# ENVIRONMENTAL EQUILIBRIUM SPACES OF THE CENTRAL REGION OF VILA VELHA (ES)

## ESPAÇOS DE EQUILÍBRIO AMBIENTAL DA REGIONAL GRANDE CENTRO DE VILA VELHA (ES)

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### Abstract

The city of Vila Velha underwent a process of accelerated urbanization that, together with the lack of urban planning and real estate valuation, replaced natural environments with built spaces that do not favor the health and quality of life of the population. In this context, this article aims to analyze the green spaces, considered in this work as "spaces of environmental equilibrium" of the Central Region of the municipality. The methodology was based on the mapping of the areas, considering Mendonça (2015), with the aid of the ArcGIS program, with reference to the master plan, satellite image and local visits. The analysis found that the spaces of environmental equilibrium of the Central Region are not well distributed and are concentrated in the Permanent Preservation Areas (PPA). It is also noteworthy the importance of potential spaces that can be used to supply the shortage of these areas. Thus, it is hoped to contribute to further research and future interventions in the free spaces of the city.

Keywords: Public Space. Urban Experience. Green Areas. Environmental Equilibrium Spaces.

### Resumo

A cidade de Vila Velha passou por um processo de urbanização acelerado que, juntamente com a falta de planejamento urbano e a valorização imobiliária, substituiu ambientes naturais por espaços construídos que não favorecem a saúde e a qualidade de vida da população. Nesse contexto, este artigo objetiva analisar os espaços verdes, considerados neste trabalho como "espaços de equilíbrio ambiental" da Regional Grande Centro do município. A metodologia baseou-se no mapeamento das áreas, considerando Mendonça (2015), com auxílio do programa ArcGIS e tendo como referência o plano diretor, imagem de satélite e visitas locais. A análise constatou que os espaços de equilíbrio ambiental não são bem distribuídos, ficando concentrados nas Áreas de Preservação Permanente. Destaca-se ainda a importância dos espaços potenciais que podem ser utilizados para suprir a carência dessas áreas. Espera-se, assim, contribuir para novas pesquisas e futuras intervenções nos espaços livres da cidade.

Palavras-chave: Espaço Público. Vivência Urbana. Áreas Verdes. Espaços de Equilíbrio Ambiental.



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## 1. Introduction

Cities are forms of collective life and a place of coexistence, where plurality starts from the coexistence between socially different actors (NETTO *et al*., 2017). This structure, by promoting human encounter and interaction, produces vitality, an essential factor in the experience of urban life. Such an experience of the world and of the other is the basis for understanding urbanity, which can be differently experienced according to the material, environmental and social conditions imposed by local spatiality.

According to Aguiar and Netto (2012), urbanity is defined as civility of urban coexistence and should be understood as an experience, being a phenomenon resulting from the relationship between space and the human being, which depends on the morphology of the city. In the contemporary city, the relationship between man and urban environment is undermined every day, as the dominant urban planning treats it as a monotonous and oppressive structure, not prioritizing the creation of free spaces for public use, which in fact consolidate it as a meeting place (SHULTZ, 2008).



For Nucci (2008), the current city model ignores the fact that society depends on the biophysical means to survive, while land use is dictated by economic interests. The dense city proposal does not care about environmental quality and other needs, such as quantity, quality and distribution of free spaces that allow socialization and urban living in a healthy way. Mascaró (2012) states that traditional urbanization is based on mono-functional gray infrastructure, in which all urban infrastructure is focused on the creation of buildings and streets that target the circulation of vehicles. The opposite of this reality would be green infrastructure, which consists of multifunctional networks of permeable and wooded spaces that restructure the urban landscape.

In this scenario, with the alteration of natural environments – from the densification of buildings, the concentration of industries, the opening of roads, the sealing of the soil, the reduction of free spaces and green areas, among other impacting actions of land use, – environmental comfort in cities is modified, changing the local microclimate and air quality, which generates noise pollution, increased temperatures and energy consumption. In addition to the health effects of the population, social effects are also evident. The densification of Brazilian cities and the lack of free spaces result in cities without spaces for coexistence and exchange of experiences, contributing to the establishment of a passive society without urbanity.

The good quality of urban space is related to the experience of the human scale, in which people meet closely with the city. For Gehl (2015), cities should provide good conditions for walking, stopping, sitting, looking, listening and talking. For these experiences to be fully lived, public spaces must offer attributes such as accessibility, comfort, attractive uses and permeability in the urban fabric (ANDRADE; LINKE, 2017).

The environmental quality of cities also includes green areas as an evaluation factor, and the absence of these spaces negatively interferes with the population's quality of life. Lima and Amorim (2006) highlight that a quality environment requires the presence of vegetation, which positively interferes with the urban quality of life.

The city of Vila Velha (municipality studied in this paper), in the state of Espírito Santo, lacks a systemic view that integrates green areas in the urban space and allows interaction with the population. Lack of planning, population densification and the urbanization process resulted in the replacement of natural environments by built spaces. This scenario negatively affects the urban environment and consequently people's health by reducing urban green areas. In this sense, realizing the failures in the planning of the city of Vila Velha, which resulted in the lack of green areas, which understands the need to identify and quantify them, seeking to highlight the fragility of the system, and thus highlight the urgency of interventions in the urban environmental quality of the municipality. Therefore, this article intends to present a critical analysis of the spaces of environmental equilibrium and the potential spaces existing in the Central Region of the municipality of Vila Velha (ES).

