most recent map as a reference and compare them in pairs from the most recent to the oldest one. It was found that the historical maps can be compared, the spatial-temporal evolution can be reconstituted and the potential use of these results can be used in planning policy.

By considering historical facts and accompanying the expansion of streets, it was verified that there was an expansion of the urban network of downtown Rio. There was

a tendency for density at the center. This should serve as a warning of the need to increase, at least, infrastructure and sanitation. Regarding the shoreline, initially it was observed its extension, and then its stagnation.

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