

# THE TIETE RIVER STRAIGHTENING PROCESS AND ITS IMPLICATIONS IN THE CITY OF SAO PAULO, BRAZIL

## O PROCESSO DE RETIFICAÇÃO DO RIO TIETÊ E SUAS IMPLICAÇÕES NA CIDADE DE SÃO PAULO, BRASIL

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### ABSTRACT

This paper deals with the straightening process of the Tiete River in Sao Paulo, Brazil, which began by the end of the nineteenth century. It aims to detect the implications generated by this intervention. This study also brings up the relation of the straightening of Sao Paulo's rivers and the implementation of the automobile industry and the investments in a road plan to justify the construction of expressways on the banks of the Tiete River. It also speculates about the use of cars and the environment decay in the city due to the use of this type of transportation system. The article discusses mistakes that occurred in consequence of this process, concerning land occupation and the destruction of nature, which implies in urban and environmental problems to these days.

Key words: Tiete River. Urban drainage. River straightening.

### RESUMO

Este artigo trata do processo de retificação do Rio Tietê, em São Paulo, cujo estudo foi iniciado no fim do século XIX e busca detectar as principais implicações geradas por essa intervenção. Procura-se compreender como a retificação do Tietê atuou como parte do processo de urbanização acelerada, na qual os interesses imobiliários reforçaram os interesses da indústria automobilística recém-implantada, justificando a construção de avenidas marginais ao longo do rio retificado. No que diz respeito à ocupação do solo e à destruição da natureza, são discutidos equívocos e consequências desse processo, que acarretaram problemas urbanos e ambientais que perduram até os dias de hoje.

Palavras-chave: Rio Tietê. Drenagem Urbana. Retificação de Rio.

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## INTRODUCTION

From the second decade of the nineteenth century, a rapid urbanization occurred in the city of Sao Paulo, due to the development of coffee agriculture in the interior of the state. Soon, the urbanizable lands of the city were occupied to the limit of the Tiete River's floodplains and of its tributaries Tamanduatei and Pinheiros.

The industrialization process that occurred in the beginning of the twentieth century speeded up the urban expansion and, in a second moment, in the middle of the century, the automobile industry was established and, consequently, the need to expand the road system. The fast growth of the city was seen as a sign of progress and people believed that the development was to benefit the population. Thus, the impacting transformations of the urban site, deforestation, rectification and channeling of watercourses were justified in the promise of progress that would improve the living conditions of the population. As occurred in many cities worldwide, it was not until the 1960s and more effectively at the end of the twentieth century that questions began to emerge, to what extent technological development would benefit society as a whole.

It is ironic to remember that technical progress has appeared since the previous centuries as a condition for realizing this dreamed globalization with the most complete humanization of life on the planet. Finally, when this technical progress reaches a higher level, globalization takes place, but not in the service of humanity... Globalization kills the notion of solidarity, restores man to the primitive condition of every man for himself and, as if we were once again jungle animals, reduces notions of public and private morality to almost nothing (SANTOS, 2002. p.41).

The metropolis is the sad materialization of this reality. This text seeks to address issues related to the straightening of the Tiete River and its tributaries from the perspective of private interests, on the one hand, and the destruction of nature, on the

other hand. The Tiete River that, in the origin of the city, had a determining role, was being treated throughout the twentieth century as an obstacle to urbanization. Its floodplain underwent drastic interventions and the river was shortened to almost half of its original length along its course in the city of Sao Paulo. This process that brings together real estate interests, disrespect for nature and disregard for the leisure of the population are dealt with in this article.

## THE TIETE RIVER AND THE SAO PAULO URBANIZATION PROCESS

Until the end of the nineteenth century, according to the census of 1900, the city of Sao Paulo had about 240 thousand inhabitants, settled in the area circumscribed between the floodplains of the Tiete, Tamanduatei and Anhangabau rivers. From the first years of colonization of Brazil until the beginning of the eighteenth century, Sao Paulo was a place of barter, therefore without transactions with money, which gives an idea of the region's poor development. Economic activity was limited to the trade in cotton cloths, groceries, meat, wax and leather. Only in 1711 Sao Paulo was emancipated to the category of city. Its greatest importance was due to the strategic location between Minas Gerais state and the cattle ranches in the south and in support of the wealth-seeking routes, gold, in the interior of the country.

