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Depollution of Rivers and Lakes

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Abstract
The need to control pollution is a relevant environmental issue in Brazil, and in the world. Population growth demands a greater exploitation of natural resources, in many cases, above the natural recovery capacity of ecosystems. The decontamination of a river or lake involves, among other forms of intervention, the management of sanitation services, thus allowing the qualitative improvement of water resources. The progressivity of the supply of sanitation infrastructure will allow the attendance of the regular areas with collection and treatment of sewage. On the other hand, in order to achieve their goals, it is also necessary to address the social issue, the precarious housing, and especially the irregularly settled ones, which demand greater efforts to provide sanitation services.

Keywords: Water body. Pollution. Lakes. Rivers

1. Introduction

Pollution of water resources is a relevant environmental issue in the world, among many reasons, due to the exponential growth of the population, which requires intensive and progressive exploitation of natural resources, in many cases, above the natural recovery capacity of the ecosystem. (UN, 2010)
Different techniques to control the pollution of water resources can be employed, varying according to the characteristics of the site to be decontaminated, depending on the material resources and the degree of pollution observed, among other factors. The level of urbanization and structuring of the supply of sanitation services, the distribution and volume of population in the territories, topography and geomorphology, the nature of the economic activities developed in the river basin, and finally, the institutional articulation involved in the treatment of the issue are Important when thinking about solutions to the problem of pollution, especially in the case of large urban centers. (SSRH, 2017)
The conventionally adopted way to control pollution consists in the adoption of water infrastructure, initially due to the need for food safety and health, followed by the supply of sewage collection networks to protect the population from direct contact with Generated effluents, both of residential origin, as well as commercial and industrial origin. At the same time or later, sewage treatment plants with secondary treatment level (to remove organic matter) and later tertiary (for nutrient removal) are installed. (SSRH, 2017) Industrial effluents, when more polluting than domestic ones, must be treated at their place of generation or transported to treatment centers, thus enabling their disposal in accordance with State Law No. 997 of May 31, 1976. (São Paulo, 1976a)
The law provides for the control of pollution of the environment.(São Paulo, 1976a) It

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was the result of the evolution of a set of norms, that consolidated in the decade of 70, served for the orientation of the federal normatization. This law was regulated by Decree No. 10.755 of November 22, 1977, which establishes the framework of water bodies receiving the State of São Paulo in the priority classes of priority uses according to the classification provided for in Decree No. 8.468 of September 8, 1976. (São Paulo, 1976b)
Pursuant to State Law 997 and Conama Resolution No. 357 of March 17, 2005, as amended by Conama Resolution No. 430/2011, it provides for the classification of water bodies and environmental guidelines for their classification, as well as establishing the conditions and standards of effluent disposal, and other measures. Water is part of the federal regulations regarding water quality control in Brazil. In the same way that the legislation of the State of São Paulo establishes criteria for the framing of water bodies. (MMA, 2005)
In the impossibility of establishing an infrastructure to provide sanitation services, in a short time horizon that occurs as a consequence of the various steps involved and the characteristic robustness to the equipment, it is possible to make use of techniques to reduce the pollutant load of the resources water. (SSRH, 2017)
The localized techniques may also be useful for the control of the remaining pollution after the installation of the sanitation infrastructure, in cases where there is concentration of pollutants in the bottom mud of the water bodies, being able to be resuspended. (Horwood et alli , 1991)
The objective of this study is to compare interventions in water resources with a view to the decontamination of rivers, using the cases of the Tietê rivers in the State of São Paulo, in the rivers Sena and Thames, clearly considering the existing differences in social, economic and environmental scenario.

2. The Depollution of the Rivers Seine and Thames

The river Seine is one of the most important rivers in France, and supports extensive industrial and commercial activities as well as intensively farmed agricultural land. Policies related to the management of water resources in the countries of the European Community have led to the improvement of water quality. In the study titled, reductions in phosphate and ammonium pollution have been identified, increasing oxygen concentrations, however, nitrate concentrations are still higher than those recommended for good freshwater status, despite substantial reductions in excess nitrogen in agricultural land in recent decades. (European Commission, 2016)
In Paris the three Water Laws were promulgated respectively in the years 1964 to 1992 and 2006. The Law of December 16, 1964, which organized decentralized management of water abstraction, created the water agencies and basin committees. The Law of January 3, 1992 consecrates water as a "common patrimony of the nation." It created the need to protect the quality and quantity of water resources. Created new tools for water management by SDAGE basin and SAGE *schémas D'aménagementet de Gestiondes Eaux-SDAGE - Water Development and Management Plan. La Loi surl'Eau et les Milieux Aquatiques (LEMA)* the Law on Water and Aquatic Environments of December 30, 2006, follows from the European directives, including the *Directive Cadre surl'eau (DCE) - Water Framework Directive*, transposed to the French law by the Law of 21 April 2004. The