It was necessary, for this work, readings of bibliographies related to the theme, focusing on the spaces of environmental equilibrium, to understand the importance of green areas for urban living. The identification of these areas was made from satellite images provided by the Google Earth program, comparing the information present in the Vila Velha Municipal Master Plan with that of local visits.

The mapping of the areas was developed in the ArcGIS geoprocessing tool, with georeferenced digital cartographic base, with specific identification labels. The mapped areas were identified according to Mendonça (2015), which classifies public free spaces into three groups: public spaces with environmental equilibrium; potential free spaces and public free spaces of social practices. In this paper, we highlight the analysis of the first two groups.

According to Mendonça (2015), the free spaces of environmental equilibrium, focus of this research, include the areas covered with vegetation of significant environmental landscape value that, in the city of Vila Velha, correspond to the Special Areas of Environmental Interest (VILA VELHA, 2008),encompassing Permanent Preservation Areas (PPA), Conservation Units and other green areas of potential landscape (Portuguese acronym: AVPP). Potential spaces include, in particular, private areas that have potential for transformation into areas of environmental equilibrium or social practices, due to their characteristics and location in the urban fabric (MENDONÇA, 2015).

With the identified and mapped areas, it was possible to perform general analyses and comparisons between the collected information, including calculating Green Area Index (GAI) of the Central Region, combining different scenarios. The results were illustrated with tables, maps and graphs, aiming to quantify and understand the influence of these areas.

## 2. Green Areas and Urban Experience

Urbanity is defined by the individual's experience in a particular urban environment. This experience can be fully experienced when urban interventions are carried out on a human scale. According to Gehl (2015), the city should offer comfort and attract people to use public spaces throughout the day, providing aesthetic experiences and pleasing sensory impressions. Importantly, there are numerous criteria that, when combined, validate a good urban experience. However, this article emphasizes the study of green areas.

Considering the "12 quality criteria with respect to the pedestrian landscape" described by Gehl (2015, p. 239), the green areas, in their range of elements, contribute directly to the pleasure, comfort and protection of the individual in his urban experience, besides being fundamental for stimulating the appropriation and participation of the human being in the dynamics of the city.

Resolution 369/2006, art. 8º, §1º defines green area as "the public domain space that performs ecological, landscape and recreational function, providing the improvement of the aesthetic, functional and environmental quality of the city, being endowed with vegetation and spaces free of sealing" (BRASIL, 2006). Lima *et al*. (1994) define it as a place with predominance of arboreal vegetation, which encompasses squares, public gardens and urban parks, as well as central flowerbeds and public roads, even if they have only aesthetic functions. For Mascaró (2008), these areas can be classified into two major groups: a) main green area, consisting of parks, vegetable gardens and florists; and b) secondary green area, which are squares, plazas and wooded streets.

Vegetation is one of the necessary components for the construction of a good urban space. Besides the landscape function, there are several attributions in the environmental, economic and social aspects indispensable to the ecological equilibrium and the quality of life of the population (LAMAS, 1993). The areas of the city that have vegetation are more valued. Trees, shrubs and other smaller plants are elements of urban composition and design that contribute to the organization, definition and delimitation of space; in addition, they help in

climate and pollution control, water conservation, erosion reduction and energy saving (MASCARÓ J; MASCARÓ L, 2010).

The most characteristic vegetal form of the urban landscape is the tree. In addition to the contributions cited above, the presence of this element generates psychological and social benefits to the human being. The presence of afforestation in high density neighborhoods also helps to reduce fear and contributes to less violent and aggressive behavior by its users, also influencing psychological and mental health (MASCARÓ J; MASCARÓ L, 2010).

According to the **Manual de arborização de São Paulo (São Paulo Afforestation Manual)** (SÃO PAULO, 2015), the presence of trees in the urban environment breaks with the monotony of buildings by promoting scenic beauty and functionality to the environment, increasing the population's quality of life. At pedestrian level, they are critical for urban comfort and livability, as they provide shade, reduce ambient temperature and induce wind effects, and protect pedestrians and cyclists by influencing the feeling of safety against high-speed vehicles (SPECK, 2016).



Another contribution of urban afforestation is the formation of ecological corridors, linking public or private green areas. As stated in the **São Paulo Afforestation Manual** (SÃO PAULO, 2015), these corridors allow the connection of fauna populations and vegetation fragments, enriching the ecosystem and increasing biodiversity. When green areas and urban afforestation interconnect, they form an ecological network, helping to mitigate the impacts of urban sprawl on biodiversity, as well as the formation of heat islands. Mascaró (2012) defines this same system as green infrastructure, responsible for restructuring the urban landscape mosaic.

It is also noteworthy that the amount of urban vegetation has been measured by indicators that express the surface of the green area per inhabitant, such as the Green Area Index (GAI). The Brazilian Society of Urban Afforestation (Portuguese acronym: SBAU) (1996) proposes a minimum index of 15m$^2$ of green area per inhabitant, which does not consider the distribution and access (radius of influence) to green spaces in cities.

Stockholm, for example, is considered to be one of the greenest cities in the world, with a GAI of approximately 86m$^2$ / inhabitant. In addition, 90% of the population has access to green areas within 300m of their homes; distance that represents an average time interval of three to four minutes of walking (PROGRAMA CIDADES SUSTENTÁVEIS, 2012).

