The pollution of Brazilian urban rivers, a study about Bombas river, Joao Pessoa/Paraíba-Brazil.

Rômulo Henrique Teixeira do Egito [1]
Bruna Letícia Oliveira da Silva [1]
Janyelle Santos Soares [1]
Rafael Aguiar de Miranda [1]
Gilcean Silva Alves [2]

Academic of Environmental Management, IFPB Campus João Pessoa/Paraíba - Brazil [1]
Professor of Environmental Management, IFPB Campus João Pessoa [2]

Abstract: This work aims to make comparative analysis between environmental degradation aspects found bacteriological analyses and environmental perception on the Bombas river in the city of João Pessoa in Paraíba state with the situation of other urban rivers throughout Brazil, the purpose is to show that the Brazilians urban rivers are contaminated in general by the same pollutants that are wastes from a failed sanitation system, poor management of solid waste, stormwater networks irregularities, among other factors, which the environmental risks and health and possible mitigating actions for pollution of the rivers.

Introduction

The presence of urban rivers is very important both from the environmental and ecological point of view, as an element of importance to society as a whole. In spite of that which is observed in Brazil's urban rivers are in their great majority are degraded, sedimentaded, as well as polluted.
The main factors that aggravate this problem are; the undue occupations on the river banks, the lack of sanitation in these regions, the excess of domestic and industrial effluents, solid waste, system failure to capture rainwater that receives sewage, the withdrawal of ciliary forest, and the populations that lives by the river that uses the rivers as toilets, disabling much of the water from the sources.

All of this is the result of the process of urbanization of the towns in a disorderly and invasive way, resulting in a high level of anthropization on the most diverse natural environments. (Mayrinck, 2005)

According to the latest census of the Brazilian Institute of Geography and Statistics (IBGE, 2010), the urban population of the country is about 160 million people, corresponding to 84.4% of the total population. This high level of urbanization causes a significant impact in the rivers that run through the cities,

because only 42.6% of domestic sewage is collected and only 30.5% receives some treatment.

According to the data collected in the year 2016 by the NGO SOS Mata Atlântica[1] which does the monitoring of 183 rivers in 12 States and 76 municipalities in Brazil, where the quality of the rivers are classified on a scale that goes from great-good-terrible-bad-regular, 59.2% of Brazilian rivers are in Regular State, 34.9% are terrible, 1.4% bad, and 4.5% in good condition in the country there is no river with great quality. This is worrying as the minimum that should be accepted so that the river has a minimum quality and may have some usefulness would be with scale from good to excellent.