At the end of the eighteenth century, with sugar cane production, Sao Paulo became part of the colonial trade circuit. This is reflected in the configuration of the city:

Until then, the streets that were seen as a continuation of the houses, began to receive a type of finishing that gave them the condition of being regarded as a public place. In 1780, for example, "an edict was issued to make a stance defining that every person who had cars should give a carriage of stones to make the streets of this city."

Slowly, sidewalks, streets, alleys and utilities were delimited, also establishing the limits of public and private property, while the State rose as a “neutral” element managing the new urban space (SEABRA. 1987. p.27).

The Tiete, Pinheiros and Tamanduatei floodplains have been the natural and historical limits of this urban expansion since 1870s, when the city began to grow rapidly and needed to expand its territory beyond the central area (Fig. 1).

Since that time, the Tiete and the Pinheiros river floodplains, considered bad land for construction, began to be seen as an

area with potential for urbanization. However, major drainage works were required. The Tiete was a meandering river with an extensive flood area. The main economic activity that took place in the river was the extraction of sand. Its floodplain was sparsely populated. The few houses of the place suffered from annual flooding that brought garbage and unpleasant odor and consequently diseases spread out easily. Because of these facts, the residents of the floodplain were called *varzeanos*, a derogatory term used to name the poorest and dirtiest areas of the city. The floodplain was also where leisure activities took place, especially soccer, a sport introduced in Brazil in the late

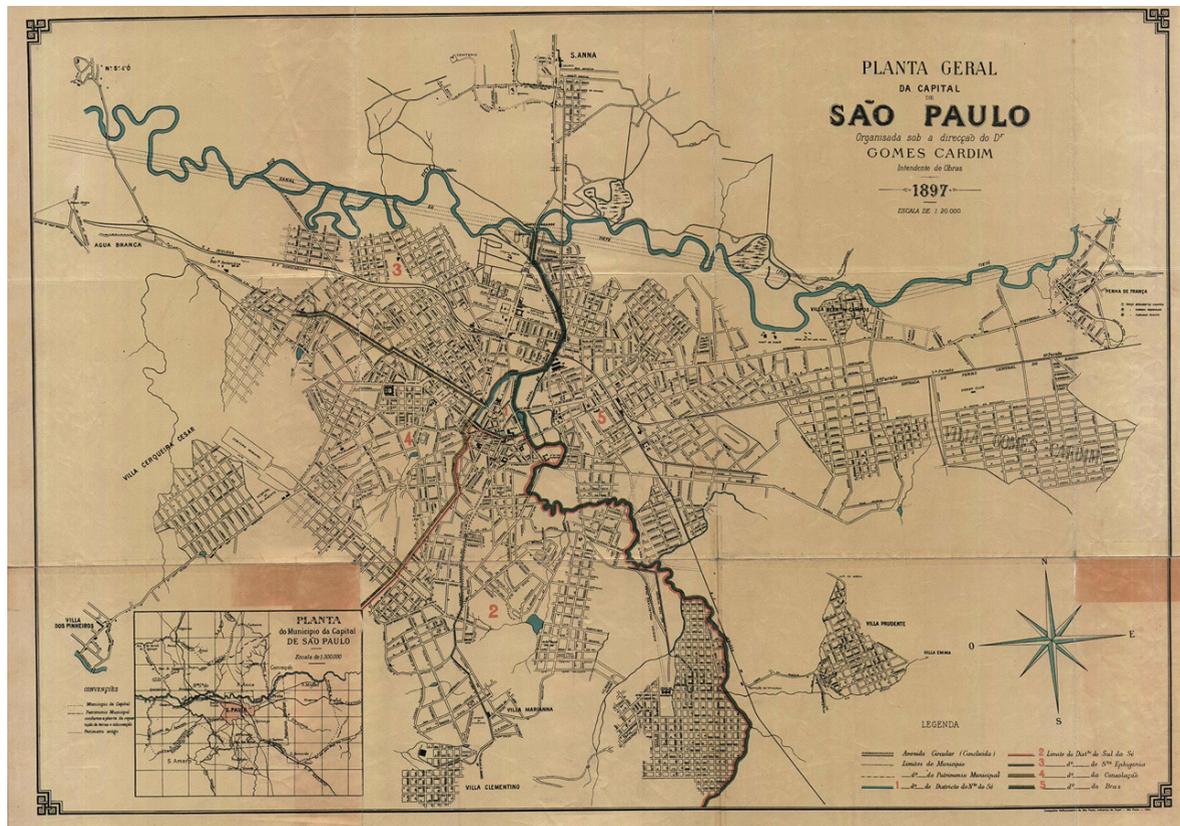


Figure 1. General plan of the capital of Sao Paulo, 1897, organized under the direction of Gomes Cardim. The plan shows the urbanized area of the city. Source: Paulista Museum, USP. Available in <http://www.arquiamigos.org.br/info/info20/i-1897.htm>. Access in: 03/06/19.