Directive organizes in particular water management largely inspired by what has been done for decades in France. With the LEMA came the royalty rates, where charges for water use began. (Eaufrance, 2006)

The public policies represented by the three Water Laws influenced the water quality of the Seine. They have established the use of the *European Environmental Quality Standard (EQS)* concentration ranges and water status related categories of the *Water Framework Directive (WFD)*. Improvements in water quality were observed, mainly by reduction of phosphate and ammonium loads in the river, with a considerable increase in oxygen concentration and lower levels of chlorophyll and an almost total absence of summer algal blooms in the estuary. (European Commission, 2016)

According to Machado e Benjamin (1993):

"The application of the polluter-pays principle presupposes the public's awareness that it has been badly damaged by the 'internalization of profits and the externalization of costs'. (Machado, 1993)". "It states that the polluter pays principle is that which imposes a duty on the polluter to bear the costs of preventing, repairing and repressing pollution. That is, states that the cause of pollution and degradation of natural resources should be the main responsible for the consequences of its action (or omission). (Benjamin, 1993)

Treatment of the Thames began in the mid-nineteenth century after the introduction of sanitary facilities and the abolition of the cesspools. All London sewage was drained untreated to the Thames, this event gave rise to the famous summer of 1858, it was the year of the *Great Stink*, the Parliament had to install curtains soaked in lemon on Your windows to diminish the unpleasant odor. In order to remedy the situation, a combined sewer and rainwater system designed by Lostph Bazalgette, were built in London sewage stations downstream of the city were built in Beckton and Crossness. (Environment Agency, 1997)

There has been a significant investment since the 1950s for the advancement of leading *Sewage Treatment Works (STWs*) where it has resulted in considerable progress in water quality. Reflecting on the fish population, including the salmon return, the increasing use of the Thames estuary by fishermen, recreational craft and windsurfing and the prestige nature of the river's evolution. (Environment Agency, 1997)

In London the 1951 Rivers (Pollution Prevention) Act provided new powers for the River Boards through the 1948 Act and Conservation Recovery Councils. The law ordered new trade unloaders or sewage effluents for inland waters to achieve "discharge consent" from river authority. From this legal document were established limits on the nature, composition, temperature and volume of the effluent allowed to be discharged, with the law in force were applied in the new discharges into inland waters and discharges to estuaries and coastal waters remained exempt from regulation. (Environment Agency, 1997)

The Pollution Control Act of 1974 is the most significant legislation for the *Control of Pollution Act (COPA)*, 1974. It controls new and current discharges into the interior, underground, tidal or coastal. COPA introduced public participation in decisions, established public records of information and allowed private processes that were previously effectively excluded. (Environment Agency, 1997)

Law 1989 Water and Water Resources, the *National Rivers Authority (NRA)* was defined under the 1989 law. It was amended by the *Water Resources Act (WRA)*, 1991, which

established changes arising from the Environmental Protection Act And all other water laws prior to 1989. The NRA duties specified in the WRA have led to the achievement of water quality objectives and pollution assessment in controlled waters. This Law shall comply with the consent rules for the discharge of commercial or sewage effluents to controlled water. (Environment Agency, 1997)

National legislation was progressively enlarged and strengthened, the United Kingdom joined the *European Economic Community (EEC)* in 1973, now known as the *European Union (EU),* to establish the legislative program recognized the global impact of pollution as well as economic aspects Of different effluent standards applicable to "competitors". Determines a system of directives that require Member States to meet certain environmental and discharge standards. (Environment Agency, 1997).

In relation to these experiences, we can observe that the countries where these experiences occurred do not have the urban complexity, for example, of the Paulistana Macrometropole. The whole of the United Kingdom is in the State of São Paulo, which indicates a greater spatial complexity in the management of water resources in the State of São Paulo.

3. Depollution in the State of São Paulo

The decontamination programs in the State of São Paulo presented measurable results so that the perspective of environmental improvement was consolidated as permanent. However, in urban centers, urban complexity interferes with the speed of response of government enterprises, which are financed by national and international sources. (SSRH, 2017)

Sewage treatment is progressively implemented, while the possibilities of localized treatment solutions in the rivers themselves are observed in the light of the best application of the resources (SSRH, 2017). This is due to the perenniality necessary to install infrastructure that tackles the causes, not the consequences as a priority.

3.1 Pollution Control Legislation

Brazilian environmental legislation is quite sophisticated and old, and has elements that help in the structuring of functional policies and the permanent search for environmental sustainability.

Among the main legal instruments originated from the search for environmental health, we can highlight Law 6.938 of August 31, 1981, which establishes the National Environmental Policy (PNMA) (Brazil, 1981) and Decree No. 99.274 of June 6 which regulates it. Among the guidelines established by it are:

- The establishment of environmental quality standards;
- The assessment of environmental impacts and;
- Licensing of polluting activities.