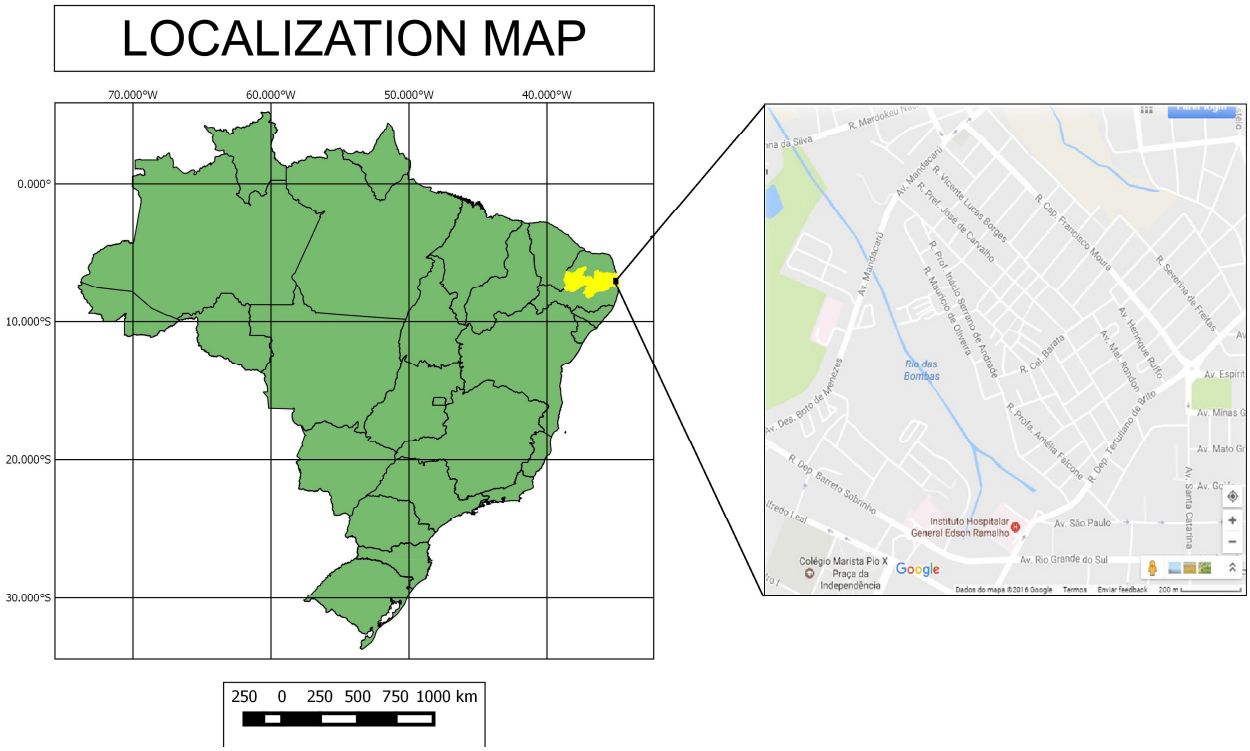
The problem with the pollution of urban rivers comes linked to a number of factors and critical consequences, where negative aspects are observed, however the lack of concern for the environment and the lack of supervision by the Brazilian public power is causing a great problem in the quality of water resources coming from urban rivers, having as main consequence, a high infant mortality rate, besides burdening the public system of health having as main consequence, high rate of infant mortality in addition to burdening the public health system, due to the immense number of hospitalizations related to bad water quality, causing the Human Development Index (HDI) of cities will reach low levels, when compared to other countries.

Thus, the present work aims to make comparative analysis between environmental degradation aspects found in bacteriological analyses and environmental perception on the Bombas river in the city of João Pessoa/PB with other Brazilian rivers, showing that in a general environmental problems found are similar.

Materials and Methods

The Bombas river also known as Cruz do Peixe river is part of the Paraíba River basin that is located in the city of João Pessoa, in the State of Paraíba – Brazil, inserted into the Municipal Park Lauro Pires Xavier where also lies the community of Filipéia, with geographical coordinates 7° 06 ' 50.6 "S 34° 52 ' 07.2" W, and according to the Municipal Plan of Conservation and Restoration of the Atlantic forest (2010) , has about 22.33 hectares, positioned at the confluence of the Jardim 13 de Maio District with the neighborhood of Tambiá, being an integral part of the Zoobotânico Arruda Câmara Park, as noted in map 1 below.

[1] Created in 20th of September of 1986 by scientists, business man, journalists and environment activists, the NGO SOS Mata Atlântica has the goal to defend the lasts remnants of Atlantic forest in Brazil.



Map 1 – Localization Map.

The area was chosen because although is located in an urban area, there is not many studies on the Lauro Pires Xavier Park and the Bombas river, and would be an excellent area if it was take care properly, it could fulfill its social role as a park to the population that there resides.

The researches were carried out between May and August of 2016, during the period 7 samples of water were collected, where 6 samples were collected in the section of Bombas River that is part of Lauro Pires Xavier Park and the other point was collected at about 20 meters from the river bank in a *caçimba* (water depot) that is used by the residents for bathing (figure 1), and were made to Bacteriological (Total and Thermotolerant Coliform) analyzes of all the collected points with the objective of investigating if the water of the river was sufficient quality for bathing or potability.

The method used for the analysis was the Multiple Tubes Technique according to Standard Methods for the Examination of Water and Wastewater and to determine the amount of coliforms was used the table of values of the Practical Handbook of Water Analysis provided by FUNASA[2] (National Health

[2] FUNASA - The National Health Foundation is an executive body of the Ministry of Health of Brazil, which aims to promote social inclusion, through sanitation actions for disease prevention and control.

