

Water Resources Management – Environmental and Legal Conceptions Applied to the Protection of Urban Ponds

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Abstract: This research is an integral part of a previous one in which was aimed to study the advance of urban space in ponds' areas. However, the topics here only aim to discuss the main legislations that should protect our water bodies, in special the ponds in Feira de Santana city, according to the environmental sciences. For this purpose, it was done a bibliographical research about the main concepts of lakes and ponds, followed by a survey to the federal, state and municipal legislations that deal with water resources. It was verified that these legislations do not address the ponds directly, but only rivers and river springs. Even though, the ponds from the place above mentioned are also considered river springs.

Key words: Legislation, ponds, Feira de Santana.

1. Introduction

The environment's study is beneficial and essential to all societies, once it considers nature and the human interference on it. The geological, environmental and economic features associated to human's intervention techniques determine the place and the means of allocation of society's housing in space, as well as the environmental impacts caused by them. As ^[1]Tyler and Miller Jr (2007) state, the environmental sciences arise from an interdisciplinary principle that approaches how they are related to each other, and how nature works. Besides, it is necessary to understand that environmental quality is a result from the human action on space and its aspects at a specific time ^[2](BOTELHO; SILVA, 2017).

Water is a crucial element on life's maintenance, once it keeps beings alive, regulates weather, shapes the terrain and dissolves wastes and pollutants as part of the hydrological recycling. As said by ^[1]Tyler and Miller Jr (2007), human beings are composed by 60% of water, and the hydrosphere corresponds to 71% of the earth's surface, but 97,4% from this is on the oceans and saline lakes. In other words, only 2,6% of water corresponds to fresh water.

Therefore, the study and management of water resources are essential to the regional city planning. By this context, urban ponds stand out considering that the advance of urban space do not respect the natural boundaries. In an attempt to stop this disorderly development, laws and models of management are created to assist the decision makers in the proper management of water resources, however the legislations do not always correspond to the real need of water resources. From this principle, this research aims to evaluate the municipal legislation in terms of its consistency with the models of systemic dynamics from the natural environment.

This research was based on the structure a list method by correlating literature review and fieldwork, besides it emphasizes the environmental impacts and correlates them with the municipal legislation. Therefore, the analysis scale is local and specific, and, although this may be the research's strong point, it also becomes a limiting factor, given the fact that just a review from ponds' main environmental and legal concepts was done; it was not analyzed all the water resources.

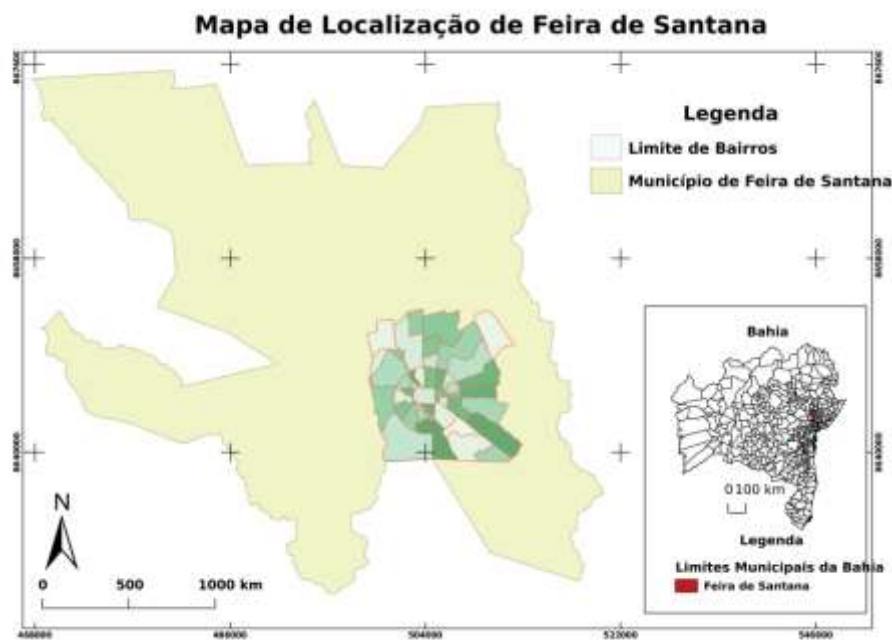
2. Material and Methods

For article's elaboration, it was done a study visit with vertical photographs as support and an empiric analysis about lake bodies damage. The empiric study was supported by field's observation combined with the bibliographical survey and the consulted legislation. Thus, it is a bibliographical and exploratory research limited to Feira de Santana city (Fig. 1), but the legislation embraces not only the Municipal law, but also the State and the Federal ones.

