URBAN RIVERS, BAHIA'S WATERS

RIOS URBANOS, ÁGUAS BAIANAS

Nayara Cristina Rosa Amorim

Abstract

This article presents the process of canalization of rivers in Salvador/Bahia, discussing how recent road interventions in permanent preservation areas can and should contribute to the improvement of environmental and social conditions of river areas, which has not occurred in the capital of Bahia. This article presents the development and application of a river characterization methodology after macro-drainage interventions, highlighting the vulnerabilities, risks, social demands and intervention potentialities. The object of study is the Mocambo river and its relationship with its surroundings: a controlled landfill and the neighborhood of Canabrava, a context of environmental and social fragility. The methodology is based on its applicability by associations of residents, social groups, NGOs, managers and designers, fostering struggles and claims for social and environmental compensation.

Keywords: Urban Rivers. River Characterization. Ecosystem Services. Urban Landscape.

Resumo

O artigo evidencia o processo de canalização dos rios em Salvador, Bahia, discutindo como as recentes intervenções viárias em áreas de preservação permanente podem e devem contribuir para a melhoria das condições ambientais e sociais das áreas fluviais, o que não tem acontecido na capital baiana. O texto apresenta o desenvolvimento e a aplicação de uma metodologia de caracterização de rios após intervenções de macrodrenagem, evidenciando vulnerabilidades, riscos, demandas sociais e potencialidades de intervenção. Apresenta, ainda, como objeto de estudo, o rio Mocambo e a relação com seu entorno: um aterro controlado desativado e o bairro de Canabrava, um contexto de fragilidade ambiental e social. A metodologia tem como premissa sua aplicabilidade por associações de moradores, grupos sociais, ONGs, gestores e projetistas, podendo fomentar lutas e reivindicações por compensações socioambientais.

Palavras-chave: Rios urbanos. Caracterização Fluvial. Serviços Ecossistêmicos. Paisagem Urbana.

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1. Introduction

When we think of urban rivers and their appropriation process in Brazilian cities, specifically the cities of Bahia, we sometimes come across memories of the rivers as a space for those seeking rest, fun, well-being and pleasure, as the Imbassay River was to the city of Dias D'Ávila, or as the Paraguaçu River was to the cities of Cachoeira and São Félix. We also remember rivers as places of transportation and work, such as the Una River, in the city of Valença, and the Jaguaripe River, for the city of Nazaré das Farinhas. When we think of rivers in the metropolises, specifically in Salvador, there are also records of rivers as places of subsistence, space for washerwomen, fishermen and offerings to Oshun. However, little by little, these descriptions of the forms of appropriation of rivers by the population are getting lost in the daily life and the popular imagination, due to the impermeable and artificialized river surroundings, often sharing space with the most precarious housing.

> The paths traveled by the waters recreate a significant part of a story, revealing the perverse relationship between urbanization and nature, because fresh waters disappear in the inverse relationship to the intensity of the urbanization process. Heading a unique history, Salvador, despite having started the process of social appropriation of water resources in what we now call Brazil, allows the environmental degradation of these water resources to be associated with urban and rural poverty. Poverty not of resources, but of destabilization of rural and urban social cohesion, in the solidarity present in a small fraction of the mosaic that is this city. Mosaic of unjust and avoidable inequalities (SANTOS et al., 2010, p. 11).

Rivers say a lot about people, the way they live, the infrastructure they have, their cultural and religious relations and the environmental context in which they are inserted. With an area of 692.818 km^2 (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2010), the city of Salvador has an Atlantic tropical climate, with annual rainfall indexes of 1,781 mm, and includes 17 basins, classified as hydrographic or drainage (SANTOS et al., 2010). The city has two river vectors that create a watershed: part runs towards the Bay of Todos os Santos and part runs towards the Atlantic Ocean. In this way, the quality of river waters influences the balneability of the soteropolitan beaches and their tourist appeal, as well as the beach landscape.

Among the main problems of bodies of water in Salvador are pollution by sanitary sewage (household, commercial, laboratory and hospital) and deposits of solid urban waste (household waste, construction debris, pruning, etc.) (GRUPO AMBIENTALISTA DA BAHIA, 2011; SANTOS et al., 2010; SEMINÁRIO..., 2017).

Recent macro-drainage works in Salvador, mainly in the hydrographic basins to the north, close to the Jaguaribe submarine sewage outfall, have created or structured new circulation routes in non-dense permanent preservation areas (PPAs). As on the Mocambo River, on Mário Sérgio Pontes de Paiva Avenue; on the Trobogy River, on Rischard Avenue; on the Mangabeiras River, on the Beira Rio da Paz Street; on the Pituaçu River, on Gal Costa Avenue; and on the initial stretch of the Jaguaribe River, on 29 de Março Avenue. These road structures in valley bottoms, licensed as works of public interest, mobility and infrastructure to minimize flooding, have caused environmental impacts and contributed to the appreciation and real estate speculation of these PPAs. This process can boost the densification of the fluvial environment in the coming years, reducing soil permeability, as happened previously in the valley-bottom avenues built during the 1970s in Salvador.