Foundation) that has a reliability limit of 95% where its values can vary between 0 and 1600 NMP (Most probable number)

To obtain the results, it was observed the Ordinance No. 2,914 of December 12, 2011 of the Ministry of Health that legislates on the issue of potability in Brazil. For human consumption water cannot have the presence of any pathogenic microorganisms Escherichia coli (thermotolerant coliforms) and Total Coliforms, which are indicators of water quality, in no amount, then according to the manual of FUNASA to consume in order to determine the quality of the water for bathing, the legal precepts are drafted by CONAMA[3] Resolution No. 274 of November 29, 2000, where in its text it is stated that the maximum limit for bathing is of 2,000 Escherichia coli per 100 milliliters, which in the NMP (Most Likely Number) values would be 100 NMP.

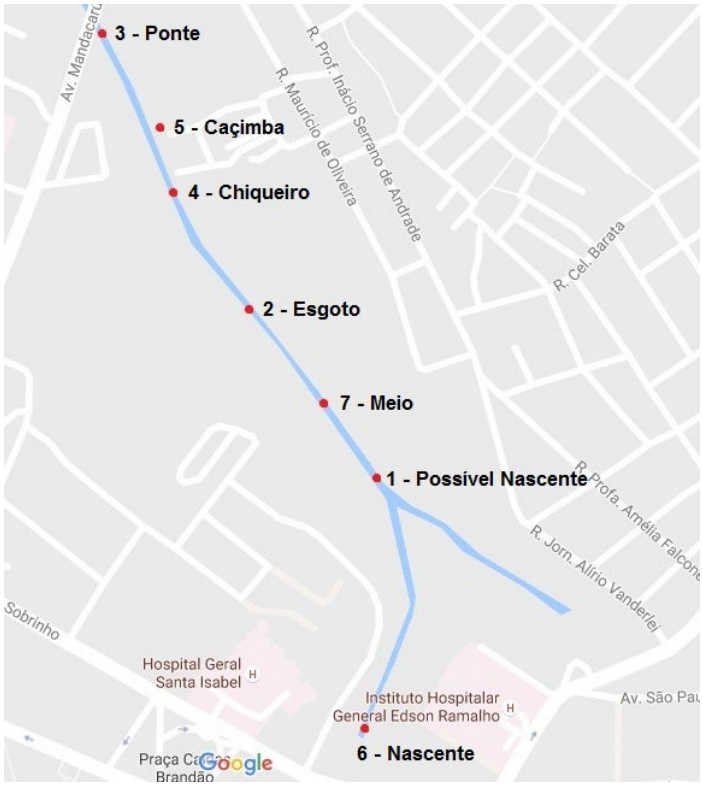


Figure 1 - The collection points

In order to determine the quality of the water for bathing, the legal precepts are drafted by CONAMA Resolution No. 274 of November 29, 2000, where in its

[3] CONAMA - National Council for the Environment is an advisory and deliberative body of the National Environmental System that establishes standards and criteria for the environment in Brazil.

text it states that the maximum limit for bathing is 2,000 Escherichia coli per 100 milliliters, which NMP (Most Probable Number) values would be 100 NMP.

From the data collected in the field, comparative analyzes were carried out with three other Brazilian rivers, the River Tiête, which is one of the most important rivers for the state of São Paulo, and has an extension of about 1,100 km, and is today one of the Most affected in the whole country. (Garcias & Afonso, 2013). It is born in Salesópolis, in the Serra do Mar, at 1,027 meters of altitude. It flows into the lake formed by the Jupiá dam on the Paraná River, in the municipality of Três Lagoas, about 50 kilometers downstream from the city of Pereira Barreto, the Tietê River is extremely polluted, as sewage and industrial effluents are dumped. However, along the river the pollution can vary (Grosso et al., 2008).

The second river chosen was the Paraíba do Sul River, which is considered one of the most polluted rivers in Brazil, is about 57,000 km long, covering three states of Brazil, São Paulo, Rio de Janeiro and Minas Gerais. It is responsible for the beginning of the settlement of the states in which it covers, when the *tropeiros* began to populate the banks of the river to capture indians that lived in the environs, for slave labor. From then on, the trend only evolved to the present day, however, from the beginning, the use of the river was predatory, resulting in its deterioration, as we can see without much difficulty nowadays. (Ribeiro, 2008).