nineteenth century (SILVA, 2015. p.2) that had more than a thousand fields in the first half of the twentieth century.

In addition to the demand for urban sprawl, there were also serious sanitation problems to address. Although the main reason for the occupation of the floodplain was urban sprawl, the most frequently used justification for the river straightening was to prevent epidemic events such as smallpox, yellow fever, cholera, tuberculosis, bubonic plague and the Spanish flu that hit the city in 1918 (PORTA, 2003).

Although the source of the Tiete River is only 22 kilometers from the Atlantic Ocean, the river crosses the Sao Paulo Sedimentary Basin. Its course crosses the Atlantic Plateau and goes upon the interior.

... Ancient depression formed by the bottom of huge rock blocks through predominantly vertical movements. This depression was soon filled by sediments brought by Tiete and its tributaries (OHTAKE, 1991. p.36).

In the large and wide alluvial gutters of Tiete and Pinheiros, as well as along some of its main tributaries, there were, before the rectification services, drainage networks typical of heavily submersible threshold plains. From Osasco to Mogi das Cruzes, in the Tiete valley, as well as in Pinheiros, dominated the extremely winding drainage, with labyrinthine meanders. At various points, due to the profusion of meanders, meander lagoons, river islands established in ancient meanders, as well as slight stretches of anastomosed drainage, it was possible to recognize labyrinthine drainage (AB'SABER, 1958. p. 78).

The Tiete River was formed over a period of about 12 million years, over land of 20 million years in its most recent sections.

The report presented by the Tiete River Improvement Commission (created in 1924) exposes Tiete's behavior. Originally, except in the rainy season, the Tiete had moderate speed. In summer, when the volume of water increases, the water velocity also increases, causing erosion of the bed that, over time, generates

meanders formed by the removal of alluvial terrain. Often, after flooding, the river changed its course, tracing a new design and thus forming islands.

The rapid expansion of the city of Sao Paulo was marked, from the beginning, by strong land speculation. Land legislation in Brazil at the end of the nineteenth century, regulated by the Land Law of 1853, did not restrict the weight of urban land ownership by charging higher taxes for undeveloped land, for example. In countries such as France, Italy, Argentina and the United States, land legislation recognized the valuation of urban properties resulting from public investments and sought to restrict them by curbing speculation, that is, by levying property taxes. In Brazil, the ownership of urban land gained in the productive process of the city without encountering obstacles. Odete Seabra interprets this process as a consequence of the absence of conflicting interests between the various segments of society:

While in other countries it appeared clearly that the legislation itself was a conformation of a conflict of interest, in Brazil and, more especially in the case of Sao Paulo, the lack of legislation may indicate overlapping roles. That is, landowners are both urban landlords and legislators. Thus, the formation of an advantageous urban circuit of appropriation of social value would not have caused them any panic (SEABRA, 1987. p.21).

As early as the end of the nineteenth century, the straightening of the rivers Tiete and Pinheiros was studied, under the justification of sanitizing the city. The first records showing the convenience of draining the Tiete floodplain date from 1866 and indicate the intention to use this land for the growth of the city. The first river rectification projects in the city of Sao Paulo were carried out from 1842. The first river to be rectified in the city was the Tamanduatei (JORGE, 2017. p.25).

At that time, rivers were also used for sports, with clubs on its banks. This was the case of the Pinheiros Club (then called Germania) in the Pinheiros River and the Tiete Regattas, the



Maia also advocated the idea that the center should have an ease communication in all directions. He proposed adaptations to the existing road system whenever possible, thus avoiding costly expropriations that would only benefit future generations.

