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## **ABSTRACT**

The hydrological heritage of the municipality of João Pessoa, Paraíba, northeastern Brazil, is in the form of sources of fresh water and fluvial and riverine plains that are still functional, with scientific, pedagogical, cultural, aesthetic and ecological values, with hydrosites being the places of hydrological interest where these values are maximized. The purpose of this essay is to present a theoretical discussion about the referred heritage, as well as to suggest potential hydrosites to be inserted in urban geotouristic routes. The definition of hydrological heritage consists of a set of elements belonging to water resources that have a use value, scientific, educational, cultural, among others, which makes them subject to protection. João Pessoa is seated in a sedimentary basin developed on a failed crystalline base, so the land has great geotouristic potential, from the point of view of its hydrological heritage, with historical sources, several river plains and the largest river plain in the State, the Paraíba River, of relevant historical, ecological and aesthetic importance. The following potential sites of hydrological interest were identified: Bica Maria Feia, Tambiá Fountain, Santo Antonio Fountain, Miracle Fountain and Cacimba do Povo.

**Keywords:** Hydrological heritage- Hydrosites- João Pessoa- Urban Geotourism.

## **RESUMO**

O patrimônio hidrológico do município de João Pessoa, Paraíba, nordeste do Brasil, se apresenta na forma de fontes de água doce e de planícies fluviais e fluviomarinhas ainda funcionais, possuindo valores científicos, pedagógicos, culturais, estéticos e ecológicos, sendo os hidrossítios os locais de interesse hidrológico onde estes valores se maximizam. O objetivo deste ensaio é apresentar uma discussão teórica acerca do referido patrimônio, assim como sugerir potenciais hidrossítios, na forma de fontes, para serem inseridos em rotas geoturísticas urbanas. A definição de patrimônio hidrológico consiste em um conjunto de elementos pertencentes aos recursos hídricos que possuam um valor de uso, científico, educacional, cultural, entre outros, o que os torna passíveis de proteção. João Pessoa está assentado em uma bacia sedimentar desenvolvida sobre um embasamento cristalino falhado, pelo que o terreno possui grande potencial geoturístico, do ponto de vista de seu patrimônio hidrológico, com fontes históricas, diversas planícies fluviais e a maior planície fluviomarina do Estado, a do Rio Paraíba, de relevante importância histórica, ecológica e estética. Foram identificados os seguintes locais potenciais de interesse hidrológico: Bica Maria Feia, Fonte Tambiá, Fonte Santo Antonio, Fonte dos Milagres e Cacimba do Povo.

**Palavras-chave:** Patrimônio Hidrológico- Hidrossítios- João Pessoa- Geoturismo Urbano.



## RESUMÉ

Le patrimoine hydrologique de la municipalité de João Pessoa, Paraíba, au nord-est du Brésil, se présente sous la forme de fontaines d'eau douce et de plaines fluviales et fluviales encore fonctionnelles, ayant des valeurs scientifiques, pédagogiques, culturelles, esthétiques et écologiques, les hydrosites étant la localité de intérêt hydrologique où ces valeurs sont maximisées. L'objectif de cet essai est de présenter une discussion théorique sur le patrimoine référencé, ainsi que de suggérer des hydrosites potentiels, sous forme de sources, à insérer dans des itinéraires géotouristiques urbains. La définition du patrimoine hydrologique consiste en un ensemble d'éléments appartenant aux ressources en eau qui ont une valeur d'usage, scientifique, éducative, culturelle, entre autres, qui les rend susceptibles de protection. João Pessoa est situé dans un bassin sédimentaire développé sur un socle cristallin défectueux, de sorte que le terrain a un grand potentiel géotouristique, du point de vue de son patrimoine hydrologique, avec des sources historiques, plusieurs plaines fluviales et la plus grande plaine fluviale de l'état, la Rio Paraíba, d'importance historique, écologique et esthétique. Les sites potentiels d'intérêt hydrologique suivants ont été identifiés : Bica Maria Feia, Fonte Tambiá, Fonte Santo Antonio, Fonte dos Milagres et Cacimba do Povo.

**Mots-clé:** Patrimoine Hydrologique - Hydrosites - João Pessoa - Géotourisme Urbain.

## 1.INTRODUÇÃO

Natural Heritage is a relatively new topic in Geosciences, and there is no unanimity in its definition and characterization. Since the United Nations Conference on the Human Environment, held in June 1972 in Stockholm, environmental issues have been discussed on an amplified scale, bringing into the conversation stakeholders who had previously been sidelined from this discussion agenda.

In a very broad view, all elements of the physical environment are considered elements of natural heritage, including soils, rivers, seas, landforms, rocks, mineral and energy resources, plants and animals that, at least its scientific, economic, cultural and social significance, among others, deserve to be studied and preserved for future generations, that is, they deserve to be integrated into sustainable development strategies.