## 3. Urban Characterization of the Central region of Vila Velha

According to the 2010 Census of the Brazilian Institute of Geography and Statistics (Portuguese acronym: IBGE) (2010); the city of Vila Velha, located on the coast of the state of Espirito Santo, has a territorial unit area of 209,965km$^2$ of which only 54,57km$^2$ are in urban perimeter. Its population is 414,586 inhabitants, which makes the municipality the second most populous in the state. It is limited to the north with the municipality of Vitória, the state capital; to the south with Guarapari; to the east with the Atlantic Ocean; and to the west with the municipalities of Viana and Cariacica. In addition, for its best organization, it has five administrative regions (Figure 1).

According to Municipal Law No. 4707/2008, the Central Region (identified in Figure 1 in blue) covers 18 (eighteen) neighborhoods of the city. Its area (15.13km$^2$) corresponds to 27.72% of the urban perimeter, and its population (147,279 inhabitants) is equivalent to 35.52% of the municipality's inhabitants (VILA VELHA, 2007).

The Municipal Master Plan (VILA VELHA, 2007), in its zoning, mentions that the Central Region consists of Priority Occupation Areas (ZOP), Environmental and Cultural Protection Areas (ZPAC), Special Equipment Areas (ZEE), Special Urban Interest Area (ZEIU) and Special Areas of Environmental Interest (ZEIA), as illustrated in Figure 2 below.

The region has important natural and cultural monuments of preservation interest, with emphasis on the Prainha Historical

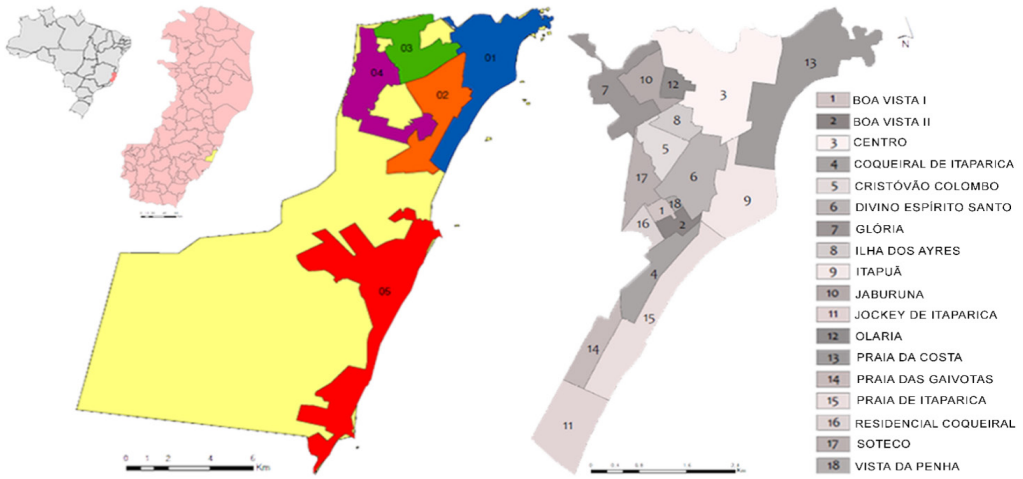


Figure 1 – Location of the municipality of Vila Velha in the national and state context. Following, map of the municipality, showing the Central Region in blue. The last map shows the neighborhoods of the municipality. Source: Image generated by ArcGIS, based on Law No. 4707/2008; modified by the authors, 2017.



Ranch (illustrated in Figure 3), the PPAs located in accentuated relief near the coast (Moreno Hill, Penha Convent and Jaburuna Hill), beyond the edge of the beaches and the rectified channels Bigossi and "da Costa.

It was chosen as a clipping of this research the Central Region for presenting areas in accelerated urban transformation, with the highest concentration of vertical density of the municipality and suppression of potential green areas. This transformation intensified, starting in the 1990s, after the construction of the Deputado Darcy Castello de Mendonça Bridge – known as the Third Bridge (highlighted in Figure 4 in yellow) –, an important metropolitan road, responsible for connecting the city of Vila Velha to the capital Vitória and other cities of the Greater Vitória Metropolitan Region (Portuguese acronym: RMGV). It is also noted, following images of Figure 4, that the densification of vertical buildings near this new connection was a determining factor for the reduction of the area occupied by the city's natural vegetation.

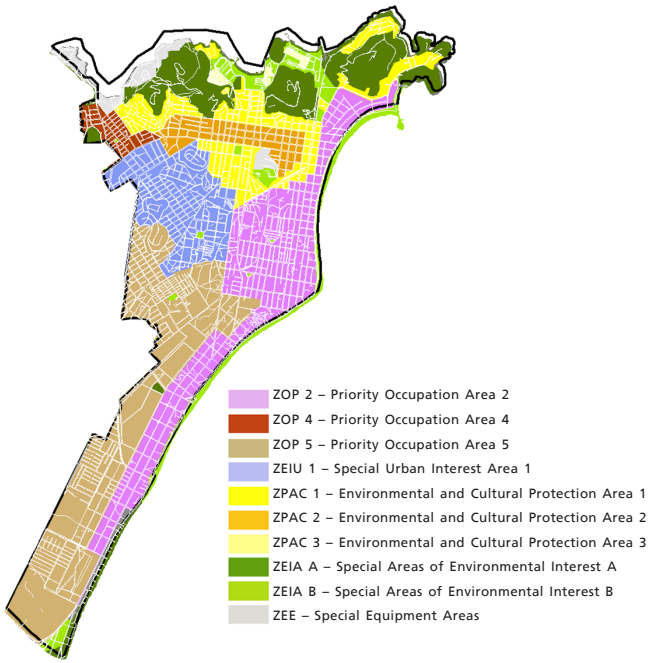


Figure 2 - Map of urban zoning of the Central Region of Vila Velha. Source: Municipal Master Plan, edited by the authors, 2018.

