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GREEN AREA INDEX FOR MACROZONE CONSOLIDATION IN PARANAVAÍ CITY – PR

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ABSTRACT

Environmental quality and life quality of population are factors affected by the expansion of the urbanization process. Urban afforestation plays an important role in mitigating adverse effects of urbanization, because of its environmental, aesthetic and social functions, promoting improvements to the environment and to the living conditions of the urban population. This study evaluated qualitatively and quantitatively the Green Areas in three zones (1, 2 and 3) in the city of Paranavaí – Paraná state - Brazil. For that purpose, we firstly used the calculation of the Green Area Index (GAI) considering the green areas, regardless of the qualitative aspect. Subsequently, we performed a qualitative analysis of these areas and recalculated the GAI. The quantitative analysis showed a reduced number of green areas in the three zones, especially in zones 1 and 3 (0 (zero) m²/inhabitants). The qualitative analysis showed deficiency in maintenance and infrastructure in all green areas, which consequently reduced the GAI to 0 (zero) m²/inhabitants in all the three zones. Therefore, the results corroborate the need to establish and maintain green areas in the urban area of Paranavaí city.

Keywords: Urbanization; Green areas; Qualitative and quantitative analysis; GAI.

ÍNDICE DE ÁREAS VERDES PARA MACROZONA DE CONSOLIDAÇÃO DE PARANAVAÍ – PR

RESUMO

A qualidade ambiental e de vida são fatores prejudicados no processo de expansão das áreas urbanas. A vegetação exerce papel relevante na amenização dos efeitos prejudiciais da urbanização, através de suas funções ambientais, estéticas e sociais, promovendo melhorias tanto na condição ambiental como na de vida da população citadina. A pesquisa procurou avaliar quali-quantitativamente a oferta de Áreas Verdes em três Zonas (1, 2 e 3) de Paranavaí-PR. Para tanto utilizou-se, num primeiro momento, o cálculo do Índice de Áreas Verdes (IAV) considerando as áreas, independentemente do aspecto qualitativo. Posteriormente, realizou-se análise qualitativa destas áreas e recalculou-se o IAV. Através do primeiro cálculo, constatou-se reduzida presença de Áreas Verdes para as três Zonas, especialmente nas Zonas 1 e 3 com 0 (zero) m²/hab. A partir da análise qualitativa verificou-se em todas as Áreas Verdes deficiência em manutenção e infra-estrutura o que, consequentemente, reduziu o IAV para 0 (zero) m²/hab., nas três Zonas. Neste sentido, caracteriza-se a necessidade existente de implantação e manutenção de Áreas Verdes no espaço intra-urbano de Paranavaí.

Palavras-chave: Área Verdes; Urbanização; Análise quali-quantitativa; IAV.

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INTRODUCTION

In the expansion process of urban areas, we have noticed that men promote radical transformation of green areas to develop cities, and these changes affect climate at various scales (microclimate, mesoclimate and topclimate), compromising the environmental quality and living conditions of the population. These urban changes have generated studies aimed to find possible solutions to mitigate adverse effects of urbanization. Cavalheiro and Del Picchia (1992), Lombardo (1985), Romero (1988), Mascaró (2002), Monteiro (2003), Nucci (2001), Henke-Oliveira (1996) among other authors have provided important contributions, analyzing causes and consequences of changes in urban spaces, proposing alternatives to reduce the negative impacts arising from such changes.

Cavalheiro and Del Picchia (1992) report that cities are established, from the physical perspective, in spaces of urban interaction (railroad network), built-up spaces (households, industry, commerce, hospitals, schools, etc) and open spaces (parks, surface water, etc). To the authors, there must be a perfect share of proportion for such spaces; however, we observe that in urban environments, open spaces have been virtually eliminated.

Nucci (2008) conducted a study on environmental quality in the district of Santa Cecília (São Paulo municipality) and found that only 2.18% of the total area of the district (3.600.000m²) was occupied by free spaces (most area was impermeable) while built-up spaces accounted for 77.99%, showing great disparity between urban land use in this district.

Lombardo (1985) states that it is necessary to carry out studies to provide basis for control urban occupation, establishing physical parameters to an urban environment more compatible with life quality. The author analyzed the dynamics of weather factors in the metropolis of São Paulo and found that the highest temperatures were recorded in areas of highest concentration of buildings, and that temperatures declined significantly in green areas. This, therefore, underscores the need to increase afforested areas in urban environments as a means to mitigate the negative impacts of urbanization that has greatly affected life quality of populations, especially in urban centers, where large built-up areas and air pollution prevail, due to the heavy flow of motor vehicles.

Mascaró (2002) discusses some contributions of vegetation to urban environmental conditions, such as the reduction of solar radiation in hotter seasons, reduction of temperature and increase of relative humidity of the environment by providing shade that reduces the heat load received by buildings, vehicles and pedestrians. In addition, urban afforestation changes speed and direction of winds and acts as an acoustic barrier, among other benefits.