In this work, it is proposed to subdivide Natural Heritage into Biotic, which includes the elements of fauna and flora that, due to their intrinsic value or because they are at risk of extinction, deserve to be protected, whatever ecosystem these forms of life are part of and; Abiotic, where the elements of geodiversity are inserted, such as water resources and their hydrosites, belonging to the Hydrological Heritage, in addition to the landforms, the geological elements and the soil, each with its sub-elements. Therefore, the Hydrological Heritage belongs to the abiotic portion of the Natural Heritage.

Most geoscientists have mistakenly used the term Geoheritage as a synonym for Geological Heritage (RODRIGUES, 2014). However, 'Geo' will not be directly related to the term 'Geology', but rather to the term 'Earth', in the broad sense of the physical phenomena that are evaluated, studied, and systematized by a range of researchers that goes beyond the limits of Geological Science and encompasses other sciences, such as Environmental Engineering, Geography, Geotechnics, Biology, Agronomy, Mining Engineering, among others, in order not to



reduce the scope of its interpretation. Therefore, geoh heritage refers to those elements of geodiversity that have exceptional values (RODRIGUES and FONSECA, 2008) and, therefore, deserve to be preserved, being divided in geomorphological, hydrological, pedological and geological heritage.

According to Sharples (1995; 2000) and Gray (2004; 2013), the main values are economic (associated with the needs of exploration by human beings, whether through mining, agriculture or civil construction, providing a patrimonial view on them, usually associated with soils, landforms and rocks. One can add subsurface and surface hydric resources, necessary for life, both today and in the past), cultural (it concerns the value that the abiotic physical environment has for certain societies, due to its social or community significance), aesthetic (related to visual appeal, being an intangible concept of geodiversity, ranging from the scale of the outcrop or the isolated element to that of gigantic landscapes), ecological (geodiversity acts as a stage for the performance of human life and its activities and works, as a substrate for the support of the ecological system or as part of a geosystemic complex) and scientific (geodiversity is a laboratory, where the theoretical classes are put into practice, having a formal or informal educational power).

According to Brilha (2005), the first step in mapping geoh heritage refers to its qualitative assessment (inventory), through the completion of forms that present the aforementioned values and are fundamental to identify which mapped sites are important elements of geodiversity or can be considered heritage assets.

The first researches in the literature on Water Heritage, in this case the Hydrogeological Heritage emerged in the late 1990s, as an insertion in the so-called 'geological heritage', from studies by European geologists, with an emphasis on Spanish researchers and research on groundwater and its therapeutic qualities. In 1997, the mineral-medical values of groundwater allowed Coloma et al. (1997) call them Hydrogeological Heritage, as a consequence of their playful and contemplative potential, suggesting protection measures. Duran et al. (1998) defined the so-called 'Places of Hydrogeological Interest' that, despite being seen in a very broad perspective, by including "all places in which the water resource is of special interest" (emphasis added), this resource can be imagined in its most diverse forms (rivers, lakes, fountains, waterfalls, hot springs, etc.). In this way, the authors centralize the relationship between geology, geomorphology and water resources in the bias of the hydrological cycle.

Places of heritage interest in the water domain, which are representative for their condition of exclusivity and representativeness, scientific importance, for example as an paleoenvironmental indicator, ecological support, aesthetic value, among others, will be called 'hydrosites'.



However, it must take into account the difficulty in separating the hydrological heritage, from the geological and geomorphological heritage (CUNHA AND VIEIRA, 2004), given the interrelationships between geology, geomorphology and hydrology. What does the value of a particular aquifer represent? The type of rocks, the morphology that they draw and that determines the circulation of the water or the quality of the water? A waterfall that, due to its spectacularity or scientific interest, deserves to have a patrimonial value and should be considered as geomorphological heritage (due to the differentiation of levels), geological (due to the lithological differentiation or the tectonics that imposes the unevenness) or hydrological (due to the amount of water involved)?

It is understood that this is where the term geoheritage acquires all its meaning, not only because it can agglutinate and geosystemically integrate the different elements of abiotic nature, but also because it can avoid procedural hierarchies in the functioning of the geosystem.

The definition of hydrological heritage, proposed in this work, consists of a set of elements belonging to water resources, of a superficial nature (exurgencies / resurgences, rivers, lakes, dams, seas and oceans), which have a scientific, cultural, economic, ecological and / or aesthetic value. This value is maximized in hydrosites and, therefore, deserve to be preserved, what justifies the mapping conducted regarding the fountains.

Thus, five fountains associated with the Cultural Heritage of the historic center were inventoried and their characteristics will be presented below. They are Bica Maria Feia, Tambiá Fountain, Santo Antonio Fountain, Miracle Fountain and Cacimba do Povo. The production of this information, brought to a wide range of researchers, scientists, students, and tourists, among others, is an important piece for building a culture that is capable of understanding that the region in which we live is much more complex than that of our ancestors and that geoheritage plays an important role in understanding this complexity.

## 2. MATERIAL AND METHODS

The study started with the bibliographic research phase, in order to get to know in depth the history, geology, geomorphology, pedology and hydrology of the physical environment of João Pessoa, lasted about two months.