In order to conclude the comparison of the pollutants found, it was studied in the Tamanduateí River that runs through four municipalities of the State of São Paulo: Mauá, Santo André, São Caetano, São Paulo. The source of the Tamanduateí River is in Mauá, in the Cave of Santa Luzia, located in a Park that houses remnants of Atlantic forest. However, at the exit of this Park we have already witnessed the first signs of pollution. Its mouth meets the Tietê River (Ramalho, 2007).

Results and discussions

Bombas River

Based on the NMP (Most Probable Number) table provided by FUNASA, the results of the analysis of the samples showed what could be noticed only in a visual perception as observed in Table 1.

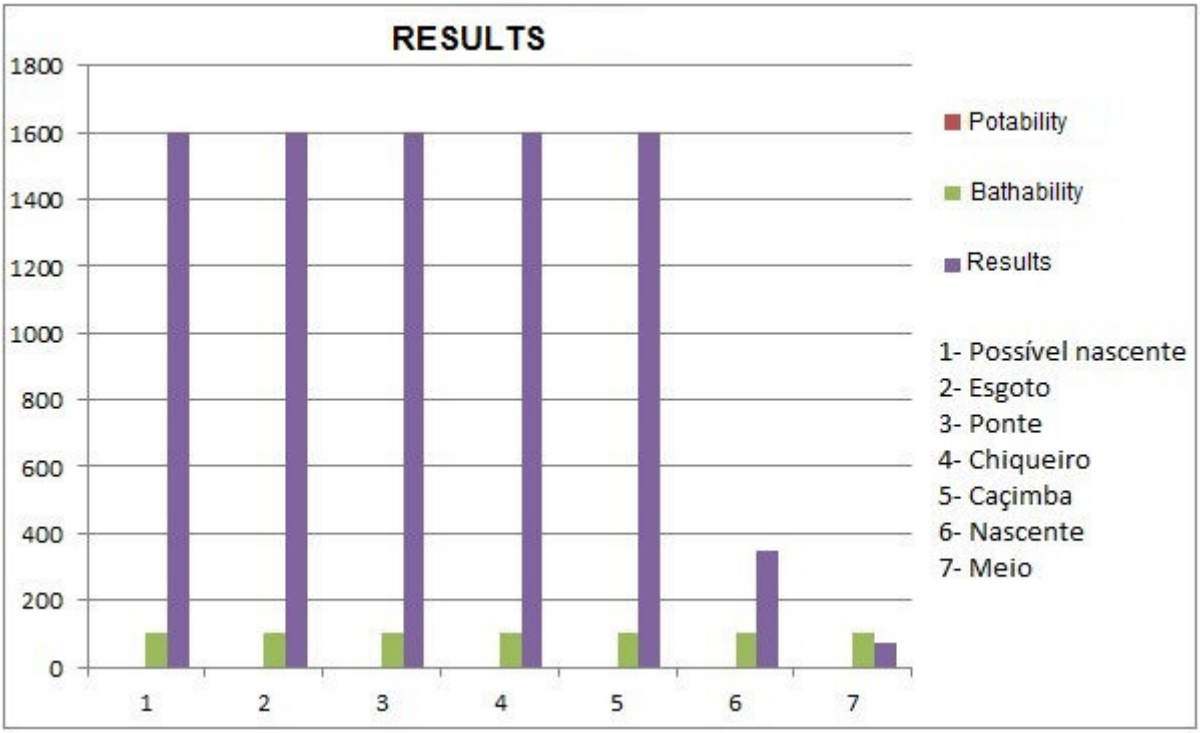


Table 1 - Analysis Results

The maximum value measured for the NMP according to the FUNASA manual is 1,600. As indicated above the maximum value for potability is 0, so the value does not appear in the graph, we observe that none of the seven points collected is within the legal standards of water quality for human consumption.