The rehabilitation of the body of water in these conditions, after river changes and road implementation, is even more necessary to maintain its existence, especially after the first years of implantation of the new valley-bottom avenues, before the densification and worsening of environmental conditions. The rivers that received the implantation of the new avenues in their surroundings have, as potential, unfulfilled promises and unspent funds that should have been destined for works of environmen-

tal compensation and relocation of houses, hundreds of seedlings of native species foreseen in the Recovery Plans for Degraded Areas, impacts evidenced in Environmental Impact Studies (EIS) and Neighborhood Impact Studies (NIS), in addition to the dream of the surrounding residents with better projects.

Given this scenario, some questions arise: how to improve the socio-environmental condition of rivers in the landscapes created after the implantation of these new valley avenues? Is it still possible to rehabilitate these rivers?

Seeking to answer the questions presented and highlight these potentialities, this research develops a methodology based on observation parameters, survey of technical data on the licensing of river works and evaluation of ecosystem services (ES). Thus, highlighting the possible low-impact, multifunctional landscape types and alternatives to river channels, which can be implemented in these riverside areas to improve the quality of urban rivers and the lives of the surrounding residents. The methodology is divided into ten steps, shown in Chart 1.

Table 1 – Steps for river intervention.

	STEPS	EXAMPLES AND SPECIFICATIONS
1	Definition of objectives	Examples: rehabilitation, restoration, recovery, maintenance, urban requalification, etc.
2	Characterization of the work implemented and the agents involved	Identification of existing documentation, resources and legal obligations.
3	Characterization of the river and ecosystem services present and demanded	It is necessary to identify: (1) regulatory ES, (2) provision ES and (3) cultural ES. The river can be divided into stretches to facilitate analysis.
4	Problems, potentialities and demands (environmental and social)	Synthesis, hierarchy and prioritization of demands, according to the information gathered in the previous step. Identification of ESs or competing demands with each other.
5	Selection of the most appropriate landscape typologies for intervention, according to the demands raised	Examples: rain gardens, bio-ditches, detention ponds, wetlands, biodigester pit, reforestation, linear parks etc.
6	Elaboration of projects	–
7	Identification of possible partnerships and foster sources	Examples: universities, sanitation companies, government secretariats, NGOs, development programs, etc.
8	Development of strategies for implementing participatory management	–
9	Project execution	–
10	Monitoring, implementation of maintenance measures and mitigation of detected problems	Development of computer programs, techniques and parameters.

Source: Prepared by the author, based on studies developed by Travassos (2010), Teiga (2011) and Haase et al. (2014).

This article presents the methodological development of the third step, the river characterization and identification of the ES present and demanded, demonstrating its applicability through the case study of the Mocambo River. Having identified as objective (Step 1) river rehabilitation, understood in this study as the partial recovery of processes and functions of an ecosystem by removing disturbances so that the natural process recovers, it seeks to establish landscapes that are stable, from the hydrological and geomorphological point of view, without seeking to reestablish the original condition of the river (SHIELDS, 2003 *apud* TRAVASSOS, 2010). The pertinent information related to the construction

of the Mário Sérgio Avenue in the PPA and the river works (Step 2) will be presented throughout the text.

Fluvial and ES characterization is a methodological step that can be applied by associations of residents, social groups, non-governmental organizations (NGOs), managers and designers, that is, agents who do not necessarily have technical knowledge of hydromorphology, but who can support and foster demands and struggles for environmental and social compensations. Therefore, a brief approach to understanding what ES is needed.

2. Ecosystem Services

According to Santos (2014), Paul Ralph Ehrlich and Anne H. Ehrlich, American biologists, coined the concept **ecosystem service,** in the 1980s. Santos (2014) Santos (2014) presents several understandings of the concept. For some researchers, ESs are **conditions** and **processes** derived from natural ecosystems and the species that compose them, which sustain and maintain human life, while for others they are the **benefits** to populations, which derive from the functions of ecosystems (MILLENNIUM ECOSYSTEM ASSESSMENT, 2005). Another common definition is that ESs are **natural resources** that support and/or contribute to human health and **well-being** (FISHER; TURNER; MORLING, 2009; HAINES-YOUNG; POTSCHIN, 2017,). It is observed that ESs are often a function from the perspective of the beneficiary, but that they do not necessarily have to be used by man, that is, they are ecological processes or functions that may or may not affect human well -being (FISHER, TURNER; MORLING, 2009). It is also important to understand that the services provided by nature are not always beneficial to the ecosystem or to the population, which can lead to disservices or environmental problems.

The Millennium Ecosystem Assessment (MEA) report was a milestone with regard to the survey of the ESs provided, since it presented the first global assessment of these services to managers, also bringing a categorization of the benefits provided and subdividing them into provision, regulation or maintenance, cultural or information and support (HAASE et al. 2014; MILLENNIUM ECOSYSTEM ASSESSMENT, 2005). These conceptual strategies point to methodological advances in the sense of measuring the benefits (intentional or unintentional) that can be obtained with the implementation of landscape strategies.