In a second phase, with the use of topographic maps, aerial photographs and orbital images, fieldwork was carried out in order to identify places of hydrological interest that have geotouristic use values. The following topographic maps were used: Sheet João Pessoa SB.25-Y-C-III, scale 1:100,000 and Mata da Aldeia SB.25-Y-C-III-1-NW, obtained from the Geoprocessing Department of the Federal Institute of Education, Science, and Technology of Paraíba, as well as aerial photographs on the scale of 1:8000 and orbital images, such as images from the



ASTER/TERRA sensor, VNIR bands, with a spatial resolution of 15m, and maps I-11, I-12, J-11, and J-12, on the scale of 1:40,000, available from the Institute of Colonization and Agrarian Reform (INCRA). The heritage elements, mapped on various scales, were inventoried by completing an identification card presented by Pereira (2019).

This card included a framework (name of the fountain, its geographical coordinates, date of observation and location on the topographic map), description of the location (mode and means of access, the scale of the object, a summary of the physical characteristics and photographic record), its importance as an element of geodiversity (justifying its choice by demarcating the aforementioned values from nonexistent to exceptional, with a brief description of the geotouristic potential) and threats (analyzing the anthropic and natural ones that make hydrosite vulnerable, suggesting measures that minimize or avoid them, as well as the existing protection regime).

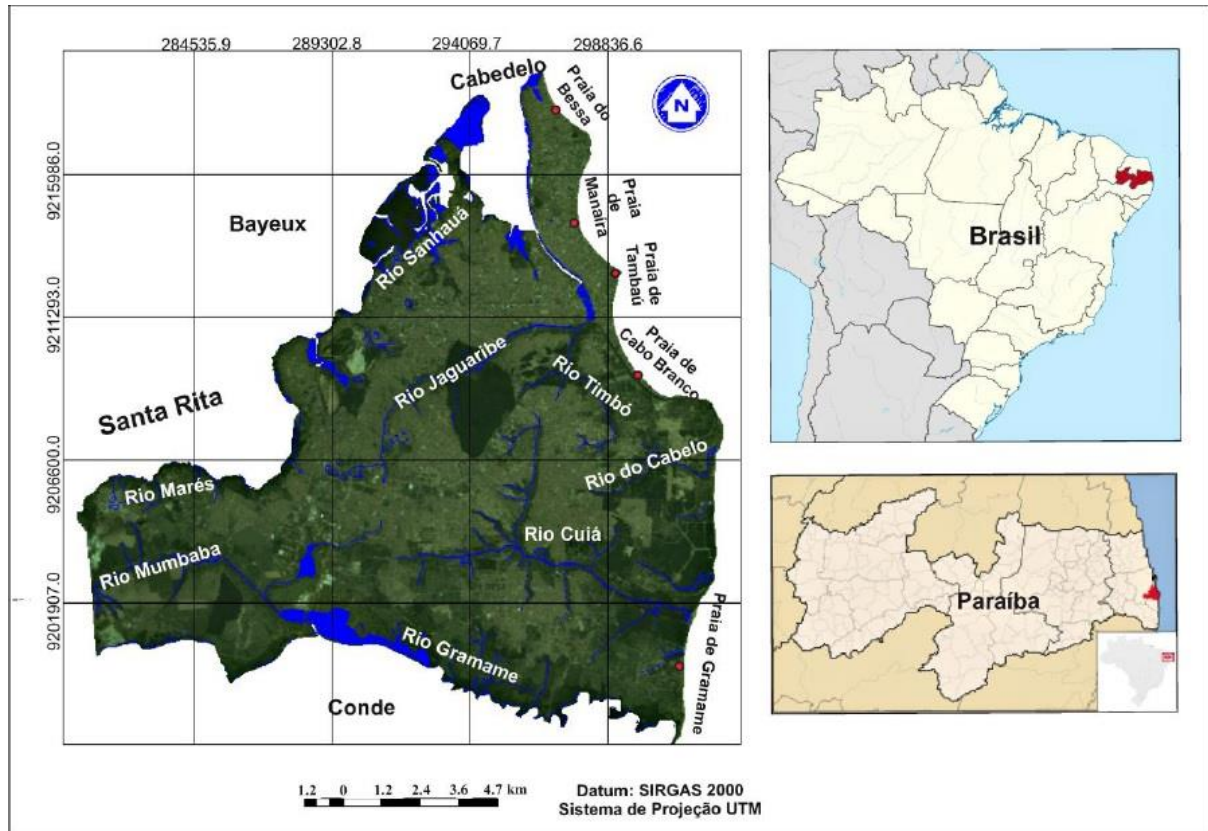
With the inventory of these fountains, it will be possible, subsequently, to insert them in an Urban Geotouristic Guide of João Pessoa (PB) where, in addition to the places of hydrological interest, presented in this essay, will be other elements of the abiotic natural heritage, such as the geomorphological, geological and pedological elements, all belonging to the area's Geoheritage.