Regarding the limits for bathing, we noticed that one of the points is in line with the quality standard that has a limit of 100 MPN, and according to analyzes the value obtained at "point 7 - Medium" was 70 MPN. The interesting thing about this place of analysis is that if we look at "Image 2" it is in the central part of the region where the collections were made, and according to what was observed during field research, the Bombas river begins with a degree of pollution in its source from a failing rainwater system, where the value found at the "6 - source" point was 350 NMP and has a high increase in "point 1 - possible source" to a value of 1,600 NMP, But the river itself tries to do a self-purification, but soon the front in the "point 2 - sewage" receives a strong intervention of sewage drastically increasing its value to 1,600 NMP and continues to receive other pollution points failing to recover.

At its source it was possible to notice the presence of a rainwater drainage system, due to a faulty system of the network, which according to information collected at the Municipal Secretariat of Infrastructure (SEINFRA) in the city of João Pessoa, there is no Mapping of João Pessoa rainwater network, making it difficult to maintain and inspect it. Other pollutants found on the banks of the Bombas River came from the sewage network which, due to lack of basic

sanitation or a system failure in the region, goes directly to the river (Picture 1), also solid wastes such as plastics, wood, metal, paper and rubber. It was observed that in a part that is inside the park and around the river serves as dump of rubbish and as a deposit of residential waste and by the population itself.

Picture 1 - Where the river meets the sewer

Other concern issues other than those already presented were the presence of a pig farm and slaughterhouse on the banks of the river, at a distance of not more than 15 meters between the place where the animals were slaughtered to the river bank, and the population living In the vicinity of the river has contact with the source, using also for the purpose of bathing a *"caçimba"* (water depot), which is the "point 5" analyzed and according to the results obtained presented the maximum value of 1,600 NMP of the indicator coliforms for bathing. Some final aspects were observed in a last visit that was on the banks of the Bombas River, contamination of the soil with solid residues, the great presence of exotic vegetation around the park as well as on the river bank and no aquatic animal species in the river. Therefore, Bombas river has a high rate of pollution from domestic sewage, solid waste, failure of the rainwater system, industrial effluents, among others. What makes it the same, does not offer the minimum condition for use by the population, for any purpose or human activity.

Tietê River

The environmental degradation of the Tietê River began subtly in the 1920s, with the construction of the Guarapiranga Dam by the a Canadian company called Light, for subsequent generation of electricity at the Edgar de Souza e Rasgão hydroelectric plants, located in Santana de Parnaíba State of São Paulo. This intervention altered the water regime of the river in the capital and was accompanied by some rectification work also by Light, who left the river bed in the area of the less winding capital. (Grosso et al., 2008).

In the 1910s and 1930s, several stretches were still used for water sports and fishing, but with the passage of time to the disorganized occupation of the city and the launching of domestic and industrial effluents without any type of treatment, eventually degrading the Tietê river basin. (Garcias & Afonso, 2013)

The Observing Rivers project of SOS Mata Atlântica monitors 17 points on the Tiête River, where it found that 14 are in terrible, bad or regular situation. The Brazilian national average is quite worrying, and from the studies the pollutants in general are the same, domestic and industrial effluents, solid waste, stormwater failure, lack of efficient treatment in *ETE* (Sewage treatment plant), among others.

Paraíba do Sul River

In a study carried out, only 10% of the population knew it, and it was easy to understand its degradation. Moreover, in the same region, it was detected that neither the local population nor the municipal government itself performs work that arouses the importance of such a river. (Ribeiro, 2008).

The main sources of degradation are: disposal of solid waste, domestic and industrial effluents, urban expansion, siltation and instability and mining. The problem of waste disposal is related to favoring infiltration and contamination of the water table with the release of slurry. The urban expansion, in turn, is interconnected to the largest pollutant factor of the basin, that is, low treatment of collected sewage resulting in the appearance and propagation of waterborne diseases.

The instability occurs due to the silting in the process of natural erosion and the latter aggravated mainly by deforestation, altering the hydraulic regime. Mining activities cause highly detrimental nefarious effects to the aquatic and riparian environment, and in many cases being irreversible, the extraction of sand, for example, due to the agitation of sediments. (Junior, 2004).