The Central Region also has the largest territorial extension and population density. It attracts daily large flow of people due to the concentration of commercial centers and sub-centers, public services – such as the City Hall, the Forum, the Public Prosecution Service and the Social Security Agency of Vila Velha –, besides the concentration of shopping malls in the city (Vila Velha, Boulevard and Praia da Costa) and also private institutions, such as Vila Velha University and Vila Velha Hospital.

## 4. Free Areas of Environmental Equilibrium

In the scope of this work, the classification of environmental equilibrium spaces used by Mendonça (2015) was considered, which comprises the areas covered by significant vegetation, involving Permanent Preservation Areas (PPA), Conservation Units and other green areas of potential landscape. In this sense, for the mapping of the free spaces of environmental equilibrium of the Central Region of Vila Velha, it was considered the Special Areas of Environmental Interest (ZEIA A) and land with predominant vegetation, that is, those considered with green areas of potential landscape (AVPP). The "ZEIA A", according to the Master Plan (VILA VELHA, 2007), encompasses PPAs referring to the areas of accentuated relief near Vitória Bay and the sandbank vegetation along the coast, as shown in Figure 5 in light and dark green.

Figure 3 – Aerial view of Prainha's Historic Ranch and preservation areas, in high relief near the coast.
Source: Collection of Paisagem Urbana e Inclusão group, 2018.


Figure 4 – Aerial images of the urban evolution around the Third Bridge, showing the accelerated densification of the municipality and the consequent suppression of green areas.
Source: Accuracy and Google Earth, edited by the authors, 2018

The AVPP are areas with potential for transformation into a public park, due to the large preserved green area (MENDONÇA, 2015). Thus, some private spaces were identified and mapped (identified in Figure 5 in orange) because they have a considerable area covered by vegetation. These areas, although private, constitute small green spaces that are beneficial to the urban environment, which can be preserved, with significant environmental value and the potential for transformation into public spaces of environmental equilibrium.

Although urban afforestation is not classified by Mendonça (2015) as free spaces of environmental equilibrium, the scope of this work also mapped public roads, boardwalk, beach trees, squares and parks (identified in Figure 5 in yellow) because we understand the importance of this vegetation for the equilibrium of the ecosystem and urban life.

To calculate the shadow areas promoted by the trees of the public roads and the boardwalk, the circumference in the approximate size of the crown of each tree was used, being identified in the base map of the ArcGIS program. Later, tables were generated in the Excel program for data organization and analysis and respective generation of green area index (GAI).

## 4.1. Reading of Green Area Indexes

As already mentioned, the green area index (GAI) indicates the amount of green area in square meters per inhabitant. After mapping, in this research, several GAI were generated, combining different scenarios, considering: PPA, AVPP, road afforestation, boardwalk, beach and squares (according to the combination specified in Table 1). This variation in green area indexes was generated by the lack of consensus among authors as to which of these spaces should be considered for the calculation of the GAI.

Considering all mapped green areas, including urban afforestation and environmental equilibrium spaces (PPA and AVPP), the region index (GAI 1) is 16.97m$^2$ / inhab. Although this index is higher than the minimum proposed by the SBAU (15m$^2$ / inhab.), most of these spaces are made up of PPAs of restricted access to the population, situated on slopes with marked relief and inadequate infrastructure to support users, besides being concentrated spaces, favoring the surrounding neighborhoods.

It is also noteworthy that the value of GAI 1 (16.97m$^2$ / inhab.) obtained this result due to the predominance of permanent

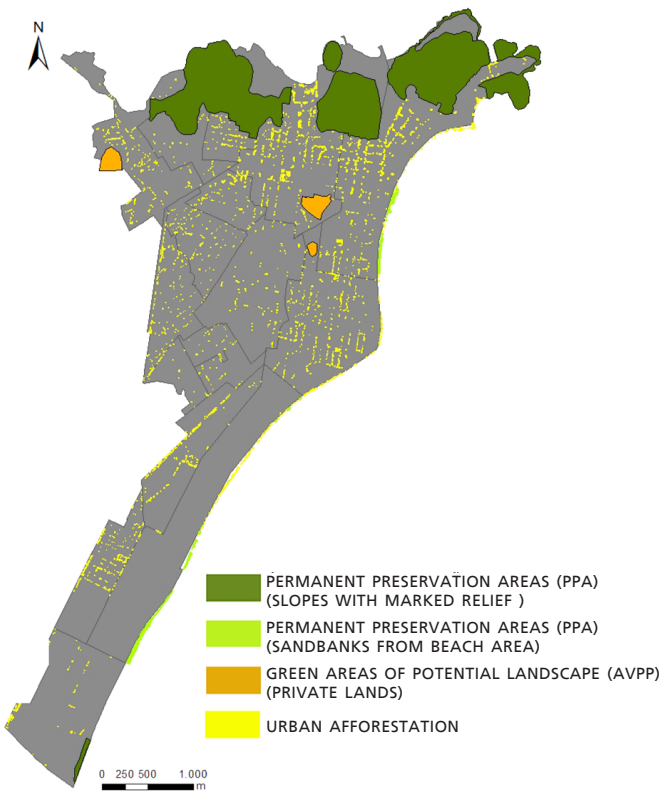


Figure 5 – Mapping of free areas of environmental equilibrium and urban afforestation present in the Central Region of Vila Velha.
Source: Image generated by ArcGIS, modified by the authors, 2018.

preservation areas among the environmentally equilibrated space (considered ZEIA by the Municipal Master Plan), whose preservation is protected by legislation. The indices also show that, if PPAs are excluded, there are no significant green spaces distributed among the Central Region neighborhoods, and the GAI significantly reduces (GAI 5 of 2.70m$^2$ / inhabitant). This fact demonstrates that the government tends to maintain the green spaces required by the legislation, without worrying about the creation of new spaces to be distributed by the neighborhoods to improve the urban living and the quality of life of the population.