### **3. WATER AS AN ELEMENT OF GEODIVERSITY IN THE CITY OF JOÃO PESSOA (PB)**

The municipality of João Pessoa is the capital of the state of Paraíba, the most eastern in Brazil. In fact, João Pessoa is known worldwide as the 'eastern extreme of the Americas', which in itself already has a potential for tourism. Its geographical coordinates are 7°7'S and 34°53'W (Figure 1), and the proximity to the Equator provides a lot of sunshine throughout the year and, therefore, high temperatures (annual average temperature of 26°C). The municipality has an area of 211.5 km<sup>2</sup> and a population of 809,015 inhabitants (IBGE, 2019), resulting in a demographic density of 3825 inhabitants / km<sup>2</sup>, the highest in the state.



**Figure 1-** Location of the research area.



Source: Barbosa (2015).

Because it is a shore city, its natural landscape is basically coastal, selling tourists an image of ‘sun and sea’, that is, coastal beach tourism. To exemplify the natural geotouristic potential of the city, considering the hydrological bias, we can mention its fresh water fountains, such as the Tambiá, dos Milagres, Cacimba do Povo, Bica Maria Feia and Santo Antonio fountains, objects of analysis in this article, with the last two located on the west side of the tablelands, probably associated with a normal fault that exposed the limestone that encloses them (ARAÚJO, 2012).

Other relevant places are the Paraíba River basins, the largest in the State, in its fluviomarine plain, and the Jaguaribe River, in its fluvial plain, the main in the urban area; the Irerês Doline, known as Solon de Lucena Park. The population increase in the municipality, which in the decade 2000-2010 was 35% (IBGE, 2019), has resulted in a greater anthropic action on this natural landscape, which corresponds to an environment that intertwines coastal, valley and plain areas. All these places of hydrological interest can be seen in figure 2.



**Figure 2-** Aerial view of the Paraíba River estuary and the municipality of João Pessoa, with the location of the Sanhauá fault, the Jaguaribe River and its primitive mouth before the Holocenic sedimentation, in addition to the Dolina dos Irerês and the fountains of the Historic Center (1- Bica Maria Feia; 2- Tambiá; 3- Santo Antônio; 4- Miracles and; 5 - Cacimba do Povo). The dashed line shows the inactive cliffs that delimit the boards (to the west) of the Holocene marine terrace (to the east).



Photo: adapted from Dirceu Tortorello (taken on 23 March, 2020).

The fountains of fresh water are located in the Historic Center, being extremely important for their historical value, since they have supplied, for centuries, the population of the nascent city of Nossa Senhora das Neves, João Pessoa's first name. After all, without drinking water, it was impossible to fix and develop an urban site and, in the case of João Pessoa, it was no different, as recorded in the historical documents (e.g. Documento Histórico A.H.U.-ACL\_CU\_014, Cx 10, doc. 791, fl 3 e A.H.U.-ACL\_CU\_014, Cx 13, doc. 1085, fl 2). Thus, some springs in particular stand out in these documents and will be detailed, because of their history and culture, they constitute true hydrological heritage, configuring themselves in hydrosites. They are: Bica Maria Feia, Tambiá Fountain, Santo Antonio Fountain, Miracle Fountain and Cacimba do Povo.

### **BICA MARIA FEIA**

Bica Maria Feia, together with Tambiá Fountain and Cacimba do Povo, are the most peripheral of the colonial urban nucleus and played a predominant role for the populations that lived far from the most central ones; in the case of Bica Maria Feia, especially the population of the eastern portion from the 19th century to the mid-1950s, being a public source (ARAÚJO, 2012).



It is located in the current neighborhood of Tambiá, about 800 meters east of Tambiá Fountain, close to Hospital Santa Isabel, belonging to the Cruz do Peixe farm, and has been very little documented. According to Rodriguez (1962), one of the few records of its existence, from the beginning of the 20th century, refers to it as Bica Mandacaru or Mindêlo.

From the geomorphological point of view, the fluvial valley where the Big Tambiá River is located, in whose straight slope and with a high slope outcrops the Bica Maria Feia, at an altitude of 16 meters, is part of a structural ensemble that includes the Arruda Câmara Park. It consists of a drainage head amphitheater filled with fine alluvial sediments overlaid by sands of the Barreiras Formation, which led to the occupation of an intense medium and large vegetation. Together with other fountains, it supplies the Big Tambiá River and its tributaries, such as Riacho das Bombas and Riacho Boa Vista. According to Araújo (op. cit.), this fountain (Figure 3), like Tambiá's, flows directly from the upper-middle portion of the Barreiras Aquifer (Figure 4).

**Figure 3** - Bica Maria Feia.

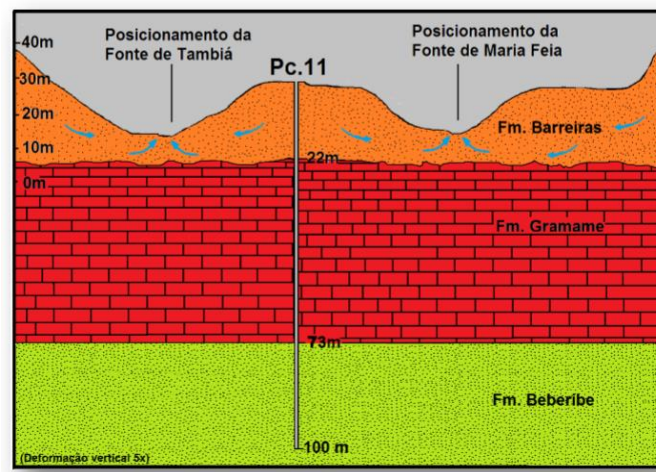


Photo: Magno de Araújo.