The connection of the radial system is through concentric road rings to the city center: the perimeter. These roads connect the neighborhoods. The outermost perimeter is defined to the north by Tiete and to the west by Pinheiros, where there would be avenues along the banks, similar to the Seine River boulevards in Paris (Fig. 3).

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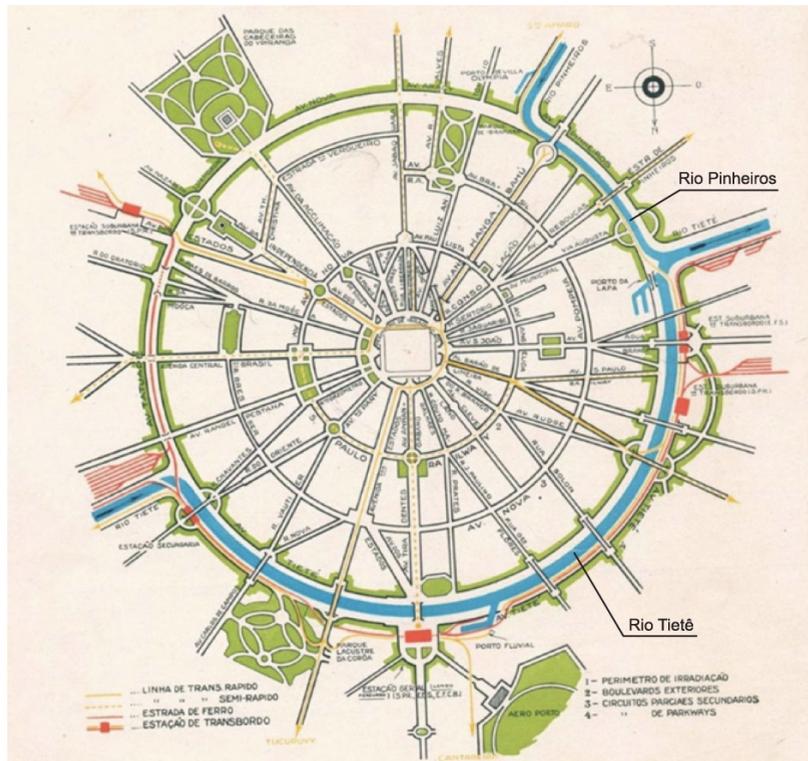


Figure 3- Diagram of the Avenue Plan. Source: Study of an Avenues Plan by Francisco de Prestes Maia, 1930.

By the late 1930s, little of the plan had advanced in relation to the implementation of the Avenues Plan. Six months after the coup of the *Estado Novo*, Prestes Maia was appointed mayor of São Paulo by the then governor, Adhemar de Barros. Only then was the Avenues Plan used as a guideline for the development of the city. The avenues Anhangabau and Itooro (today Nove de Julho Avenue), 23 de Maio and Prestes Maia avenues, the Consolação-Rebouças axis, Radial Leste were built, among others. The perimeter avenues Tiete and Pinheiros, as conceived in the plan, a boulevard along the river, were never executed.

Another study that recommended the Tiete River straightening, floodplain sanitation and urbanization was the Moses report, conducted by the IBEC (International Basic Economy Corporation) in 1950, during the administration of Lineu Prestes, appointed by the then governor, Adhemar de Barros. The study was directed by Robert Moses, a New York engineer and lawyer, who had extensive experience in urban planning in New York. The report proposed the development of the suburbs, connecting them to the center through expressways, following the United States freeways model. The study also recommended that the Pinheiros River should be rectified by the Light Company in a public-private partnership where Light would receive a portion of land along the river as a payment to its investments. This type of partnership was an innovation that had already been tested in North America (SOMEKH and MALTA, 2002. p.85).

The drainage of the floodplain and the rectification of the rivers made it possible to create urban land with ample profit opportunities for investors. At the time, there was no legislation and tax fees that prevented the accumulation of vacant land by the same owner, which favored real estate speculation.

The Tiete River Improvement Commission, created to study the problems of the Tiete and Pinheiros river floods and propose solutions, presented the Tiete River straightening project, coordinated by sanitary engineer Francisco Saturnino Rodrigues de Brito, which included a park and two lakes of one million square meters of surface each for water level control (Fig. 4).