3. Objective

The research has as main objective to present a bibliographical review about the environmental concepts about ponds and their relationship with the municipal legislation of Feira de Santana, in Bahia state, by assessing the municipal law in terms of its compliance with environmental concepts. Besides, it will be presented a bibliographical review about the environmental concepts of ponds and the environment’s damage.

Localization of Feira de Santana city, in Bahia state. It is verified that it has a higher water deficit, what implies a important preservation of water bodies, Fig. 1.



The consulted legislation can be verified on the following Fig.2. It is necessary to emphasize that the search’s focus was verifying the protective actions to urban lakes and ponds in Feira de Santana city.

Consulted legislate onto the research’s elaboration, Fig. 2.

Law No.	Year	Governmental Sphere
9433	1997	Federal
8001	1990	Federal
CONAMA’s Resolution 357	2005	Federal
1612	1992	Municipal
41	2009	Municipal

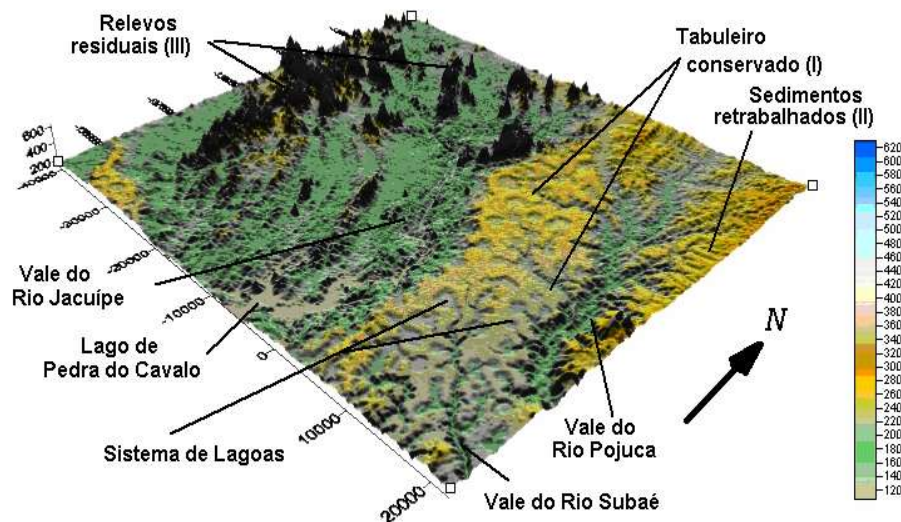
4. Results and Discussion

4.1 Ponds and Damage.

According to ^[3]Mackenzie and Moran (2005), we can comprehend ponds as water bodies that usually have a low flow and can be natural or artificial; artificial when it is a human’s building and is usually smaller than a natural lake. Ponds and lakes are different from rivers, streams and creeks due to their water flow speed. In rivers, streams and creeks, the water flow is easily noted, while in lakes and ponds there is not a real flow but a *micro water flow* that is conducted by the action of temperature and

wind. These features distinguish a pond from other geomorphological forms with aquatic aspects such as the natural pools composed by tides ^[3](MACKENZIE; MORAN, 2005). For ^[4]Tundisi (2008), lakes and ponds are static water bodies, settled in a specific basin and disconnected from the ocean. From this principle, we can understand a pond as an integral part of river, and, in many cases, as the proper river spring, as happens in Feira de Santana city (Fig. 3). However, all of them are considered integral parts of the hydrographic basin, by the geomorphological perspective.

Lake complex in Feira de Santana city, it can be noticed that most of ponds are Pojuca's river springs, Fig. 3.