The PPAs are present in the 18 neighborhoods that make up the Central Region, they are: Centro (Downtown), Glória Jaburuna, Jockey de Itaparica, Olaria and Praia da Costa, not directly benefiting the other neighborhoods. Vila Velha Downtown is the neighborhood with the highest Green Area Index: GAI 1 of 141,25m$^2$ / inhab, as shown in Table 2. This number reflects the presence of Special Areas of Environmental Interest (ZEIA), contemplated by the Moreno Hill, Penha Convent and part of Jaburuna Hill.

If considered by neighborhood, it is possible to observe that the GAI 1 of the neighboring neighborhoods to the PPA (Downtown, Gloria, Jaburuna and Praia da Costa) reach more satisfactory values; however, the neighborhoods furthest from them have rates close to zero. For example, the neighborhoods Boa Vista I and Boa Vista II have, respectively, GAI1 of 0.38 and 0.35m$^2$ / inhab., while in the Downtown this index reaches 141.25m$^2$ / inhab.

It is noted, as shown in Figure 6, that few neighborhoods meet the minimum availability of green areas per inhabitant suggested by SBAU (15m$^2$ / inhab). Only the Downtown (141.25m$^2$ / inhab), Gloria (17.12m$^2$ / inhab), Jaburuna (28.45m$^2$ / inhab) and Praia da Costa (28.61m$^2$ / inhab) neighborhoods have GAI above the minimum proposed. , due to the proximity of the PPAs.

The impact of PPAs on the calculation of GAI is great. Therefore, if only PPAs on slopes are considered, GAI 2 is 14.28m$^2$ / inhab. That is, considering all mapped green areas, the index is 16.97 m$^2$ / inhab., but if considered only the PPA, the index is 14.28 m$^2$ / inhab., and without the PPA, the index drops to 2.56m$^2$ / inhab.



| GAI | GAI m² / inhab. | PPA (m²) | | Treetops (m²) | | | | AVPP (m²) |
|---|---|---|---|---|---|---|---|---|
| | | Slopes | Sandbanks | Public roads | Boardwalk | Beach | Squares | |
| GAI 1 | 16.97 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| GAI 2 | 14.28 | ✓ | | | | | | |
| GAI 3 | 16.18 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| GAI 4 | 1.90 | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| GAI 5 | 2.70 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| GAI 6 | 1.15 | | | ✓ | | | | |
| GAI 7 | 1.50 | | | ✓ | ✓ | ✓ | ✓ | |
| GAI 8 | 0.80 | | | | | | | ✓ |
| GAI 9 | 14.70 | ✓ | ✓ | | | | | ✓ |

Table1 – Green areas considered for the calculation of Green Area Indexes. Marking by means of "ü " indicates what was considered for the generation of each index.

(GAI 5). It is noteworthy that in the calculation of the GAI that considers only the areas of environmental equilibrium classified by Mendonça (2015), the green area index also does not reach the minimum proposed by the SBAU (GAI 9 of 14.70 m2 / inhab.).

Adding to the shady areas of the trees of public roads, boardwalk, beach, squares and parks, the index is only 1.50m$^2$ / inhab. (GAI 7) .The GAI 6, of 1.15 m$^2$ / inhab., was calculated considering only the trees of public roads, which shows the precariousness of urban afforestation distributed by the neighborhoods. Another consideration concerns the range of areas of environmental equilibrium. After mapping, around permanent preservation areas (PPA) and green areas of potential landscape (AVPP), a radius of 300m was demarcated to identify the influence and distribution of these areas, as shown in Figure 7.

The green areas of landscape value alone generate a GAI of 0.8 m$^2$ / inhab. (GAI 8). If we consider the total area of the Region studied, the coverage of these areas – considered a 300m radius around existing permanent preservation areas (PPA) – corre-

| Neighborhoods | Area (m2) | Population (inhab.) | GAI 1 (m² / inh.) |
|---|---|---|---|
| **Boa Vista I** | 91.190 | 3.143 | 0.38 |
| **Boa Vista II** | 207.862 | 3.515 | 0.35 |
| **Centro** | 2.563.492 | 7.880 | 141.25 |
| **Coqueiral de Itaparica** | 787.687 | 13.696 | 0.90 |
| **Cristóvão Colombo** | 494.169 | 6.835 | 0.75 |
| **Divino Espírito Santo** | 1.248.045 | 8.031 | 0.75 |
| **Glória** | 781.946 | 7.900 | 17.12 |
| **Ilha dos Ayres** | 356.167 | 3.691 | 1.71 |
| **Itapuã** | 1.075.374 | 22.808 | 1.89 |
| **Jaburuna** | 627.049 | 5.836 | 28.45 |
| **Jockey de Itaparica** | 1.272.120 | 2.393 | 13.05 |
| **Olaria** | 244.920 | 1.596 | 4.33 |
| **Praia da Costa** | 2.715.610 | 31.083 | 28.61 |
| **Praia das Gaivotas** | 324.022 | 6.282 | 1.82 |
| **Praia de Itaparica** | 1.600.313 | 11.648 | 5.18 |
| **Residencial Coqueiral** | 218.365 | 1.554 | 0.62 |
| **Soteco** | 481.072 | 8.189 | 1.17 |
| **Vista da Penha** | 45.125 | 1.199 | 0.41 |
| **TOTAL REGION 01** | 15.134.528 | **147.279** | **16.97** |