This project was not executed and, in 1929, Saturnino de Brito presented to the Sao Paulo City Council a report on the Tiete and Pinheiros rivers regularization plan. In this report, he criticized the interruption of the observations initiated by the Sanitation Commission in 1893, headed by the engineer José Antonio da Fonseca Rodrigues, and the lack of further hydrological studies.

Although the drainage of the Tiete floodplain was urgent due to the unhealthiness of the area, the rectification works were postponed many times. The 1929 World Crisis and the 1930's Revolution delayed their beginning. From 1937 on, João Florence

de Ulhôa Cintra was responsible for the studies of rectification of Tiete and his project, named Cintra Project, was executed, having the works carried out in the 1950s and 1960s. The project foresaw the channeling and deepening of 4 meters of the river quota in the portion between Guarulhos and Osasco, that is, in the portion of the river that was within the municipality of Sao Paulo. The two dikes proposed by Saturnino de Brito were not executed because, according to Cintra, they could break and cause a devastating flood.

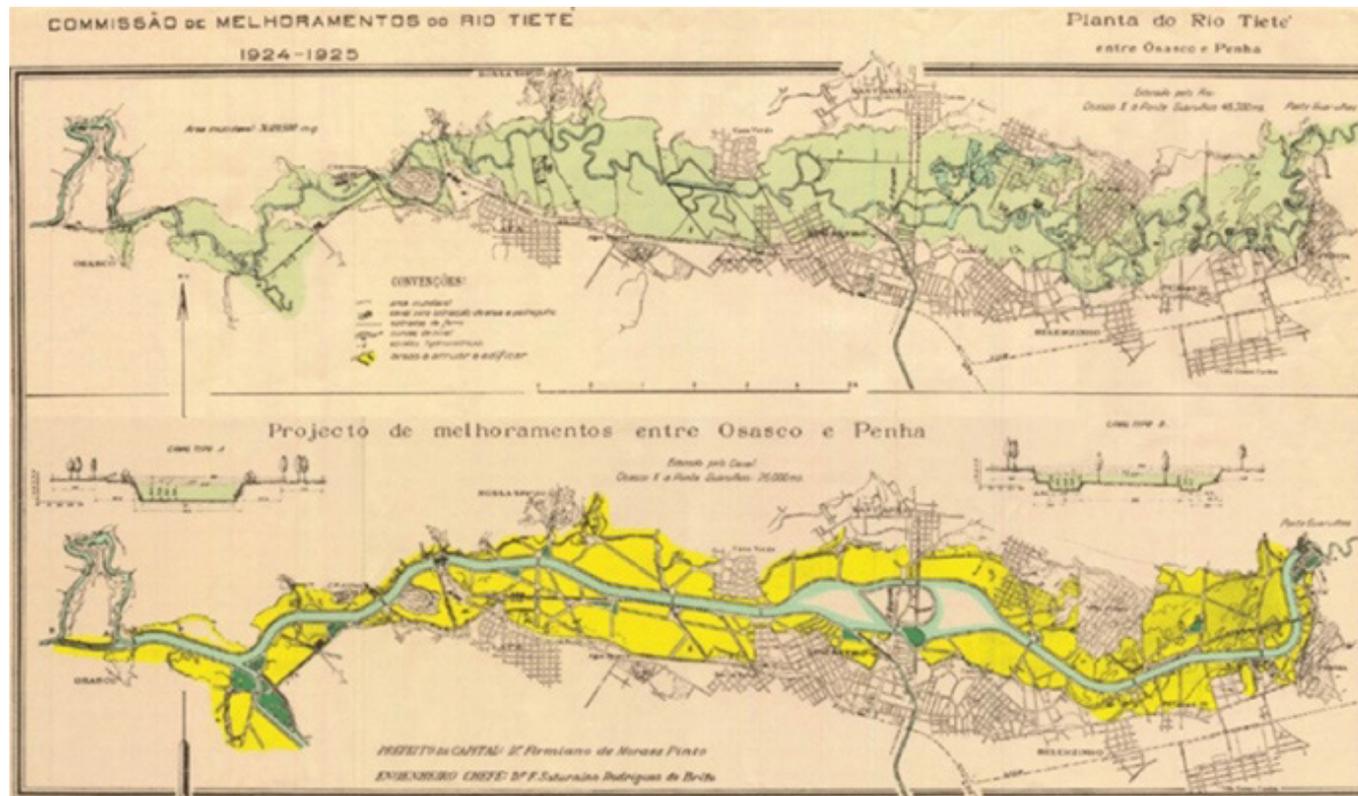


Figure 4- Project carried out by Francisco Saturnino Rodrigues de Brito for the Tiete river. Source: Benedito Lima de Toledo-Prestes Maia and the Origins of Modern Urbanism in Sao Paulo, 1996.