The State of São Paulo was a pioneer since, since the 1970s, it has had bold legislation to control environmental pollution, which has served as a guide to pollution control programs that have existed in the country since then.

These legal instruments aim to control the discharge of sewage treated in the water bodies considering the preservation of the same with respect to aesthetic parameters,

aquatic life and public health according to Conama's resolutions.
The Forest Code, established by Law No. 12,651 / 2012, amends Laws 6.938 / 1981, 9.393 / 1996 and 11.428 / 2006, repeals Laws 4.771 / 1965 and 7.754 / 1989, Provisional Measure No. 2.166-67 / 2001, Item 22 of item II of art. 167 of Law 6.015 / 1973, and § 2 of art. 4 of Law no. 12.651 / 2012 and modified by Law 12.727 of October 17, 2012, establishes general norms on the protection of vegetation, Permanent Preservation areas and Legal Reserve areas; Logging, supply of forest raw material, control of the origin of forest products and control and prevention of forest fires, and provides economic and financial instruments to achieve its objectives. (Brasil, 2012a) The Permanent Preservation Area is a protected area, covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability and biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and Ensure the well-being of human populations. (Brasil, 2012b)
An example of the long tradition of preservation legislation in Brazil is the Water Code, which has been in force since 1934 through Federal Decree No. 24.643, which among other things regulates the occupation of the banks of streams and rivers and the preservation of their springs, which must be Preserved. (Brasil, 1934)

4. The Case of the Tietê River, São Paulo (Brazil)

Photo 01: Delfim Martins

Comparing the projects of the Rivers Sena and Thames and Tietê in Brazil, common points are observed, as they all cross large urban centers. In the case of the Tietê river, one of the largest urban centers is the Macrometropole Paulista, receiving an expressive load of pollutants in this stretch, which is characterized as one of the densest urban regions of the planet.
The Tietê River rises at an altitude of 1.030 meters from the Serra do Mar, in the São Paulo municipality of Salesópolis, 22 km from the Atlantic Ocean and 96 km from the capital, and travels more than 1.100 km to the Paraná River. It is used as an important means of transportation, and remains an object of tourist activities, in Barra Bonita its

biggest attraction are the walks to the lock. (DAEE, 1996)

"To tell their story, we must first remember the evolution of São Paulo ", as the historian Fausto Henrique Gomes Nogueira says: São Paulo and the Tietê are closely linked by history, geography, culture, and also by difficulties. Of the city is a fundamental person during the economic periods of the flags, monsoons, of the coffee-growing and the industrialization. (DAEE, 1996)

The decontamination of the Tietê river is a long-term project and, in order to achieve its objectives, it is also necessary to address the social issue. Precarious housing, and especially those set up irregularly, call for greater efforts to implement sanitation systems. (SSRH, 2017)

In the case of irregular occupations, actions related to urbanization may be initiated only after regularization. Since this is a chronic problem in the metropolis of São Paulo, only the treatment, in the first instance, of the social question and its legal aspects will enable the full care of these populations. (SSRH, 2017)

The Tietê Project, financed by the Inter-American Development Bank (IDB), began in 1990, had the section with the highest concentration of organic load extending 530 km from Mogi das Cruzes to the Barra Bonita reservoir at the end of 2010, at the end of 2010 After the end of the second stage of the project, it was adopted as a zero mark for the monitoring of the current and future stages. The stretch of the dead river comprised an extension of 243 km, from Suzano to Porto Feliz. The 25-year mobilization for the Tietê's recovery resulted in indicators measured by the company that show positive results. (SSRH, 2017)

There were significant reductions in the pollutant loads affluent to the Tietê River and in the control of industrial pollution, as well as the reduction of tons of untreated sewage that were dumped directly into the rivers of the Tietê basin. However, the urban complexity, the need for a long perspective for the execution of the established plans and the irregularities observed in the fulfillment of the plans of use and occupation of the soil, causes the results to be distributed over several time horizons. (SSRH, 2017)

In 2015, the best rates of removal (and reduction) of organic load were in the Water Resources Management Units - UGRHIs of the Rio Grande do Sul Hydrographic Region: 15-TG and 08-SMG, with 82% and 81% of the Effectively reduced sewage, respectively. (SSRH, 2017)

Of the streams recovered from the Clean Stream Program we have the Mandaqui, in the North Zone, where the Basic Sanitation Company of the State of São Paulo (Sabesp) carried out a 440 km sweep of sewage collection networks, pointing out repairs, for improvements and locating clandestine launches, installed 10 km of pipelines for sewage collection and sewerage, and executed 455 new home connections. The state government invested R $ 18 million to manage 40 km of water courses, 7,5 km of Mandaqui and 33 km of its tributaries. (SVMA, 2017)