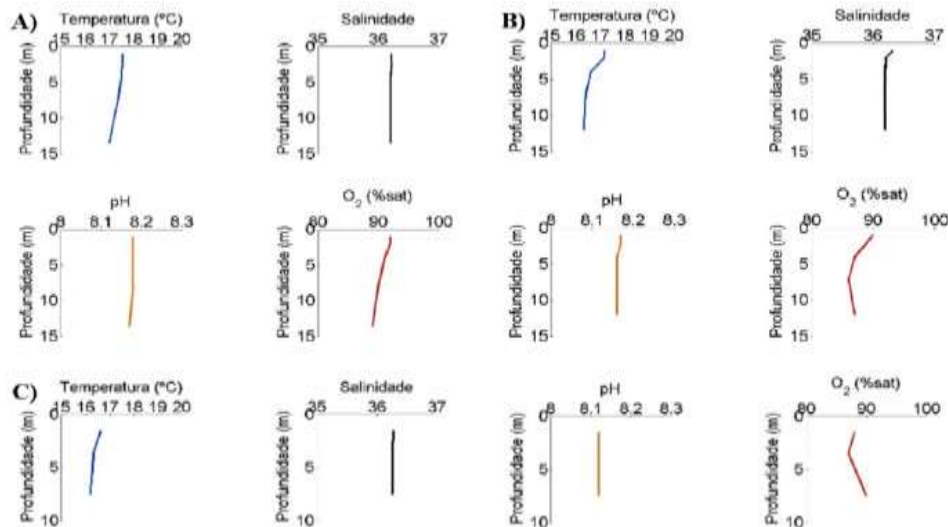


The geomorphological studies had a crucial role on the knowledge of ponds' origin, as well as in the description of the ecosystem's processes dynamics ^[5](SWANSON, 1980). However, for elaborating an appropriate description of lakes it is necessary to make points about the perennial condition. Ponds with humid phases and irregular floods, flooded areas, canals and ponds which flood in rivers, coastal, perennial, intermittent lakes and ponds, or disconnected from coastal waters or permanently connected to coastal water by canals; all these landscape's topics are submitted to a continuous process of modification that is directly affected by the hydrographic basin. It leads to the conclusion that they are transitory forms of landscape ^[4](TUNDISI, 2008).

All continental aquatic ecosystems are submitted to a bunch of impacts caused by human's activities and the large use of the hydrographic basins, including lakes, rivers, dams, flooded areas and swamps ^[4](TUNDISI, 2008). As the use of water resources is increasing, the environment issues become more complicated, what implies a harder and most expensive solution.

Natural ponds have a short life time when it is considered the geological time scale, and because of this, it is possible to make a prognosis about ponds' vanishing. However, human's actions are playing an important role for ponds' vanishing due to the increasement of pollution. We can understand water pollution as any type of chemical, biological or physical variation in water quality that damages living organisms or makes water improper for drinking ^[1](TYLER; MILLER JR, 2007). Rivers can recover faster from the damages due to the wasted energy in water flow. On the other hand, ponds do not have this feature, what implies a faster deterioration of them. As ^[1]Tyler and Miller Jr (2007) states, the wastewater dilution in lakes and water reservoirs is less effective as in water flows for two reasons: the first one is because lakes and reservoirs have stratified layers that face a low vertical mixture, as consequence of their low flow. The second one is related to the duration of waters' recycling: in lakes and huge reservoirs it can last from one to a hundred of years (Fig.4), and in watercourses it lasts days or weeks.

Typical behavior of a water column in lakes and reservoirs on annual scale, Fig. 4.
Source: Ovelheiro, 2015.



The eutrophication process can be defined as a natural enrichment with nutrients of lakes mainly because of the vegetable nutrients' outflow. Humans' actions can highly speed up the presence of vegetable nutrients in a pond and this process is called *cultural eutrophication*. However, the main causes of ponds' pollution and eutrophication are the wastewaters containing nitrate and phosphate. In urban ponds, the sources of nitrate and phosphate pollution are the home sewers. Besides, the vegetation's replacement by houses results in a higher sedimentation of ponds ^[1](TYLER; MILLER JR, 2007).

Continental ecosystems' sedimentation plays an important quantitative and qualitative impact in ponds considering the careless of soil's use, what results in many problems of chemical, physical and biological orders ^[4](TUNDISI, 2008). Among these questions, we can list: turbidity's increase, disturbance of the biogeochemical cycle, food chain disorder, hydrodynamics' disturbance, decrease of water volume, heavy metal accumulation and a dramatically decrease of oxygen concentration. Sediments' transportation carried by morphodynamics depends on rock type, plant cover, declivity and drainage. The impact is regional and is conditioned by soil's use ^[6](CAMPAGNOLI, 2002).

4.2 Water Resources Protection Laws

4.2.1 Federal Legislation on Hydrographical Basins Management.

According to environmental conceptions, we can understand that the study of ponds and their legal notions are based on the same legislation that institutes rivers' studies. Therefore, all the legislation referred here was originally written to rivers' management, once there is not a specific one that institutes ponds.

For a long time, Brazil had looked at water as an endless resource that could be unlimitedly consumed. However, by facing the late struggles arising in our society, this conception has gradually been changing. Water scarcity has been noticed as an evident problem (an example is water rationing faced by São Paulo's metropolitan zone). However, this legal understanding just had begun in the 90s when water became a resource with an inherent economic value ^[7](HARTMMANN, 2010).