## THE WORKS FOR THE STRAIGHTENING OF THE TIETE AND PINHEIROS RIVERS

The Tiete rectification work was carried out with public funds. The floodplain area was, over time, being used for projects of public interest, such as the Tiete Bus Terminal, the accesses to bridges and the construction of the Santa Casa (now occupied by the Barra Funda Criminal Court), but also for other purposes, such as the Anhembi Convention Center.

The main purpose of the Pinheiros River straightening was to produce electricity. The Canadian company Sao Paulo Tramway, Light and Power Company, known as Light, which already produced electricity in Sao Paulo, carried out this work. The Light Company received, in exchange for the execution of the work, the lands below the maximum flood quota of the Pinheiros River and was allowed to negotiate them freely. After the rectification, even the Sao Paulo State Government had to acquire land from the company to carry out the marginal and CEAGESP (Sao Paulo State Warehouses and Warehouses Company) (SEABRA, 1987. p.174). The rectification of rivers was considered the best alternative to solve flood and unhealthy floodplain problems. Undoubtedly, this alternative favored the Light more, as it had its investment highly rewarded.

Concerning the rapid growth of the urban population of Sao Paulo and the emergency of floodplain sanitation works, other alternatives could have been adopted. It would be possible to drain the river floodplain without drastically altering it. Another possibility would be to create a proper sewage collection and treatment system and, at the same time, to densify the existing urban area, leaving the floodplain unoccupied. It is worth remembering that the city had a very low density at that time and, even with the rapid growth that occurred in the early twentieth century, kept density far below other metropolises. Another possibility would be to amend the Land Law to prevent the valorization of the floodplain lands and thus avoid its speculation. (LANGENBURCH, 1971)

The issue of floodplain drainage presented incompatible interests. It was necessary to keep the rivers and dams at a very low level, so that the soil was always drained. However, for power generation and its commercialization, Light intended to keep the dams always full.

In his report, Saturnino de Brito draws attention to the influence of Light's dams on the river regime, recommending the lowering of one meter of the Paraiba Dam maximum quota.

A technical possibility of regulating the river regime could be to retain part of the volume of water in the headwaters during the rains, to release them gradually in the dry months of the year. This would not, however, suppress works on the riverbed, but could make them less costly. This possibility was even discussed, and even the Light Company, which was interested in installing the Sao Paulo hydroelectric system, would have obtained a concession in 1925 to carry out these impoundments. This project was abandoned and another alternative was defined (SEABRA, 1987. p.27).

The Decree 4487 of November 1928 granted Light the lands of the Pinheiros River floodplain, establishing that the granted area corresponded to the maximum flood. There were no records of such a maximum quota of the river, so it was necessary to delimit the flood level of the Pinheiros and Tiete rivers. For this purpose, the flood that occurred shortly thereafter in February 1929 was used. This was the worst flood ever, and the waters reached a level of 720.55 meters at the Bandeira Bridge. The Tiete River and the river mouth, where they were measured, registered quotas never reported before. The maximum quota recorded until then was about 719.80 meters. Apparently, this flood was criminally manipulated by Light, to ensure a vast area of floodplain and consequent appreciation of the company's investments (SEABRA, 1987. p.54).

Rainfall was intense in the city of Sao Paulo at the beginning of 1929. However, in February, when the Tiete and Pinheiros

rivers flooded, the rainfall was lower than in January. Rainfall, in the first half of February, had not been worrying, especially in the days before the floods. In the period between the 15th and 20th there was a drought period with sunny days. The day in which the greatest flood occurred was February 18, few days after the rain ended. Even with several consecutive days of sunshine, the water level remained high (SEABRA, 1987. p.55).