Subsequently, the Common International Classification of Ecosystem Services (Cices), a digital platform that had its first version (V.4.3) published in 2013, designed to help measure, account for and assess ecosystem services, rediscussed the categorization of ESs. The Cices took, as a starting point, the categorization presented by MEA, however its current version (V5.1), published in 2016, brings a review of these categories. In this version, support services are no longer included, as it is considered that "space", in itself, is not an ecosystem service and is better worked separately, in specific land accounting systems or platforms, such as SEEA Central Framework (HAINES-YOUNG; POTSCHIN, 2017). The categories and subdivisions adopted by Cices - V5.1S are: regulation and maintenance (transformation and regulation), provision (biotic and abiotic) and cultural (direct and indirect), which will be incorporated in the presented methodology.

When planning the implementation of landscape typologies capable of providing ecosystem services, the first issue to be considered should be the demand of the population. However, the ecological assessment that precedes these interventions often does not directly consider human needs or stated preferences and desires: instead, it considers physical or non-physical environmental results, which have indirect value for human beings (WINKLER, 2006 *apud* HAASE et al., 2014). It is noticed that the development of characterization, parameterization and quantification methods capable of coping with these multiple perspectives (social/economic/ecological) is one of the biggest challenges to make the ecosystemic approaches to urban planning operational in terms of policies and decision making. In this sense, this research seeks to identify the relationships established between the population surrounding the Mocambo River and the river itself, its uses, occupations and demands for ecosystem services.

3. Ecosystem Services in the Mocambo River

The research aims to approach the Mocambo River, located near the neighborhoods of Canabrava and Nova Brasília, and to the Socio-Environmental Park of Canabrava, a deactivated controlled landfill in Salvador. This river, with the construction of the Mário Sérgio Avenue (2015-2018), was diverted, straightened, had part of its flood plains landed, suffered cuts in the land, fragmentation of its tributaries and removal of vegetation, as shown in Figure 1. The residents of Canabrava claim to the State Public Ministry (Portuguese acronym: MPE) and the Public Defender of the State of Bahia (Portuguese acronym: DPE/BA) environmental and social compensation for the impacts caused by the work. In view of this, the proposed methodology seeks to identify possible strategies and techniques for the rehabilitation of rivers capable of meeting social demands and improving the quality of river waters, to support such claims.

The Urban Development Master Plan for the City of Salvador (2004) recognizes part of the neighborhoods on the banks of the Mocambo River (Canabrava and Nova Brasília) as a Special Area of Social Interest (Portuguese acronym: Zeis). The Law No. 9,148/2016 defines the Zeis as areas intended for land tenure regularization (urban and legal) and for the production, maintenance or qualification of Social Interest Housing (Portuguese acronym: HIS) and Popular Market Housing (Portuguese acronym: HMP). Most of the Canabrava neighborhood corresponds to type 1 Zeis, characterized by precarious settlements,

Figure 1: Construction of the Mário Sérgio Avenue on the Mocambo River PPA, with floodplain on the right side.
Photo: Nayara Amorim, March 2017.

predominantly inhabited by low-income population and located on public or private land (SALVADOR, 2016), which shows the diversity of the demands of these neighborhoods.

To apply the characterization method, the Mocambo River was divided into three stretches, which were established by the uniformity of the physical and anthropic attributes of the landscape of its banks. Figure 2 shows the location of the three stretches of analysis and the characteristics of use in the micro-basin.

The information presented in Tables 2, 3 and 4 was collected on April 12, 2019, about a year after the construction of the Mário Sérgio Avenue was closed. The observations took place in the morning, with an average temperature of 25 ° C, with the par-