Table 2 – Distribution of green areas by neighborhoods of Central Region of Vilha Velha.

sponds to only 14.78%, which corroborates the need for new areas to be created green areas accessible to the population and distributed evenly among neighborhoods. Including the AVPP (shown in orange in Figure 7), the coverage reaches 21.76% of the total area of the Region, increasing the population benefited by the green areas.

## 5. Identification of Potential Free Spaces

In the scope of this research, empty spaces were considered potential free spaces, without any kind of infrastructure, but with potential to be worked by the public power to encourage and create new green spaces (MENDONÇA, 2015).

Potential lands were identified by comparing the areas not covered by the mapping of areas free of environmental equilibrium and their coverage areas, considering the 300 m radius of influence of existing environmental equilibrium areas for the installation of new green areas, filling the deficient spaces, as illustrated in Figure 8.

Potential spaces, shown in orange in Figure 8, are extremely important for better distributing the presence of green areas, balancing their concentration throughout the Region, and contributing to the improvement of the urban life of the population. It is believed that, if potential spaces are transformed into green areas, they may provide the formation of ecological corridors together with existing permanent preservation areas. For this,



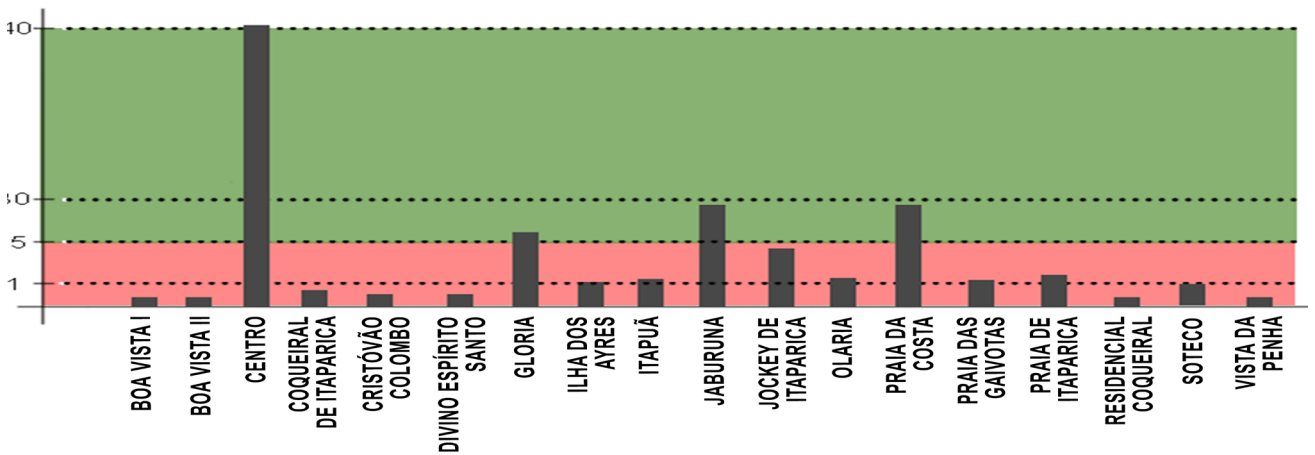


Figure 6 – Distribution chart of green areas by neighborhood of the Central Region of Vilha Velha.

it would be necessary to afforest the roads that connect these areas with trees of species suitable for the urban environment, considering a minimum spacing between them.

As stated, with the exception of permanent preservation areas, the remaining spaces are potential. The AVPP are already covered by considerable vegetation, but as they are private areas, they are not considered areas of environmental interest by the municipality. The squares, parks and boardwalk, despite being public spaces, do not have enough green area, requiring the planting of trees and other plant species. Potential spaces are private, vegetation-deprived areas that would need to be expropriated by the government for transformation into green areas.

## 6. Considerations for Increasing Green Areas

The results generated by the research indicate the need for intervention to increase the green areas, aiming to promote improvement in urban living and environmental quality of the Central Region of Vila Velha. To contribute to the efficiency of these interventions, the following propositions are suggested:

- Inserting an Urban Afforestation Plan in the new allotment projects, since the Law no. 6.6666 / 1979 (BRASIL, 1979), of land parceling, does not address this issue. By afforestation of public roads, squares and parks, it would be possible to indicate suitable places for planting and species specific to each situation. It would also be essential for the municipality to develop an urban afforestation manual specific to the city of Vila Velha.
- Include in the municipal project Calçada Legal (Legal Sidewalk) (VILA VELHA, 2014) guidelines for planting trees on sidewalks. The amount and species would be evaluated according to road size and local climate.
- In situations where the width of the sidewalk does not include the planting of trees, work on the alternative