The flooding of the Tiete, Tamanduatei and Pinheiros rivers hit the neighborhoods next to the rivers. Hundreds of families were forced to leave their homes. The scenery was devastating. It seemed that the flood was caused by the Light dams. The headlines of the newspaper highlighted this fact, as was the case of the newspaper "O Estado de Sao Paulo" of February 16, 1929, which said: "The waters of the Light dams invaded Santo Amaro" (at that time, Santo Amaro was a municipality neighbor of Sao Paulo). Light did not comment on:

The silence of the Light Company, though frightening, also had a reason. If some discussions were held, correlations could easily be made between the Decree 4487 of November 1928 and the Company's need to demarcate the boundary of its jurisdiction on the ground. According to clause XX of the Decree 4487: "...but before conducting the pipeline works of the Pinheiros River and its tributaries, the Company shall submit to the Government for approval the plant of the area to be expropriated with indication of its limits, as well as the detailed design of the sanitation works or the benefits to be realized in this area..."

This seems to be the fundamental issue that ensured as wide a land area in the floodplains as possible over which it would exercise the rights contained in the obtained Concession.

...What actually happened was that on the second rainy day (14<sup>th</sup>), the flooded dams were opened and from the region of Santo Amaro, a wave of floods spread over the

existing waters in the Pinheiros floodplains and reached, by delayed effect, the Tiete River (SEABRA, 1987. p.191).

The City Company, an English allotment enterprise, responsible for several land subdivision projects in the city and for the creation of neighborhoods such as Jardim America and Jardim Europa, owner of expropriated land, questioned the demarcation of Light. The company questioned the legality of using the 1929 maximum flood quota and also raised the suspicion that the flood could have been caused on purpose. Later, the City Company made a deal with the Light Company and obtained part of the expropriated land.

The Light Company had a significant gain from its investment by collecting the energy produced and by selling the land, valued by the Pinheiros rectification works, drainage and sanitation. In addition, it profited from the growth of the city, which was undergoing a moment of great expansion (PESSOA, 2006. p.115).

## THE IMPLEMENTATION OF THE MARGINAL TIETE AND PINHEIROS AVENUES

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The beginning of the activities of the automobile industry in Brazil occurred concurrently with the planning of the Tiete drainage and the implementation of the national road plan, initiated under the Dutra government in 1945, when Sao Paulo had a population of about one million inhabitants. At that time, public transportation predominated in the city, especially trams. Cars were scarce. The city's population grew rapidly, reaching 4.7 million inhabitants in 1960 and 8.2 million over that decade.

The road plan would encourage the acquisition of private cars and, in 1968, the federal government created legislation for the purchase of cars through consortium, thereby ensuring the outflow of the vehicle production. The implantation of the automobile industry in Brazil occurred in this scenario and it was clear from the beginning the aim of making the acquisition of the automobile accessible to a considerable part of the population.

In the beginning, industrialization in Brazil was concentrated in the City of Sao Paulo and in adjacent cities, which were rapidly growing and forming a troubled area. Automobile production grew, especially in the area where it was produced, which caused a major impact on the city of Sao Paulo, whose road network did not support the large increase in vehicles in circulation.

The floodplains of the rivers, then supposedly free of flooding, were possibilities for connections from the east and west of Sao Paulo - in the case of the Tiete floodplain - and from the north and south - in the case of the Pinheiros floodplain. The rivers, which until then were considered obstacles by the decision makers of the city design, would serve to implement a road system, connecting the extremes of the city of Sao Paulo.

The road system was placed very close to the channels, leaving no free areas that could be used as river enjoyment areas (Fig. 5). Thus, these rivers were confined between express avenues, without any condition of use by the population for nobler uses as, less than a hundred years before, seemed to be their vocation: the practice of sports, fishing, leisure.

### ENVIRONMENTAL IMPACTS DUE TO THE STRAIGHTENING OF THE TIETE AND PINHEIROS RIVERS

With the straightening of the rivers, more than one thousand soccer fields - the cradle of Brazilian soccer culture - the regattas clubs and boats disappeared due to the industrialization force, the necessity of electric power generation, the imposition of the production flow of high-speed lanes that connected the various roads that depart from the city of Sao Paulo.

Despite the straightening and increase of the Tiete River channel, flooding continued to occur. In 1963, a parliamentary committee was established to evaluate the rectification work. A problem that still remained during the construction of the channel was the siltation of the river, which received large volumes of waste. The environmental damage caused by the Tiete rectification is



Figure 5- Tamanduatei and Tiete River meeting, showing the Marginal Tiete Avenue. Photo- Agnaldo Bertolo, 2008

intense. On the one hand, due to the knock-off of the material removed, which is a problem of great magnitude; on the other, the problems generated by this practice, such as the cost of transporting the river debris and the environmental deterioration of the area where this material is disposed of.