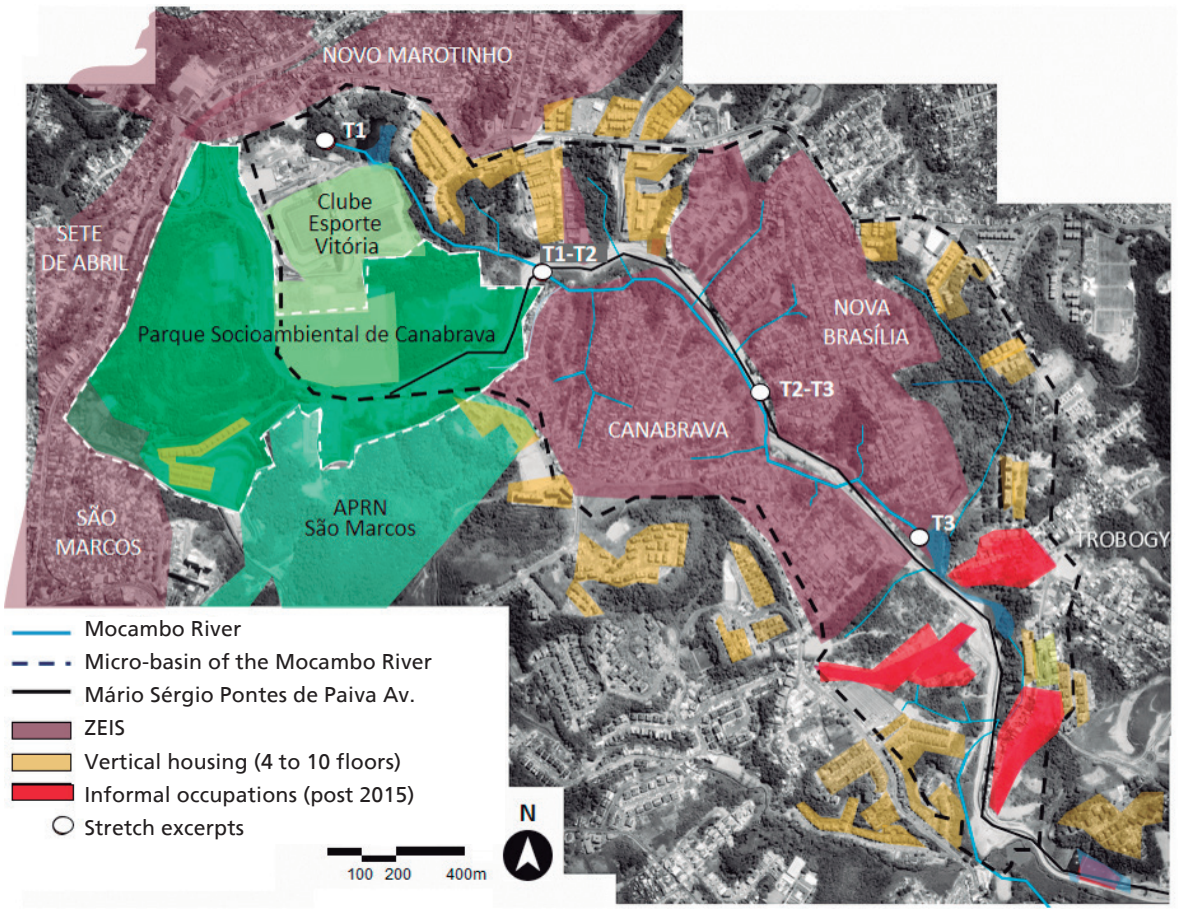

Figure 2: Predominant uses in the Mocambo River micro-basin.
Source: Prepared by the author.

ticipation of two residents of the surroundings, and in the days preceding the data collection there was no rain. The pluviometric and temperature characteristics contribute to the reduction of the water volume and concentration of diffuse and punctual pollution[1] in the body of water. It is important that this collection does not occur immediately after the completion of the works in the riverside area, as the water characteristics are not yet stable (TEIGA, 2011).

The characterization of the relationship between the Mocambo River and the ESs was divided into three categories: (1) regulation and maintenance; (2) provision; and (3) cultural – each corresponding to a table to be filled in accordance with the conditions of the river and the analyzed PPA. The tables present the main characterization parameters, however, when the methodology is applied in other river conditions, complementary parameters can be added to the tables.

3.1 The river and the regulation and maintenance services

The regulation and maintenance ESs, as the name itself shows, are regulators of environmental conditions and interfere in the weather balance, in the maintenance of water, soil and air quality, in the regulation of rainfall, pollination, biological control, among others. This topic seeks to highlight the physical characteristics of waters, soil, sediments and the shape of the banks that influence the maintenance of river quality.

The different forms of river layouts (meandering, straight, anastomosed, interlaced) respond to a flow regime that corresponds to the fluvial volume variation during the year, which impacts on the regulation of soil and sediment characteristics on the banks, as well as in its erosion and sedimentation processes. Sediments affect the maintenance of water quality during the flow regime, directly affecting the physicochemical properties of the water, with a decrease in dissolved salts, problems with dissolved oxygen concentration or changes in water temperature, producing changes in biological cycles (TEIGA, 2011). In this sense, characterizing the physical structure of the river and its tributaries is important to highlight its impacts on soil structure and water quality.

Table 2 seeks to show qualification parameters for regulatory ESs. The answers in bold correspond to actions or spaces after the construction of the Mário Sérgio Avenue.

From the characteristics of color (**P4**), odor (**P5**) and evidence of water (**P6**), it is evident that Stretch 1 has as main pollutants slurry and solid waste carried by the landfill. In this stretch, the presence of domestic effluents was not identified. To combat these environmental problems, it is necessary to implement phytoextraction or phytostabilization techniques in the landfill area, so that these pollutants do not continue to be carried in the following stretches (BARROS, 2017; PINHEIRO, 2017).

In Stretches 2 and 3, the main pollutants are likely to be domestic effluents discharged into the river, diffuse pollution and sediments carried by rainwater, and chemical pollutants are also carried in the first stretch of the study. In view of these observations, it is evident the need to study techniques for decentralized treatment of sewage and rainwater.

1 **Diffuse pollution** includes pollutants that reach rivers transported by rainwater, such as oil residues, fuels, organic matter, agricultural pesticide residues, among others. **Point pollution**, on the other hand, is understood as concentrated and individual discharges that occur on the riverbed, as domestic sewage networks and industrial effluents (BARROS, 2017; PINHEIRO, 2017).

Table 2 – Characterization of ecosystem regulating services on the Mocambo River.