The Cruzeiro do Sul stream, in São Miguel Paulista, East Zone, has 18 km of sewage collection networks, where sweeps were also carried out in its extension, for the treatment of the stream were installed 3,5 km of network for collection and removal of Sewage and 596 new sewage connections. The state government invested R $ 3.5 million, to get more than 2 km of water courses to the Tietê river, the 35 thousand residents were benefited. (SVMA, 2017)

The decontamination of the streams Riacho do Ipiranga and Stream dos Freitas beyond their dimensions, are strategic for the sources and present critical frames that involve among other factors irregular occupations. In these areas, more than 1.000 families need to be removed. The recovery of these bodies of water will contribute directly to the recovery of the rivers Pinheiros and Tietê. (SVMA, 2017)

The Pinheiros Clean Program has the participation and support of the State Government of São Paulo - through the Energy and Mining, Water Resources and Environment Secretariats and companies such as the São Paulo State Sewage Company (Sabesp), the Environmental Sanitation Technology Company (Cetesb) and the Metropolitan Water and Energy Company (Emae). (ABDIB, 2017)

The development should be carried out on the basis of conditions stipulated by an Emae reference term, offering solutions to improve the quality of the Pinheiros canal water by authorizing in stages the possibility of pumping up to 50 m^3 / s of water class 2 for The Billings dam, according to Conama Resolutions 357/2005 and 430/2011. By executing the parameters, the water resources may be indicated for human consumption after conventional treatment, for protection of aquatic communities and for recreational activities such as swimming and diving. (ABDIB, 2017)

The environmental conditions of the Pinheiros River should maintain the current flood control condition of the Pinheiros Canal basin, improve the water quality of the Billings dam, increase water availability at the Billings dam for supply to the Metropolitan Region of São Paulo and Of Baixada Santista and the expansion of water availability for power generation at the Henry Borden Plant.(ABDIB, 2017)

4.1 Applying legislation

The anthropogenic pressure exerted by the large housing nuclei on the sources, the predominance of economic activities associated with the provision of RMSP services and their surroundings, the obstacles encountered in the provision of sanitation services and infrastructure, the economic and social vulnerability of precariously settled groups , And the large volumes of water required for the development of the Paulista Macrometropole, compete with the need for preservation, directly linked to the sustainability of the river basin. (SSRH, 2017)

Article 2 of Law No. 7.663 of 1991 states that: "The State Policy for Water Resources aims to ensure that water, a natural resource essential to life, economic development and social well-being, can be controlled and utilized , In satisfactory quality standards, by its current users and future generations, throughout the territory of the State of São Paulo. " This law grants rights of water use; Defines infractions and penalties; Establish collection; Defines the cost criterion of the works; Defines policy for the management of water resources; Creates the participatory integration of society and other bodies involved; Creates the participation of municipalities; Creates the FEHIDRO - State Water Resources Fund, with management, resources and their applications. (São Paulo, 1991)

Brazilian laws provide a legal basis for the progressive establishment of the improvement of the protection of water resources, continually approaching the full exercise of the principles of ecological sustainability, social equity and economic efficiency.

5. Conclusion

The Tietê Project presents progressive results related to the improvement of the quality of the Tietê River. (SSRH, 2017) At the same time the Clean Stream Project has been doing a good job with the scans of the rivers' extensions to perform repairs and improvements, for their treatment. (SVMA, 2017)

Twenty-five years ago, improvements have been observed and amplified, the current situation is already much better than what existed in 1992 at the beginning of the works. The Tietê River has peculiarities, already mentioned in the scope of this article, that help to understand why the works aimed at recovering it need a considerable time horizon, although the actions undertaken show significant and measurable results. Hence the importance of a continuous, uninterrupted program as has been the Tietê Project. (SSRH, 2017)

The Tietê river project demands a long term, to reach its objectives, if it is necessary to address the social issue, the precarious housing, and especially, the irregularly settled ones demands greater efforts. (SSRH, 2017) The example of regularizations carried out through Clean Stream Project. (SVMA, 2017)

For the implementation of urban infrastructure equipment, it is necessary to strengthen the union of the plans to the reality experienced and to increase the interfaces between the governmental plans, providing a greater energy to the urban planning. The need to enhance the linkage of policies as an ideal of sustainable progress as part of strengthening the conservation, recovery and sustainable use of terrestrial ecosystems, including their biodiversity, enhancing their ability to deliver benefits that are essential to our development. (SSRH, 2017)

Compared pollution projects share several similarities such as: elaboration and implementation of public policies for water resources management, pollution control and treatment of organic loads.

The main difference observed between the São Paulo project and the European projects is the complexity of the urban occupation observed especially by the Macrometrople Paulistana, which is not observed in European cases.

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