**Figure 4** - Profile elaborated from survey testimonies (Pc.11) with the location of the Fountain of Tambiá and Bica Maria Feia.



Source: Araújo (2012, p. 220).

Even though it consists of an isolated fountain inside a forest, it is under pressure from real estate speculation, which gives it a high degree of anthropic vulnerability. There is also a small risk of silting, since there is no protective measure around it. Thus, it is necessary to protect the surrounding forests, since they have a fundamental role both in the hydrological cycle and in sustaining the sedimentation that can silt it. It is also necessary to build a protective wall for the spring, which would also avoid the silting process.

It was selected as an important element of local geodiversity for its high scientific value, as a representative of the Barreiras Aquifer outcrop and for being part of the city's supply history, especially between the 19th and early 20th centuries (RODRIGUEZ, 1962), which justifies its high economic value.

## TAMBIÁ FOUNTAIN

It has been widely iconographed since the 18th century when documents and images show its existence, and of its importance for the population, especially the high income, since it was located in the upper city.

It is located in the Arruda Câmara Park, popularly known as 'Bica', with 26.4 ha, managed by the City Hall and which can be easily accessed by several bus lines. It is a point of rest and leisure for residents and tourists, with a zoo, a lake with pedal boats, leafy trees and a century-old history.

The area surrounding the fountain was transformed into a park, in honor of the Paraíba botanist, by Mayor Guedes Pereira, in 1922. The forest reserve has a fundamental role in protecting the spring and is located outside the perimeter of the Historic Center, but in the vicinity of its northern boundary (RODRIGUEZ, 1962).



While piped water did not reach the city, the role of this spring was crucial, especially in the 19th century, due to its good flow and quality. The approval date for the construction of Tambiá Fountain is March 1782 (PINTO, 1977), under the management of Governor Jeronymo de Castro e Melo. However, since the 1730s, documents have been exchanged between the provider of Fazenda Real and King D. João V about the need to reconstruct the fountain in Tambiá, which allows us to infer that some type of building was there before (historical document AHU -ACL\_CU\_014, Box 10, doc. 791, page 3 and AHU-ACL\_CU\_014, Box 13, doc. 1085, page 2).

The name of this fountain is associated with a local legend, denoting the folkloric aspect of its cultural value. According to Rodriguez (op. cit), a young indigenous virgin named Aipré, from the Potiguara tribe, would have fallen in love with a Cariri warrior, an enemy of his tribe, called Tambiá. After the death of this one by her relatives, the young woman cried for 50 moons over the tomb, and her weeping gave rise to the waters of the spring.

In the 19th century, with the increase in demand for its waters, intensified the concern with the preservation of its surroundings, especially its forests, and several repair works were carried out on its building, according to historical documents. At the beginning of the 20th century, with the plumbing of water for the public, the fountain was losing space, but unlike others, it managed to preserve itself as a record of the city's water supply (AGUIAR, 1992).

From a geomorphological point of view, according to Araújo (op. cit), it flows from the Barreiras Formation, about 7 meters above the Gramame limestone, with an approximate altitude of 19 meters (figure 4). The author proposes that the northeast sector, where this fountain and Bica Maria Feia spring, has a calcareous depth greater than the west slope and that they are springs originating from the upper-middle portion of the Barreiras Aquifer.

Only one of the inventoried fountains that was listed by the State, in this case by the National Historical and Architectural Heritage Institute (IPHAN) on September 26, 1941 and by the Institute of Historical and Architectural Heritage of the State of Paraíba (IPHAEP), in 1980, the latter covering the entire Park.

Despite the listed, its fronton presents terrible current conditions, such as cracks and inclination, which can be caused by repression of the foundation, forcing the City Hall to place a wooden screen (Figure 5). Thus, measures must be taken to mitigate this problem that could come to harm such an important Cultural Heritage, such as a project of patrimonial and/or environmental diagnosis by the parts responsible for its administration.



**Figure 5** - Degrading situation of the pediment built in the 18th century to identify the Tambiá Fountain, richly carved in limestone with baroque elements.



Photo: the authors, taken on 12 March, 2019.

It can be considered an example of a geoh heritage asset due to its exceptional cultural value, associated with the extremely high scientific and economic values.

### **SANTO ANTONIO FOUNTAIN**

It is located on the land of the Franciscans, inside the annex garden, on the northwest side of the boards. To access it, you must go down a relatively steep path for about 350 meters. Since the beginning of the conquest of the captaincy, its waters have supplied the population, which justifies its high economic value. In Dutch iconography, the dimension with which it was portrayed appeared to be large, with a stream that flowed towards the Sanhauá River. It also appeared in numerous Portuguese iconographies, which denotes its high cultural value (PEREIRA, 2019).