In Sao Paulo, there was an accelerated urban growth that aggravates the deterioration of the environment. The new buildings completely or partially waterproof the soil, which makes that rainwater, that previously infiltrated into the soil, would be taken directly to the watercourses. The population, which at the beginning of the rectification works was about one million inhabitants, was multiplying to reach more than 12 million inhabitants today (IBGE, 2017). It passively witnessed changes and losses, unaware of the urban degradation that occurred.

In 1999, the City of Sao Paulo reached a ratio of two inhabitants per vehicle, accounting for more than five million vehicles. Investments by state and municipal governments in public transportation have been insufficient. Sao Paulo still does not have the complete subway network today, with only a few lines, insufficient for the transportation of the population.

The urban area continues to grow. The value of property in areas with good infrastructure continues to rise, which forces people to live in the periphery, making the car more and more desirable. Most of the routes take place on the banks of Tiete and Pinheiros, which impedes the possibility of the river recovery from being envisioned.

After the Tiete rectification, the water velocity was increased because the meanders, natural decelerators, were eliminated. In addition, the increase in water velocity causes a deposit of the solid material brought by the river, which reduces channel flow, favoring flooding. In other words, the river seeks to return to the original path, chosen by nature; changing its natural condition causes environmental imbalance, because the river will always be trying to return to its course, defined over millions of years.

River clearing needs to be done around the clock so as not to aggravate the problem caused by flooding. The straightening works were made to drain the floodplain, however, to this day, this has not been fully achieved.

The Tiete new canal, shortly after its construction, had insufficient flow. The original river flow was 330m<sup>3</sup> / sec, reaching 440 m<sup>3</sup> / sec after the rectification works. In 2002, another work began to increase the river channel, resulting in a flow of 1048 m<sup>3</sup> / sec (Jornal O Estado de Sao Paulo, 10/31/2002, C3). In this work, besides the increase of the river gutter, a lock was built in the mobile dam under Cebolao, a road complex on the confluence of the Pinheiros and Tiete rivers. The flow of water in Tiete keeps growing and, as a consequence, urban problems grow.

Almost all of Sao Paulo urban area is inside the Tiete River Basin. Prior to rectification, the river received the contribution of rainfall from its basin and part of the sewage from the metropolitan area of Sao Paulo. Large amounts of rainwater were absorbed by the soil, as the city had a large permeable area, with many unpaved streets, vacant lots, house gardens, etc., so that rainwater reached the river in substantially the same amount as the river received in its original state.

Today the population of Sao Paulo exceeds 12 million people without efficient criteria of environmental planning. The constructions were made waterproofing almost the entire area of the lots. The paving of the streets also drastically reduced the permeable area of the city. Therefore, a large portion of rainwater, previously absorbed by the soil, began to flow directly and faster into the city's watercourses. Urban growth had another impact: water catchment to supply the city in other, more distant, basins. The Piracicaba River, outside the city of Sao Paulo, provides about half of the water consumed. This water is depleted in the Tiete River, which considerably increases its flow. These factors have led to environmental problems and irreversible damage.

## CONCLUSION

The intense occupation of Sao Paulo and the lack of a counterpoint that balances the strength of the real estate market and the interests of the society, as well as the absence of conflicting interests between legislators and construction entrepreneurs, were a favorable scenario for making profits without encountering barriers that would prevent their free action. Real estate speculation, mainly exercised by the Light Company, benefited from this lack of antagonistic interests and the connivance of the state. In the same way, the automobile industry, newly created at the time of the Tiete River straightening, had a great influence on the urbanization of the floodplains, creating a design compatible with the use of the automobile and, consequently, with the car production sale.

The lack of concern with the environmental and landscape impact of works such as the marginal avenues of Tiete and Pinheiros, that frequently occurred last century in cities undergoing industrialization, contributed to the lack of appreciation of the integration of the city with rivers on the human scale, where people could continue to enjoy the direct contact with its banks, which was in its origin, an aspect so valued in the life of Sao Paulo. This mistaken design has negative consequences to the present days, since it practically precludes another design that allows people to access the rivers to use their floodplain as an area of recreation and contact with nature.

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