Parameters	Stretch 1	Stretch 2	Stretch 3
1 Main riverbed flow regime type (A) Perennial (B) Intermittent	A	A	A
2 Number of tributaries received	2	8	4
3 Tributaries flow regime type (A) Perennial (B) Intermittent	A	A and B	B
4 Water color (A) Milky (B) Dark green (C) Blue-gray (D) Brown/Earthy (E) Transparent (F) Other color (specify)	B	C	C
5 Water odor (A) Chemical odor (chlorine) (B) Decomposition odor (C) Sewer odor (D) Fresh (E) No odor (F) Other odor (specify)	B	C	C
6 Water evidence (A) Organic waste (B) Foam (C) Sewers (D) Oils, multicolored reflections (E) Plastic or metallic material (F) Leaves and tree trunks	E and F	C, D and E	C, D and E
7 Type of sewage treatment in the surrounding area (A) Sewage directly deposited in the river (B) Collector network deployed and functioning (C) Collector network in the process of implementation (D) Compact Sewage Treatment Plant - STP (decentralized station) (E) Individual or collective septic tanks (F) Evapotranspiration basins/ banana tank (G) Stabilization pond ((concentrated detention - pools/"potty")	Not applicable	A B and D	A and C
8 Collection of solid waste (A) Collected on all streets (B) Collected only on deposit points (C) Specific collection of recyclable materials (D) No collection	Not applicable	B	B
9 Channel structure (A) Buffered (B) Concrete plumbing (C) Plumbing in gabion (D) Rectified bed, without channeling (E) No changes, natural bed	E	**D**	**D**
10 Average water depth ((m)	2	1.5	1.5
11 Flood areas on the banks (A) Permanent ponds (B) Temporary ponds (C) Permanent standing water (D) Temporary standing water (E) Floods (F) Weirs (G) Dams	A	C	D and E

12 Sediments at the banks (A) Gullies (B) Landslides (C) Field cuts (D) Lanfills	B	D: RB C: LB	A: RB D: LB
1 Permeability on the banks (d ≤ 30m) (A) Absent (B) < 30% (C) 30 – 60% (D) 61% – 90% (E) > 91%	D	B: RB D: RB	B
2 Shading of the banks (d = ≤ 30m) (A) Absent (B) < 30% (C) 30 – 60% (D) 61% – 90% (E) > 91%	E	A	B
13 Channel Flow (A) Chaotic, turbulent (B) Fast and with sound (C) Ascendant (incoming tide) (D) Slow/stopped (E) Current without sound (F) Dry, without water	E	D	E
Complementary parameters that can be added: water quality index – WQI (dissolved oxygen, thermotolerant coliform, pH, biochemical oxygen demand – BOD, water temperature, total nitrogen, total phosphorus, turbidity, and total waste).			

RB: right bank; LB: left bank; QQI: water quality index *. Some environmental reports, such as the EIS, can inform some of these parameters.
Source: Prepared by the author.

Regarding the type of sewage treatment (**P7**), the *Canabrava Neighborhood Plan* (PROGRAMA CATA AÇÃO, 2012) identified that more than 70% of the houses in Canabrava lacked basic sanitation and 32% of the houses were exposed to some type risk of landslide. Canabrava is part of the Trobogy sanitary sewer basin, which is in the process of being implemented and is integrated with the submarine sewage outfall of Boca do Rio, opened in 2011 (EMPRESA BAIANA DE ÁGUAS E SANEAMENTO, 2013). The sewage treatment in Salvador, operated by the Bahia Water and Sanitation Company (Portuguese acronym: Embasa), consists of removing solid and floating material from the sewer, taking it to the submarine outfall and subsequently launching it to the sea, at a depth of 45 meters, at 3,670 meters from the coast (EMPRESA BAIANA DE ÁGUAS E SANEAMENTO, 2013). The concessionaire does not cite measures taken to reduce the impact on marine life caused by the daily disposal of sewage, only that this disposal does not impact the balneability of the beaches. However, the beaches near the two emissaries are constantly unsuitable for swimming, according to data from the Environment and Water Resources Institute (Portuguese acronym: Inema)[2].

In Stretch 1, as it is a riverside space not yet urbanized and close to the mouth, where there is no drainage of other water courses that permeate areas and whose surroundings have not yet been urbanized or occupied, it appears that some characteristics are not present, or **do not apply**, such as sewage treatment (**P7**) and solid waste collection (**P8**).

One of the problems with a traditional sewage collection network in the process of being implemented in low-income areas is that the population needs to pay for the works inside the houses to connect the residential piping to the public network. Many claim not to be able to afford the works and the costs of using this public service and continue to deposit effluents directly into bodies of water or in the circulation routes. So far, no public exemption programs or financing for the costs of hydraulic works in houses have been identified.

Despite the straightening of the channel shown in (**P9**), the waters show low flow velocity (**P13**), forming flooding areas in some stretches (**P11**), which are conducive to phytoremediation treatment and can have their ecological functions enhanced by

2 The data are made available weekly by the Balneability Bulletin, available on the website: http://www.inema.ba.gov.br/servicos/monitoramento/qualidade-das-praias/.

the river rehabilitation project. A reduced volume of water was identified (outside the rainy months), which could be diagnosed by the intermittency of its tributaries impacted by the surrounding buildings. This makes it necessary to protect such areas of springs, as well as the path of the tributaries, with subsequent recovery of riparian vegetation to assist the process of treating these waters, which also receive sewage and diffuse pollution.

In relation to the sediments on the banks (**P12**) of the Mocambo River, the disordered occupation of the area and the installation of the Canabrava landfill promoted quite significant erosion processes, such as flooding of the springs, slope instability and silting of the ponds and streams. As a result, sediments in the process of decomposition and manure from the landfill (KUCHARSKI et al., 2011) increase the soil.