However, despite this abundance in the volume of water, the population only had unrestricted access to it until 1609, when the guardian of the Church of São Francisco, Frei Cosmo de São Damião built the wall surrounding the Church, represented in iconographies (PINTO, op. cit.). In 1717, the facade of the fountain (PINTO, op. cit.) was built, according to the year carved on a cornice with volutes and acanthus leaves on the upper part. Access will be restricted to the Franciscan community, except in cases of public calamities, such as droughts or diseases, when it would be open to the population (RODRIGUEZ, op. cit.). Until today, its access is only authorized by the Archdiocese of Paraíba.

The symmetrical and worked in limestone facade maintains the original characteristics in Baroque and presents several small cards with Latin sentences, among them ‘S. Antoni Ora Pro



Nobis ’(“ Saint Anthony prays for us ”). The base consists of a 1.8 m long and 40 cm high tank, parallel to the retaining wall that extends to the sides of the set that forms the frontispiece (figure 6). This is formed by limestone blocks 50 cm long by 30 cm high. According to old photos, water gushed from the pediment to the tank through a dolphin carved out of limestone. However, this piece was lost, leaving only the part closest to the wall (PINTO, op. cit.).

**Figure 6** – Frontispiece of the Fountain of Santo Antônio.



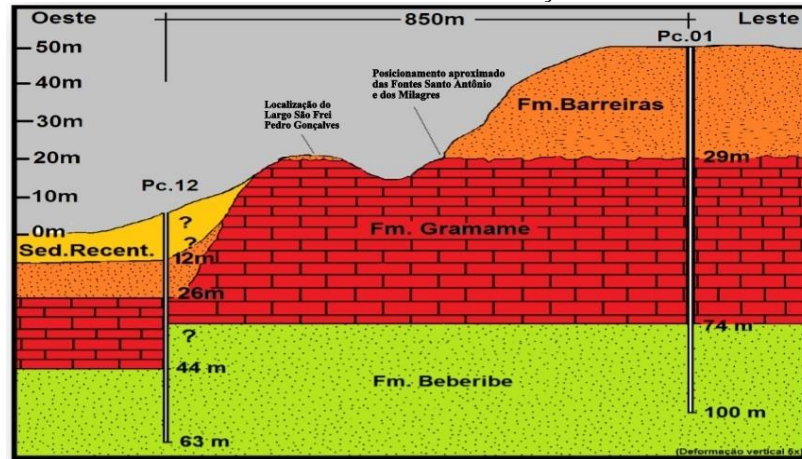
Photo: the authors, taken on 14 March, 2019.

What remains of the dolphin sculpture is surrounded by four narrow columns, about 10 cm wide, forming a lower floor, with two nipples, about half a meter high, at the ends. The narrower upper floor is more ornate, reducing the size of the nipples at the ends and adding small scowls and acanthus leaves that make up two narrow columns. In the center, the niche where the image of Santo Antônio was located was lost over time. Still, it has the best pediment worked in masonry compared with all fountains in the city, which justifies its high aesthetic value.

From the geomorphological point of view, it is located on the west-facing slopes, at an altitude of about 22 meters, in a great depression, directly seated on the limestone (Figure 7), which flourished abundantly on the ground of the Franciscans. Thus, it can be classified as a 'source of geological contact'. According to Araújo (2012), these aspects are complex, with different segment profiles. In the upper and lower portions the profile, of the straight type, presents a high slope that decreases in the intermediate portion, where the source is located, in the contact of the Barreiras sandstone (top) with the Gramame limestone (base). This area consists of the drainage head amphitheater, which tends to reduce the speed of the water flow and even retain it, forming small streams and ponds. Thus, its scientific value is high.



**Figure 7** - Profile elaborated from survey testimonies (Pc. 01 and Pc.11) with the location of the Fountain of Santo Antônio and Miracles, and the Place of São Frei Pedro Gonçalves.



Source: Araújo (2012, p. 221).

It was listed, along with the entire São Francisco Complex, by IPHAN, on October 16, 1952. Its anthropic and natural vulnerability is low, justified by being in an isolated location, with limited access by people. The main necessary protection measure is the correct administration under the jurisdiction of the Franciscans, from their pediment, currently in reasonable conditions.

### MIRACLE FOUNTAIN

On the south side of those who descend the São Francisco Slope, at Rua Augusto Simões, 59, former Beco dos Milagres, it is assumed that it had great importance in the initial period of formation of the city, as it is located close to the first streets of the upper city, where a good part of the population lived, in São Francisco Slope, which connected the upper city to the lower city, on the land of the first vicar of the Igreja Matriz (AGUIAR, 1992).