The basic principles from the federal legislation are in Law No. 9,433 of January 8, 1997 that establishes water resources, institutes the national water resources policy, creates the national water resources management system, establishes the subsection XIX of the article 21 of the Federal Constitution and alters the first article of Law No. 8,001 of March 13, 1990 that had modified Law No. 7,990 of December 28, 1989. This legislation establishes water as a natural and limited resource with economic value. In a scarcity situation, the priority of its use must be for human and animal consumption. In relation to water resources management, the law emphasizes that it must provide the water's multiple uses. One of the legislation's most important points for the environmental studies is the subsection V of the first article that establishes the hydrographic basin as the land unit to water resources national policy implementation and water resources management national system action. Thus, the subsection matches the environmental studies that settle hydrographic basin as a landscape's basic unit, what is sustained by the geo system's theory.

Concluding with the legislation’s basic principles, they point out that water resources management must be decentralized and involve public authorities (Federal and State Governments), users and communities’ participation. Here we can find at least two basic problems: firstly, the cities do not have the power of decision related to water resources management, and secondly, when an assembly (bestowal term) happens, it is usually located in different places, what hinders the participation of the poorest layers of people who have no condition of displacement. Unlike this situation, the agribusiness, represented by the sector main businessmen, takes part of all the assemblies and can make a management that better talks to its concerns.

According to ^[7]Hartmann (2010), another important point of the legislation is the rivers’ division in federal and state rivers. It is relevant to point out that the 1998 Brazilian Constitution had already established those two levels of competence to water resources management. By this conception, to be considered a state river its river spring, its fluvial canal and its mouth must be limited to a specific state territory, while those rivers whose mouths are in a different state from its spring is a federal responsibility.

Law No. 9,433 of 1997 also declares that it must be established a water resources plan, not only in the federal sphere but also in the state one. ^[7]Hartmann (2010) says that the plan must be elaborated in the long term with the participation of all involved entities and considers aspects such as demographical evolution, economic structure from a specific area, and then identifies offers and demands to foresee possible forward conflicts. Thus, it comes up the need of framing the water bodies, what implies the water quality rating and its consistency to the main uses of water. In this case, the framing aims to decrease the costs of controlling water pollution through permanent and preventive actions. The classes of water use (Fig.5) can be divided in four levels and then in other different levels.

It refers to the classes of water use according to CONAMA, Fig. 5



It can be understood that Law No. 9,433 of 1997 do not set a specific policy against rivers’ damage, and even less against a fragile ecosystem as the pond. In this case, the responsibility to qualify the water condition stays on CONAMA (National Council for the Environment).

Brazilian national legislation that states about water resources management and its inspiring model, the French legislation, have as bestowal basic principle to ensure the quantitative and qualitative control of water use and to guarantee the effective right of water access. As ^[7]Hartmann (2010) states, as consequence, there is the necessity of new agents to assume water resources policy and this role is handed to the hydrographic basins committees, participative entities that represent the main institution of this new legislation. These entities are responsible for water resources policy’s implementation in its corresponding hydrographic basin. Besides, the committees devise the cooperation and participation factors, aiming to represent all the interested parts, on other words, it refers to those people affected by the management of the respective water resources. In this regard, the municipal city halls are just one more committees’ participant and not a decision maker institution.

The need of classifying water in useclasses is due to the many damages that those water bodies have suffered over their improper uses. The use classes for fresh water can be illustrated on the following Fig. 6, according to CONAMA.

Use classes of fresh water according to CONAMA resolution 357 of 2005, Fig. 6.

Use Class Use

Special	Domestic provision without a previous or a simple cleansing.
I	Domestic provision after a simplified treatment; protection of aquatic communities; primary contact recreation (swimming, water ski and scuba diving); greenery watery that are eaten in raw, with no removed layer; protection of aquatic communities in native lands.
II	Domestic provision after the conventional one; protection of aquatic communities; primary contact recreation (water ski, swimming and scuba diving), watery of greenery, fruit plants, parks, gardens, sports and leisure fields, where people can have a direct contact; fish farming and fishing.
III	Human's consumption provision after the conventional or advanced treatment; watery of arboreal, cereal and forage cultivation; water for animal consumption; amateur fishing, landscaping balance.
IV	Sailing; landscaping balance.

The previous conceptions are essential to understand how water resources management works and consequently the ponds' management. However, it is necessary a further development of the municipal legislation that states water resources protection in Feira de Santana city.