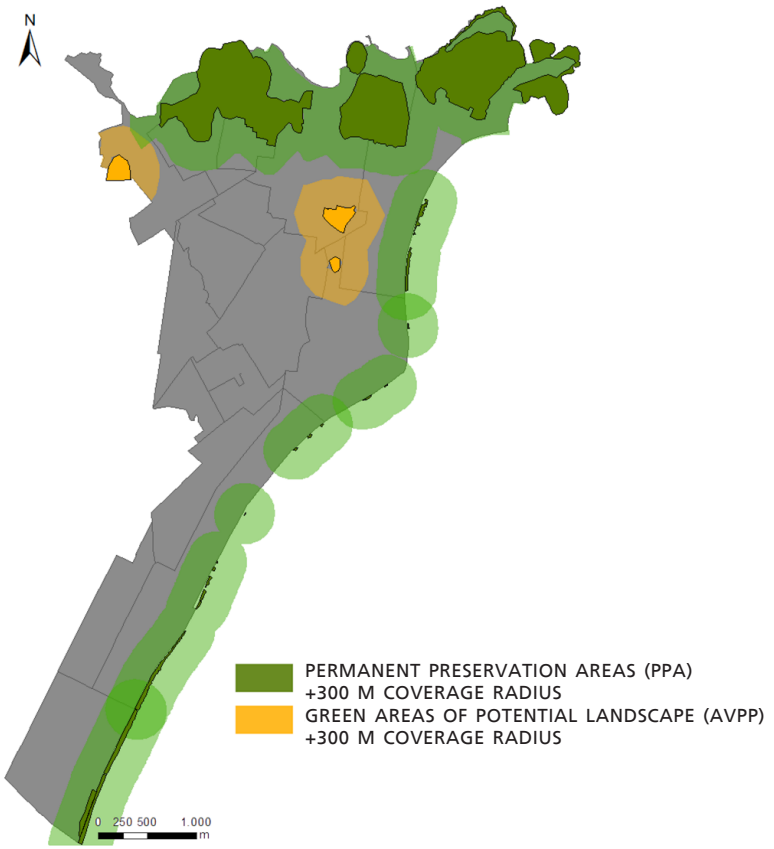


Figure 7 – Mapping of spaces of environmental equilibrium (PPA and AVPP) and coverage, considering 300m.
Source: Image generated by ArcGIS; modified by the authors, 2018.

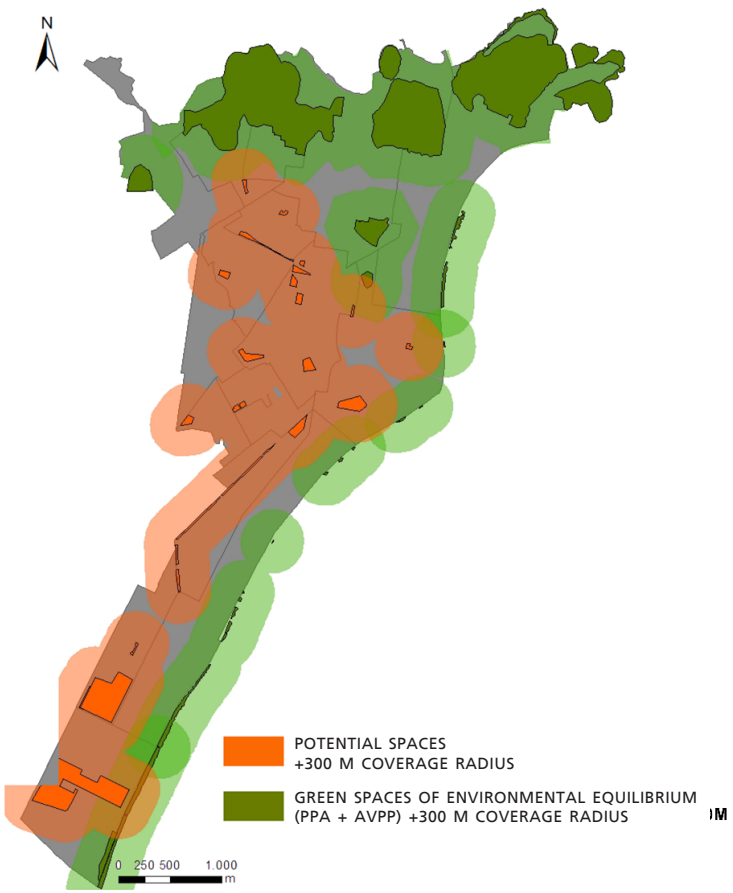


Figure 8 – Mapping of free spaces of environmental equilibrium clearances (PPA + AVPP) of potential land and its coverage, considering a radius of 300m.
Source: Image generated by ArcGIS; modified by the authors,, 2018.

of planting them in places intended for vehicle parking, such as extending the sidewalk itself, maintaining a reasonable number of parking spaces and promoting environmental quality of public roads through afforestation. The flowerbeds, exemplified in Figure 9, are examples of sidewalk extension in places that would initially be used for car parking. In the case of narrow sidewalks, flowerbeds of this model could be the solution for afforestation of public roads.

- For large buildings, including multifamily vertical buildings, include in the Neighborhood Impact Study (NIS) the environmental and landscape impact assessment of the surroundings. The NIS can establish a way of environmental compensation for the degradation that has occurred on the enterprise site, such as logging, for example. In addition, it can foresee larger frontal clearances so that landscaping treatments are carried out that benefit the city's environmental quality.
- Establish a minimum percentage of green area in squares and parks, as well as a minimum percentage of permeable land area in frontal clearance, to promote urbanity and walkability on public roads, stimulating, in addition to soil permeability, landscape treatment in these spaces and increased thermal comfort and urban aesthetic quality.
- Design new green spaces to be distributed homogeneously in the municipality, using the potential spaces mapped in this work.
- Encourage tree planting in parking lots of large private and public enterprises, such as shopping malls, airports, hospitals and schools.