3.2 The river and provision services

The provision services comprise the materials produced by the ecosystem, which can be consumed by animals, especially by man. Some examples: water, food, natural medicines, biomass, raw materials for crafts, fuel or construction. This provision can be for both consumption and commercialization, which can boost the local economy.

The waters of the Mocambo River have already been used as a provision ES, mainly by washerwomen and fishermen, as the older residents say, but currently, due to the low quality of the water, it has not been used much. It is noticed that vegetation has been the most significant element as a provision service around the Mocambo River and, therefore, the analyses will be directed to identify the diversity and problems of plant species.

Table 3 shows the qualification parameters of the provision ES, and the answers in bold correspond to actions or spaces after the implementation of the Mário Sérgio Avenue.

The vegetal typologies of the banks (P3) show the presence of pond areas (swamp/quagmire/wetland/swamp), humid areas where it is not possible to see the water depth in the dry months. In which the predominant presence of the invasive species (**P4**) cattail (*Typha angustifolia*) was observed, in the form of plants up to 2 meters high, a species that can compete for space and soil nutrients with native species, but which also has potential phytoremediation, contributing to the removal of pollutants from water (PINHEIRO, 2017). In the rainy periods, the quagmire areas flood and the animals that live in these areas move to the highest parts of the land, where occupations are concentrated, showing part of the local fauna.

Due to the characteristics of the species removed (**P5**), it is possible to identify part of the probable fauna present in the ecosystem, mainly birds, bees and pollinating insects, as well as some fruit species, such as jackfruit, mango and murici. According to residents' reports and on-site observations, residents near the river also planted avocados, banana trees and cocoa. It is customary, especially for children, to collect these fruits, which shows the provision of food by the local flora. Figure 3 illustrates one of the areas where fruit is still planted.

Ecosystem provision services can be worked on in river rehabilitation projects as strategies to foster the local economy. When we choose to use phytoremediation techniques to treat water and soil, cut species, such as flowers and foliage, which can be commercialized can be used. It is also possible to use vegetable fiber for artisanal production, for example, Cattail fiber (*Typha angustifolia*). The inhabitants of the surroundings can do the management of these vegetable productions, mainly by the local associations previously identified. Therefore, it is necessary to include training courses for both artisanal production and management in river rehabilitation projects, these being understood as part of investments in environmental education.

Table 3 – Characterization of cultural ecosystem services on the Mocambo River.

Parameters	Stretch 1	Stretch 2	Stretch 3
1 Use of water (A) Home use (B) Commercial use (C) Industrial use (D) Agricultural irrigation (E) Dam (F) River beach (G) Soil extraction (H) Hunting and fishing (I) Livestock/grazing (J) Obstruction of anthropic origin	F: River beach H: Hunting and fishing	**J – Obstruction of anthropic origin: sediments from the construction of Mário Sérgio Avenue**	**J – Obstruction of anthropic origin: sediments from the construction of Mário Sérgio Avenue**
2 Provisions for consumption or marketing (A) Vegetables and crops (B) Fruits (C) Cut plants (foliage, flowers) (D) Livestock, sheep and goats (E) Breeding of fish and crustaceans (F) Beekeeping	–	A – Cassava B – Fruits: jackfruit, mango, avocado, banana, cocoa and murici (*Byrsonima crassifolia*).	A – Vegetables and crops B – Fruits: banana, mango and lemon tree.
Vegetable types of the banks (native + exotic) (A)Aquatic (B) Mangrove (C) Sandbank (D) Grasses (clear field) (E) Herbaceous (dirty field) (F) Arboreal (G) Shrubs (H) Palmaceae	G and F	E: Herbaceous wetlands on the right bank **H**	D, E and **H**
4 Exotic/invasive species identified	Cattail (*Typha angustifolia*)	Cattail (*Typha angustifolia*)	Cattail (*Typha angustifolia)* and Leucena (*Leucaena leucocephala*)

5 Vegetable types removed for road implantation (A)Aquatic (B) Grasses (clear field) (C) Herbaceous (dirty field) (D) Shrubs (E) Arboreal (F) Palmaceae (G) Mangrove (H) Sandbanks		E – 315 tree species of the species: pau-pombo (*Tapirira obtusa*), selva-de-leite (*Para glabrata*), cinzeiro (*Hirtella hebeclada*), vez-materia (*Kielmeyera reticulata*), matataúba (*Shefflera morototoni*), biriba-branca (*Eschweilera ovata*), paraíba (*Simarouba amara*), cecropia (*Cecropia hololeuca*), jack tree (*Artocarpus heterophyllus*), amescla (*Trattinnickia burseraefolia*), acacia (*Acacia sp.*), mango tree (*Mangifera indica*), wild peanuts (*Pterogyne nitens*), mundururu (*Miconia prasina*), murici (*Byrsonima basiloba*), Amescla (*Trattinnickia burseraefolia*).* (F) 5 Palmaceae of the species: buritizeiro (*Mauritia flexuosa*), imperial palm (*Roystonea oleracea*).*
6 Number of species determined for environmental compensation		3,200 tree species*
Complementary parameters that can be added: fauna data, biological factors, psychological and epidemiological aspects of health.		

* Data Vegetation Suppression Authorization nº 2015-Sucom/DAL/CLA/ASV-005, Administrative Process nº PR 75 2014 1641 Environmental Licensing.
Source: Prepared by the author.