Tamanduateí river

The process of degradation and pollution of this important water source began in the middle of the XX century, the urban and industrial development of the region of the Great ABC along the Tamanduateí river in São Paulo (MOUSSA, 2005) intensified. This expansion occurred taking the river as the main reference, that is, the initial focus of growth occurred on the banks of the same. Concurrently with this development, there was a gradual increase in the Tamanduateí pollution process, resulting, for example, in the dumping of domestic and industrial waste, as there was no effective treatment system for this waste; This occurs to this day. (Gouveia, 2010). The Tamanduateí river is also monitored by the NGO SOS Mata Atlântica and in 4 points that are monitored, 3 are considered of poor quality and only one with regular characteristics.

As an example, the Isar River in Germany, one of its problems is the same one found in the pollution of our urban rivers, which is the question of basic sanitation, was practically resolved with 95% of its area having access to a sewage treatment plant . To solve this problem Germany began to treat pollution in all its aspects, integrating the physical, chemical, morphological and biological aspects. Another action was to remove concrete dams, increasing their water retention capacity and reducing flooding. A major source of pollutants still from this river is from agriculture, and another difficulty is the morphological modification in their beds (Arzet, 2010). But what we can note is that there is already concrete work of revitalization and a concern to improve the quality of this water source.

The release of pollution in urban rivers problems caused by man in the environment, such as the morphological change of rivers, death of special animals and plants in general (Santos, 2004)

In addition to the damages caused to the environment the pollution of rivers can cause numerous diseases in humans, some of them if not taken care of in time can be fatal, table 1:

DISEASES	CAUSAL AGENTS
CHOLERA	*Vibrio cholerae*
BACILLARY DYSENTERY	*Shigella sp.*
TYPHOID FEVER	*Salmonella typh*
INFECTIOUS HEPATITIS	*Hepatitis virus a*
PARATYPHOIDS FEVER	*Salmonella paratyph a ,b e c*
GASTROENTERITIS	*Other types of salmonella, shiggela, prateus sp.*

LEPTOSPIROSIS	*Leptospira sp.*

Table 2: Diseases related to contaminated water and its causal agents

Final Considerations.

When we talk about recovering, as well as restoring an already degraded river, there are several ways to do this, but in order to start any type of restoration or recovery, we should look for the emitter of the pollution and interrupt as soon as possible, so there it is. Start doing some analysis about the place, knowing the level of pollution in which it is, where depending on the results if the necessary attitude is taken.

In Brazil there are some examples of rivers that have been recovered, one of the most well-known projects is the "manuelzão" project whose main objective is to revitalize the old river, which in turn is one of the main tributaries of the São Francisco river.

"The coordinators of the Manuelzão Project emphasize that the way society treats its rivers represents the cultural mentality of this society. Because it is an action idealized by the academy, the project presents transdisciplinary characteristics, in line with what is thought in relation to revitalization actions according to this line of thought, two objectives are proposed: a technical and operational objective, which is the return of the fish to the river, and a political objective, which is the change of mentality in relation to the planet Earth. (Garcias and Afonso, 2013)

Urgent measures have to be taken so that it can still be possible to save Urban Rivers, which can bring us so much both in relation to water availability, and in aspects of quality of life, the world's population is increasing and instead of taking care of these water sources are going the opposite way.

Bibliographic References

APHA - American Public Health Association (1995) 19 ed. *Standard methods for the examination of water and wastewater*. Washington: Byrd Prepess Spingfiel

Arzet, K. (2010) State Office of Water Management Munich. in: Machado, A. T. G. M., Lisboa, A. H., Alves, C. B. M., Lopes, D. A., Goulart, E. M. A., Leite, F. A., Polignano, M. V. (eds) *Revitalização de Rios no Mundo - América, Europa e Ásia.* Brasil, pp. 153-168 Available from: http://cbhvelhas.org.br/images/CBHVELHAS/arquivosgerais/revitalizacao-de-rios.pdf [Accessed: 13th December 2016]

Brasil. Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal. Resolução n° 274, de 29 de novembro de 2000- CONAMA. .Available from: http://www.mma.gov.br/port/conama/res/res00/res27400.html [Accessed: 10th December 2016]

FUNASA – Fundação National de Saúde (2013). *Manual Prático de Análise de Águas*. 4 , Brasil. .Available from: http://www.funasa.gov.br/site/wp-content/files_mf/manual_pratico_de_analise_de_agua_2.pdf [Accessed: 10th December 2016]

Garcias, C. M. & Afonso, J. A. C. (2013) Revitalização de Rios Urbanos. *Revista eletrônica de Gestão e Tecnololgias Ambientais*, 1, 131-144, .Available from: https://portalseer.ufba.br/index.php/gesta/article/viewArticle/7111[Accessed: 12th December 2016].