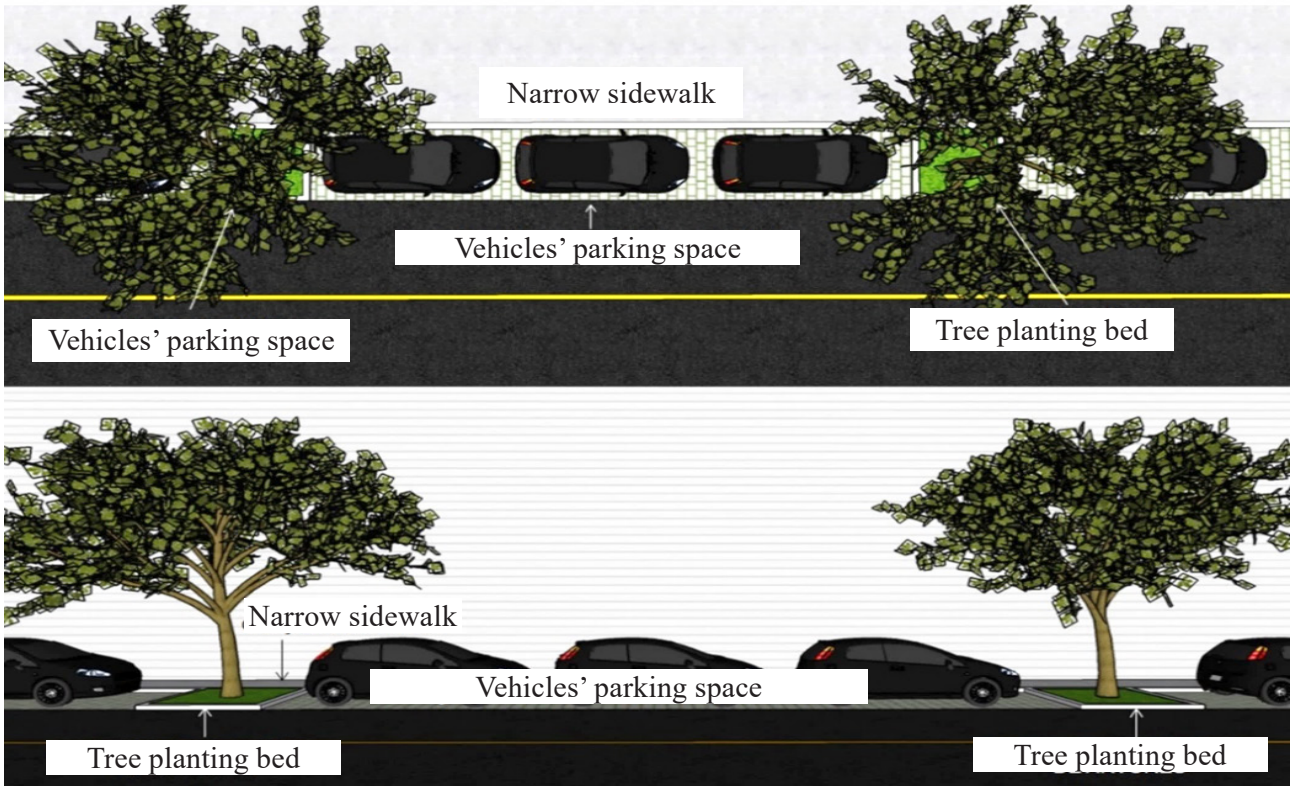


Figure 9 – Sketches exemplifying the public garden afforestation beds located in the parking spaces.



## 7. Conclusion

The research demonstrates, by mapping the environmental equilibrium areas of the Central Region of Vila Velha, that they do not homogeneously serve the population, as they are concentrated in a few neighborhoods of the city, in areas of high relief, near the Bay of Vitória. Other neighborhoods lack green spaces and, throughout the region, afforestation is precarious.

Considering a range of 300m from the PPA, a low territorial portion is observed contemplated by these areas. The area of influence increases when considering the AVPP, thus highlighting the need for projects that transform these places into areas of environmental interest by the municipality. Although private and inaccessible, AVPPs benefit the city because of the available vegetation area.

In several parts of the Central Region, lands with potential to be transformed into green spaces accessible to the population were also identified. If part of these lands were modified, it would be possible to cover the entire Central Region of the municipality in a better distributed way, significantly increasing environmental quality, and creating spaces for social practices.

The importance of PPAs is unquestionable. However, as already explained, they focus on specific regions, covering a small part of the Central Region. Trees on public roads should be more numerous, contributing to climate control, improved air quality, development of the local ecosystem, as well as providing aesthetic benefits for the city, as well as psychological benefits to residents and visitors.

The generated maps and tables are data sources for possible future interventions in the conception of free spaces for public use for the municipality of Vila Velha, aiming to increase the quality of life of the population in the urban, environmental and, consequently, social aspects, since green areas can be public living spaces.

Further studies are recommended, focusing on the development of a system of green areas for the municipality, with diversity of use and consumption, with spaces for a local public and regional, municipal and even metropolitan.



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