Figure 3: Stretch II, right bank of the Mocambo River during construction of the road. In the floodplain, the vegetation composed of grasses and herbaceous that cover the water layer and, in the background, in the more inclined areas, large vegetation and the neighborhood of Canabrava.
Photo: Canabrava Community Cultural and Sports Association, March 2017.

The Mário Sérgio Avenue is approximately 20 meters wide and separates the fragments of vegetation from the two banks of the Mocambo River, impacting fauna relations and the connection between the neighborhoods that border the track. To mitigate this environmental impact, it is necessary to plan urban afforestation. In the stretches where there is a central flowerbed of approximately one meter in width, some palm seedlings have been planted, but this plant species does little to contribute to the connectivity of local fauna and flora and the provision of ES. Public lighting and underground electrical wiring are also concentrated in the central part of the track, making it difficult to plant larger species. Therefore, to mitigate road impacts, it is recommended to plant fruit tree species of great local occurrence on both sides of the road, which will also contribute to the regulation of thermal comfort on sidewalks and bicycle paths, an ecosystem service that we will deal with next.

3.3 The river and the cultural services

To understand the demands for cultural ecosystem services, it is necessary to identify the local demands (education, health, infrastructure, accessibility, employment, etc.), whether these are related to the body of water or not. In this sense, characterizing the different uses and types of occupation near a river can assist in the process, identifying the urban morphology of the surroundings, which often shows the origin of environmental problems.

Table 4 shows qualification parameters for cultural ES, and the answers in bold correspond to actions or spaces after the implantation of the. Mário Sérgio Avenue.

It is important to point out that the open spaces for leisure built on the side of the road (**P1**) and the complementary mobility works were not foreseen in the initial project, and were only carried out through claims by the surrounding residents to the Public Defender of the State of Bahia. Among these areas, we have: a grassy area with paths (approximately 1.100 m^2), without direct access to the surrounding houses, the informal square of Vila Mar (approximately 30 m^2), which consists of a grassy area, and the square of the Araújo Martins lane (approximately80 m^2). Equally the result of the claims are the bicycle paths on both sides of the track (l = 1 m), three bus stops (Figure 4), two staircases and some bridges over the Mocambo River (Figure 5), which connect residents to the new road. The Pôr do Sol (Sunset) Square was also built, which has a sand court, gym equipment and children's toys (approximately 4 thousand square meters), which, however, is not within the study area, as it is about three hundred distant meters.

On the occasion of the construction of the Mário Sérgio Avenue, for the expropriated housing (**P3**), a link to the My House My Life (Portuguese acronym: MCMV) program was offered, but many residents did not accept it, because they had no intention of moving away from the neighborhood, to places away from family and work relationships. A sum of money was also offered, referring only to the value of the building's improvements, as the residents do not have possession of the land they occupy, because they are public areas that are configured as PPA. Most of those affected accepted the amount of money and built new buildings near the river, in some cases a few meters away from the expropriation area for the construction of the road, some even within the PPA itself.

With regard to the ethnographic heritage (**P4**), festivals or cultural traditions directly related to the Mocambo River were not identified, mainly due to the current conditions of pollution of its waters. As an important cultural moment for the Liliane Tavares neighborhood, a tribute to the biologist and community leader of the same name, the *Lavagem de Canabrava* stands out. In this event, several groups come together to make presentations, and groups from other communities are also invited when dance and music shows take place, as well as a gymkhana, in which food is collected to be distributed to families in the neighborhood (SANTOS et al., 2010). The *Lavagem de Canabrava* has not occurred in recent years, but, according to residents of the neighborhood, the event is considered of extreme importance for generating income in the neighborhood. The river remains in the stories and memories of the older residents as a leisure space, as evidenced in a conversation with a resident:

Table 4 – Characterization of cultural ecosystem services on the Mocambo River.

Parameters	Stretch 1	Stretch 2	Stretch 3
1 Open spaces on the banks (d ≤ 30 m) (A) Parks or squares (B) Soccer field (C) Vegetable gardens, orchards/ crops (D) Street and sidewalk (E) Bicycle path/bicycle lane (F) Other (specify)	A: Canabrava Socio-Environmental Park	**A: Grassy square and Vila Mar square** C: Vegetable garden and private orchards D: Informal field **E: Bicycle path of the** *Mário Sérgio* **Avenue**	**A: Square on Araújo Martins Street** **E: Bicycle path of the Mário Sérgio Avenue**
2 Number of buildings on the banks (d = ≤ 30 m)	0	7	+/– 20
3 Expropriations		287 foreseen in the initial project	
4 Ethnographic heritage (A) Festivals and traditions (B) Stories and short stories (C) Use of the river for bathing (D) Sports practice (F) Religious use (E) Other (specify)	B: Stories and short stories about the pond C: Use of the river for bathing	**D: Exercise on the banks – walking and running** F: Mãe Roquinha *Terreiro* (Ritual Grounds)	**D: Exercise on the banks – walking and running** F: Mokambo *Terreiro* (Ritual Grounds)
5 Surrounding groups (A) Sport (B) Artistic/musical (C) Associations (D) NGOs	A: Canabrava Sports League, Raízes do Dendê Capoeira, Bandeira Brasil Capoeira Association, Bicho da Cana Cultural Group, Monas Odara, Barcelona (Boxing), Cobra Association (Hapkido) B: Mania de Samba Reggae and MC's Rap bands C: * Community Speakers Association, Canabrava Residents Association (Amocabra), Canabrava Neighborhood Friends Community Association, Canabrava Youth Community Association (ACJC), Community Cultural and Sports Association (Acecc), Jovens do Amanhã (Youth of Tomorrow) Cultural Association, Association of Parents and Friends of the Canabrava Community (Acac), Projeto Sementes do Amanhã (Seeds of Tomorrow) Project and Cantos de Leitura (Reading Chants) Project.		
Complementary parameters that can be added: access to free spaces and distance, number of visitors, willingness to pay, health and disease recurrence, recreation opportunities, user motivation, cash flow, increase in real estate value, aesthetic appreciation, inspiration for culture, spiritual/religious experience and identity/belonging.			