Schmalz (1966) presents the figure of this vicar, named João Vaz Salem dos Santos, who arrived in the city a year after its foundation. Interestingly, the land where the Benedictine Convent is located and part of his property belonged to the aforementioned priest, who was confiscated by the Crown (PINTO, op. cit.). It cannot be confused with Cacimba da Jaqueira, located on the same site and considered the oldest in the city. According to Pinto (op. cit.), the

[...] site of Father João Vaz to the corner of the street that goes to the fountain and Varadouro, running down the street until you find a fountain with which this city is now used, from which the fountain gives you a third part of the water from the well which is done under conditions that will not, under any circumstances, make another well deeper or any other improvement that damages Water, nor cover or tolerate the people, except for the said third part that it will be able to use the said well only with Caldeirão. The Monastery Fence will go from where the water flows directly to the Mangroves and the mangroves will run until it gets bogged down with the ground and land that was given to the Capuchin Fathers with a declaration that the quarry of the Cantaria that the said Father João Vaz discovered will be freed for the people with way to serve her outside the Fence, which time some will tolerate, for Her Majesty's Service [...] (Pinto, 1977, p. 31)<sup>1</sup>.

<sup>1</sup> [...] dito sitio do Padre João Vaz até o canto da rua que vae para a fonte e Varadouro, correndo pela dita rua abaixo até entestar com fonte de que ora se serve esta Cidade, da qual fonte lhe dão 3a parte da agoa do posso que está feito com condições que em tempo



The name ‘Miracle’ is related to a local legend, from where the name of the Alley descends. According to Aguiar (1992), it was from this spring that, in 1801, the Franciscan friar José de Jesus Maria Lopes would have murdered his mestizo lover, Tereza, after impaling her for a bath in the moonlight. Considering that there is no ‘miracle’ in this fact, Araújo (op. cit.) proposes another origin for the name: the miraculous medicinal properties of its waters, reported in the “Book that gives reason for the State of Brazil”.

In 1849 the facade was built, according to historical documents cited by Araújo (op. cit.), to improve the distribution of water to the population, without having to resort to the Tambiá Fountain, but which was not very successful due to the small size of its accumulation tank and low water flow. According to Rodriguez (op. cit.), it had two bronze taps and limestone pilasters with capitals topped by a semicircular cornice, with a symbol of the imperial weapons at the top, which was removed after the Proclamation of the Republic.

What remains of this fountain, incorporated into a wall, without leaking any more water, are the limestone pilasters, the holes where the two taps were and, in high relief, the indication of the year of construction, all plastered with lime and paint white, which demonstrates the little case that is made of the city's natural and cultural heritage (Figure 8).

**Figura 8** – Miracle’s Fountain.



Photo: the authors, taken on 22 march, 2019.

algum não façam outro posso mais fundo nem outro bemfeitoria que faça prejuízo a dita Agua, nem tapem nem tolham ao povo, salvo a dita terça parte que lhe couber servindo-se do dito posso somente com Caldeirão. A Cerca do Mosteiro irá donde a dita Agua corre directa aos Mangues e dos ditos mangues irá correndo até emtestar com o chão e terras que foi dadas aos Padres Capuchos com declaração que a pedreira da Cantaria que o dita Padre João Vaz descobriu ficará liberta para o povo com caminho para serventia della fora da Cerca, a qual tempo algum tolharão, por que lha não dão nem darão por dada por assim o aver por Serviço de Sua Majestade [...] (Pinto,1977, p. 31).



It has the same characteristics as the Santo Antônio Fountain. With a height of around 17 meters, located at the contact of the Barreiras sandstone and the Gramame limestone, it is a 'source of geological contact', as well as a 'source of failure', as it is located on the slope that represents a failure plane (Figure 7).

Due to the fact that it does not correspond to a listed property and is abandoned, practically unrecognizable due to the existing alterations, this place of interest has a very high anthropic vulnerability. It is of utmost importance that the competent bodies carry out actions that avoid degradation and that seek to recover this patrimonial asset of importance for the history of the city, combined with its dissemination as a tourist location.

It was selected as an important element of local geodiversity for its high scientific value as a representative of the Barreiras Aquifer outcrop and for being part of the city's supply history (economic value). Its name is a classic example of the cultural value of geodiversity in its mythological bias.

### **CACIMBA DO POVO**

It is located in the Bairro das Trincheiras, inside a site in the Mechanical District. Rodriguez (op. cit.) highlights its importance as a source of supply for the population of the southern region, with the year 1857 is the year of its construction, having, since then, a reference in several historical documents of the 19th and early 20th centuries. With the plumbing of the water, in the middle of 1950, it was losing importance, until its (almost) total oblivion.

From the geomorphological point of view, the entire area of the Mechanical District is embedded in a drainage head amphitheater filled with fine alluvial sediments, covered by intense medium and large sizes vegetation. Together with other exurgencies and streams, it supplies the Sanhauá River and its tributaries. Unlike the three previous fountains, this one is located on a slope facing west, at an altitude of about 19 meters (ARAÚJO, 2012).

The fountain, in fact, consists of an accumulation tank, excavated in the limestone, about 1.60 m x 1.30 m and 1.0 meter deep, which stores water from an upper level (Figure 9). Considering that at that altitude is located the base of the Barreiras Formation, responsible for the water reservoir, the exurgence can be classified both as a 'source of geological contact' (Figure 10) and as a 'source' of failure ', according to Leinz and Amaral (2001), for being associated with the geological fault, whose plan is positioned west of the boards of the Barreiras Formation.