Gouveia, I. C. M. C (2010) *Da originalidade do sítio urbano de São Paulo às formas antrópicas: aplicação da abordagem da geomorfologia antropogênica na bacia hidrográfica do Rio Tamanduateí, na região metropolitana de São Paulo. Tese de doutorado USP.* Available from: https://www.researchgate.net/publication/274837078_Da_originalidade_do_sitio_urbano_de_Sao_Paulo_as_formas_antropicas_aplicacao_da_abordagem_da_Geomorfologia_Antropogenica_na_Bacia_Hidrografica_do_Rio_Tamanduatei_na_Regiao_Metropolitana_de_Sao_Paulo [Accessed: 17th December 2016].

Grosso, F. G., Moura, R. P., Raymundo, W. D., Bernardi, M. M. (2008) *Toxicidade das águas do Rio Tietê coletadas na Grande São Paulo em peixes Danio rerio*. Revista do Instituto de Ciências da Saúde, São Paulo, 26, 4, 387-391. Available from: http://producao.usp.br/handle/BDPI/2262. [Accessed: 12th December 2016]

IBGE – Instituto Brasileiro de Geografia e Estatística (2010). Censo demográfico 2010. Available from: http://www.ibge.gov.br/home/estatistica/populacao/censo2010/ [Accessed: 20th December 2016]

Junior, D. I. S. (2004) *A degradação da Bacia do Rio Paraíba do Sul;* ENGEVISTA, 6, 3, 99-105. Available from: http://www.uff.br/engevista/3_6Engevista8.pdf [Accessed: 13th December 2016]

Mayrinck, V. (2005) Dinâmica das paisagens de rios urbanos. In*: XI Encontro Nacional da ANPUR, Salvador. Planejamento, Soberania e Solidariedade; perspectivas para o território e a cidade*. Available from: http://www.xienanpur.ufba.br/334.pdf [Accessed: 20th December 2016]

Moussa, A. N. (2005) *O Rio Tamanduateí e o desenho urbano*. Monografia (Disciplina de AUP 272). São Paulo, Universidade de São Paulo, Available from:http://www.fau.usp.br/cursos/graduacao/arq_urbanismo/disciplinas/aup0272/6t-alun/2005/m4-moussa/index.html [Accessed: 12th December 2016]

Plano Municipal de Conservação e Recuperação da Mata Atântica (2010), João Pessoa. Available from: https://www.sosma.org.br/wp-content/uploads/2014/04/pmma_joao_pessoa.pdf [Accessed: 12th December 2016]

RAMALHO, D. (2007) *Rio tamanduateí – nascente à foz: percepções da paisagem e processos participativos.* Paisagem Ambiente – . 24 – São Paulo – 99–114 Available from:http://www.revistas.usp.br/paam/article/download/85723/88496; [Accessed: 12th December 2016]

Ribeiro, F., Cruz, N. C., Sene, T. C. A., Mangialardo, V. C. (2008) *A importância do patrimônio natural: O Rio Paraíba do Sul*. Available from: http://www.inicepg.univap.br/cd/INIC_2008/anais/arquivosEPG/EPG01428_03_O.pdf [Accessed: 12th December 2016]

Santos, F. P. (2004) *Meio ambiente e poluição.* Revista Jus Navigandi, Teresina, 9,201. Available from: https://jus.com.br/artigos/4753/meio-ambiente-e-poluicao/2 [Accessed: 20th December 2016]

SOS Mata Atlântica (2016), *Projeto Observando Rios.* Available from: https://www.sosma.org.br/wp-content/uploads/2016/03/dados_IQA2016_Geral.pdf [Accessed: 18th December 2016]