* It was not possible to confirm which of these groups remain active.
Source: Prepared by the author. Complemented data based on Santos et al. (2010), Cata Ação Program (2012); Hansen and Pauleit (2014), Expropriation Plan... (2016).

Figure 4: Bus stop, with bike path and leisure equipment in the background.
Photo: Thiago Jr., February 2018.

Figure 5: In the foreground, the line that marks the bike path, the bridge over the Mocambo River and the access staircase.
Photos: Thiago Jr., February 2018.

> *The Mocambo River was a river that started at Barradão Pond, it had a very long extension, and it cut the coast of Canabrava. At the time, there was alligator, there was fish, the community fished and, with the arrival of the dump here, it started to be polluted* [...]. *At the time, the vegetation that existed in the river was Canabrava, which was a type of cane, and it was from that cane that, due to the immensity that existed in the flooded places, we named the neighborhood of Canabrava. The Mocambo River today is not what it used to be, the river is now dead, it is no longer the Mocambo River, it is the "Dead-Mocambo" river* (Ubiratan S. Rosa, 4 dez. 2018).

Several sports, artistic groups and associations (**P5**) were identified in the surroundings, most without their own headquarters or public space conducive to exercising their activities. In this sense, it would be important that existing and implemented public spaces were designed to receive these demands, which did not happen.

Among the main demands for cultural ecosystem services around the Mocambo River, the need for physical space and the structure to house the groups and associations present in the neighborhood, especially those related to sport and music, stand out. It is noticed that cultural inspiration is very present, which is reflected in the number of cultural groups and productions, and that it has contributed to the strengthening of the feeling of belonging to the neighborhood, but this identity is rarely associated with the Mocambo River.

4. Final Considerations

The tables presented throughout the text seek to highlight the characteristics of the riverside area after the implementation of the macro-drainage projects, the environmental and social impacts, as well as the information that can support subsequent intervention projects or compensatory measures. It was observed, through the process of methodological application, that the river characterization not only highlights the environmental con-

ditions of the river. In addition, it also brings residents closer to the problem, making them more aware of the current state of the river, its history and its potential, contributing to the strengthening of the perception of identity and belonging between the river and the residents of its surroundings.

It can be seen, throughout the text, that the Mário Sérgio Avenue road project and the macro drainage of the Mocambo River brought benefits to the surrounding population, after residents' claims, such as improved mobility, with bus stops and bicycle paths and the implementation of open leisure spaces, such as the squares on Araújo Martins Street and Vila Mar. However, the quality of these deployments needs to be considered, as they take little account of the demands of the local population and culture. The work does not contribute to improving the quality of the waters of the Mocambo River, waterproofs part of the PPA and does not include a maintenance plan for the infiltration or recharge areas near the river. It is known that road construction can generate real estate appreciation, which contributes to the increase in density and waterproofing of the area, a phenomenon that is already happening in Canabrava, and this process can further accentuate the worsening of river quality.

The quality of an urban river is not limited to the environmental condition of its waters, PPAs and ecosystem services. The configuration of riverside spaces, free and built, directly reflects the perception of bodies of water. PPAs, when configured as places of social interaction (sport, leisure, contemplation), are open spaces of extreme importance for the strengthening of cultural practices, relationships of belonging and environmental education. However, we need to advance in the understanding of these open spaces as potential sites for the decentralized treatment of effluents and rainwater, with landscape typologies of phytoremediation, thus enhancing the provision ES.

The evaluation of ES as a product and methodology of landscape planning has anchored other concepts, such as green infrastructure and nature-based solutions (HAINES-YOUNG; POTSCHIN, 2017; HANSEN; PAULEIT, 2014;). That is why it is essential to advance and consolidate the ES measurement methodologies, which can support the decisions of managers and the development of projects that are more articulated with social and environmental demands, especially in urban areas.

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Nayara Cristina Rosa Amorim
Universidade Federal da Bahia (UFBA), Faculdade de Arquitetura. Programa de Pós-Graduação em Arquitetura e Urbanismo da Universidade de São Paulo (FAU-USP).
Rua Caetano Moura, nº 121, Salvador, BA, Brasil, CEP 40210-905
Orcid: https://orcid.org/0000-0002-6653-457X
E-mail: nayaraamorim@ufba.br

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