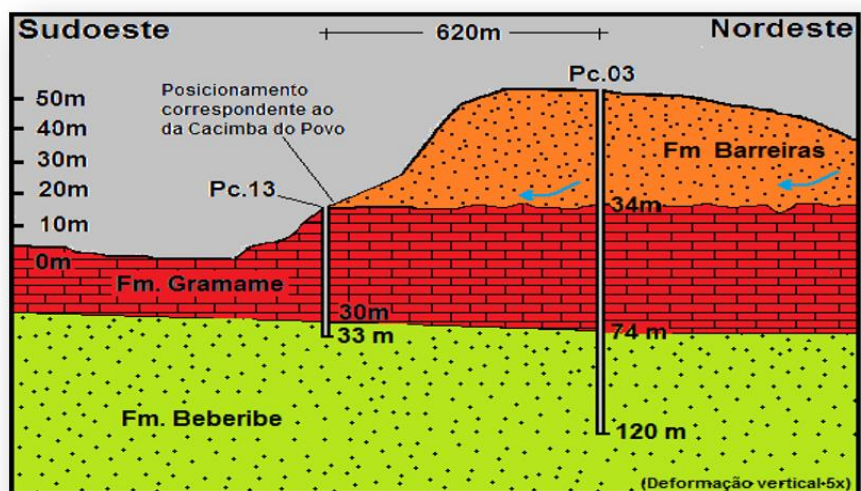


**Figure 9** - Cacimba do Povo.



Photo: the authors, taken on 23 March, 2019.

**Figura 10** - Profile elaborated from survey testimonies (Pc.03 and Pc. 13) with the location of the Cacimba do Povo.



Source: Araújo (2012, p. 224).

It has a high anthropic vulnerability, as it is not a listed property and is located in a place with the minimum conditions of protection. There is also the risk of real estate speculation, which would result in the removal of its surrounding forest, with a consequent risk of silting up.

Thus, just like Bica Maria Feia, it is necessary to protect the surrounding forests, since they have a fundamental role both in the hydrological cycle and in sustaining the sedimentation that can silt it. Common sense is also necessary on the part of the residents of the place, so that they carry out a constant cleaning of the tank, to remove debris, such as leaves and branches, which always hinder the flow of water.





It was selected as an important element of local geodiversity for its high scientific and economic value. Its scientific importance is justified by the fact that it is an example of a 'source of geological contact' and testifies to the process of subsurface drainage of water from the base of the Barreiras Aquifer, which reaches the slopes of a headwater drainage amphitheater and overflows along the slope. Its economic importance lies in the fact that it supplies the population of the southern portion of the city, mainly between the 19th and the mid-1950s (ARAÚJO, 2012).

#### 4. CONCLUSIONS

Water, as an important element of geodiversity, is the result of the action of a set of endogenous and exogenous factors. At the moment when human beings value places of hydrological interest, these hydrosites have heritage value and deserve to be safeguarded for future generations, which corresponds to one of the principles of geoconservation.

The inventory consists of the first step in the survey of geodiversity, its geoheritage and, specifically, hydrosites that represent its history from the physical point of view, being the basis for the purpose that is desired, in the case of this work, the insertion of these sites in an urban geotouristic itinerary in the Historic Center of João Pessoa, Paraíba.

From previous studies about the geomorphology and geology of the area, the history of the city and other pre-established criteria, such as scientific, cultural, ecological, economic and aesthetic value, five hydrosites were identified at various scales. All sources are considered important elements of geodiversity, with the exception of Tambiá Fountain, elevated to the status of geoheritage due to the very high cultural value and high economic and ecological value.

The present work aimed at disseminating this hydrological heritage. João Pessoa is a popular tourist destination in Brazil, from the point of view of sun and sea tourism. It is pertinent, therefore, to intertwine this heritage with tourism in João Pessoa, so that one more motivation arouses the interest of tourists, now turned only to the lithosphere and hydrosphere bias.

Regarding the degree of vulnerability, most fountains, located in isolated lands, without access by the population, municipal lands, in the case of Tambiá Fountain or private lands, in the case of Cacimba do Povo and Santo Antônio Fountain, which protects from impacts anthropic, has a lower risk of vulnerability when compared to Miracle Fountain, exposed to anthropic depredation and to Bica Maria Feia, absent from the protection regime and suffering from real estate speculation.

It is concluded that the municipality has a rich hydrological heritage potential, based on the high values identified in the fountains. The development of urban geotourism in João Pessoa is a dynamic way of disseminating this geoheritage to as many people as possible, whether tourists or



not, aiming at its geoconservation, since geotourism corresponds to an integrated activity between Geosciences, culture and history of the place in which they are inserted. This practice is still incipient and the inventory of this geodiversity with the intention of disseminating Geosciences and protecting hydrosites, was necessary and was of importance for urban management and planning.

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