4.2.2 Municipal Legislation and the Water Resources Protection.

Before going further on this topic, we need to point out that pond's management is not a municipal responsibility. However, if the municipal management aims the population's well-being, just as the environment protection, it is necessary to look up to those questions as opportunities to help the city's spring waters protection. In addition, the public law in its municipal scope must manage about soil's use, working on its environmental preservation. In that way, it is necessary to protect areas that are subject to a specific regulation, as Feira de Santana's ponds are.

The legislation corresponds to the ^[8]Complementary Law No. 41 of September 3, 2009 that refers to the modification and extension of the new wording, Law No. 1,612/92. It establishes the environment's code and states about the environment's municipal system as a municipal management in terms of environment's quality, protection, control and development plus the proper use of city's natural resources.

Legislation's section II of article 3 subsection V aims to decrease the contamination of atmosphere, waters, soil plus audio and visual pollution. Here we have as a basic premise that can be a municipal subsidy in city's ponds protection. But it does not occur in an effective way due to the growth of people's movement towards the ponds' areas with unplanned houses.

The environmental legislation of Feira de Santana points out that the environmental zoning will be done as well as the creation of areas with ecological interest and/or with landscaping importance. Zoning and creation of important ecological areas can be understood as regions subject to high or low restrictions to soil's use aiming the natural resources' use. This point reveals an economic perspective, where the environment is seen just as a resource, what despises the sustainable development idea.

The legislation moves on establishing that for environmental conservation or population's provision, the river springs must be protected with a fence up to the place where the interested area is limited. And to this it must be used the annual collection. The law also states that is a responsibility from the Municipal Environment Office to implement the ecological and economic zoning, but it does not set a methodology either a precise time to begin with that.

Once it is created the area subject to the specific regulation to Feira de Santana's environmental legislation, it establishes that any actions or activities that compromise, or that can compromise in the future, directly or indirectly, the inherent features from the areas of the previous article are flatly forbidden. The legislation concludes that in infringement's situation there will be the

expropriation of the areas. But it almost does not happen in practice, even with the increase of population's interest and pressure about it.

However, Feira de Santana's environmental code emphasizes that: it must be created Areas Subject to Specific Regulation - ASRE on the Subcategory of Natural Resources Preservation Areas - APRN: these areas must surround the following ponds: Grande, Salgada, Pindoba, Tabua, Mudéu, Pirixi, Seca, Doce, Prato Raso, Berreca and Subaé. It prevails a 30 (thirty) meters range on ponds' surrounding, horizontally sized from its higher level, as provided by the article. The measure must be extended up to the pond's boundary, and in rural areas must prevail a 100 (one hundred) meters range. At first sight, the approach seems consistent, however the demarcation was never been done and the progress of urban tissue upon the city's water resources is more and more current.

In the section that talks about water resources themselves, the environmental code of Feira de Santana ratifies the waters code, and does not present an article for water resources protection.

4.3 Relation between waters code and Feira de Santana's environmental code.

The waters code introduces many advances in the protection sense and the proper use of water resources. But it embraces almost all the entered elements of the hydrographic basin, also it decentralizes the decisions related to water resources management. The city's environmental code ratifies waters code and presents some advances related to the protection of the areas located in ponds' boundary. And when both codes are applied in whole they can be a powerful tool for the water resources management, in special for Feira de Santana's ponds. However, there are some faults with respect to the wording codes, as for example the fact they do not approach ponds as integral parts of rivers. But questions like this could be easily solved with the limno logical studies. Nevertheless, the classification's problem of ponds as integral parts of rivers is observed on the municipal law, once that for rivers that cross the city it is established a 100 meters area as permanent protection areas, while for ponds this area corresponds to 30 meters only. Then a question comes up, if ponds are areas of spring rivers that drain their waters slowly towards riverbed, how allowing that river springs be destroyed without destroying the rivers them selves? It is impossible, because according to studies about the general theory of systems, both river and pond are parts of the same systemic complex of dynamical balance and one's pollution implies other's impacts. Thus, the wording must be reconsidered.

5. Final considerations.

The study case here only handled with the theoretical discussion and do not intend to exhaust the topic. It only aims to reach the art state by raising questions that were not addressed when the two mentioned laws were elaborated.

In this way, we suggest that this research do not be finished with a theoretical and conceptual discussion but goes further by covering elements that need to be considered with more attention. Such as the ponds' mapping which was not built yet and the environmental surveys about how urban occupancy impacts the ponds' condition.

In addition, it must be considered the establishment of a ponds' demarcation in terms of their border mapping. And, also, the effective public policies must be applied to avoid the disorderly occupancy of this water resource.

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