Henke-Oliveira (1996) and Saydelles (2005) add that vegetation acts intercepting runoff on rainy days. Moreover, due to the physical protection and stabilization function of tree roots, afforestation intercepts raindrops in their foliage, thus, preventing physical disruption of the surface horizon, conserving soil, while it improves structural conditions suitable for the soil by providing organic matter from waste. Furthermore, urban vegetation has the capacity to mitigate high temperature levels, as it absorbs solar radiation and releases it into the atmosphere as latent heat in evapotranspiration, not as sensitive heat.

Romero (1988) highlights that urban vegetation favors the oxygen/carbon dioxide cycle that is essential to renew the air and to ensure air quality for human breathing.

Lombardo (1990) groups these and other contributions as follows: atmospheric composition, soil-climate-vegetation balance, noise levels and aesthetics (Table1).

Table 1. Contributions of vegetation to improve urban environment

ATMOSPHERIC COMPOSITION	✓ Purifying action by fixing dust and residues; ✓ Purifying action by bacterial depuration and other microorganisms ✓ Purifying action by recycling gases through photosynthetic mechanisms ✓ Purifying action by fixing toxic gases
SOIL-CLIMATE-VEGETATION BALANCE	✓ Luminosity and temperature: urban vegetation filters solar radiation and minimizes external temperatures ✓ Humidity and temperature: urban vegetation contributes to preservation of humidity in the soil, reducing its temperature ✓ Reduces wind speed ✓ Maintains soil properties: permeability and fertility ✓ Shelters local fauna ✓ Provides hydric balance
NOISE LEVELS	✓ Reduction of continuous and discontinuous noise, common in big cities
AESTHETICS	✓ Breaks landscape monotony of cities, caused by building complexes ✓ Values visual and ornamental aspects of urban spaces ✓ Characterizes spaces constituting an element of integration between anthropogenic actions and the environment.

Source: Lombardo (1990)

Thus, it is undeniable the importance of vegetation cover in cities, because it is evident the important role it plays in urban areas, through its environmental, aesthetic and social functions.

However, Nucci (2008) attests that in the urban development process, urban vegetation has been neglected, despite its extreme importance for better ambience and quality of urban life. Unlike other physical resources of the city, afforestation is not perceived as an obvious need for the urban environment, and in most situations, it has its functions reduced to sentimental and aesthetic values.

Therefore, it is essential to encourage all possible ways to increase afforestation in urban areas, which have become increasingly inhospitable and not very welcoming to any form of life.

The creation of green areas is an alternative to keep significant amount of vegetation cover in cities. Toledo et al. (2009) emphasize that the creation of green areas such as parks and squares in urban areas increases the GAI *per capita*, enhancing life quality.

However, there is evident difficulty to define the term "green areas". Lack of clarification of this definition can be traced back to the period of afforestation absence in the medieval and Renaissance cities, given that only from the 19th century with the advent of the Industrial Revolution in England, France, Germany and the United States, this issue began to be considered, often due to concerns of authorities with aesthetics and sanitary problems (TOLEDO; SANTOS, 2008).

Barbosa (2005) argues that the difficulty to define "green areas" takes larger proportions due to existence of similar terms equally comprehensive such as "free spaces", "open spaces", "entertainment systems", among others.

However, Lima et al. (1994) conducted a study to raise the issue in a more global scope, through consultation with research and learning institutions and urban planning of the Southeastern Regional of the Brazilian Society of Urban Afforestation and professionals in the

field and discussed the definition of some technical terms, such as green areas, urban parks, squares and urban afforestation. According to the authors, these terms are defined as follows:

- Green Areas: sites where there is predominance of woody vegetation, including squares, public gardens and parks. Median strips of public roads and traffic circles, which have only aesthetic and ecological functions, should also be conceptualized as Green Areas. However, trees that come in the flowerbeds of public roads, should not considered as such.
- Urban Park: green areas with an ecological, aesthetic and recreational function, however with a greater extent than the so-called squares and public gardens.
- Squares: similar to green areas with the primary function of leisure. A square may not necessarily be a green area, when it has no vegetation and is impermeable. In case there is vegetation, it is considered a garden.
- Urban Afforestation: relates to the elements of arboreal plants within of the urban space, such as trees and others. In this respect, trees planted in sidewalks are part of urban afforestation, but not part of green areas (LIMA et al. 1994, p.549).

For Buccheri-Filho and Nucci (2006), central flowerbeds and traffic circles of public roads cannot be considered green areas, but road green ornaments, which, like sidewalks, belong to the category of built-up spaces or urban integration spaces. The authors add that green areas must meet three main objectives: ecological-environmental, aesthetic and recreational. Furthermore, vegetation should be the basic element and, together with the permeable soil, cover, at least, 70% of the area.

However, despite the need of studies on conceptual problems regarding green areas, we should highlight the importance of studies that aim to investigate their dynamics in urban areas.

Costa and Ferreira (2009) state that an indicator of great relevance to report the presence or absence of these green areas is the Green Area index (GAI). This index, according to Fontes (2008), is the relation between the value of an area characterized as "green area" and the local population. For Henke-Oliveira (2001), the GAI must be calculated from the public green areas of collective access, i.e., squares, gardens and urban forests, excluding road median strips.

Cavalheiro and de Del Picchia (1992, p.32) underline that:

> The existing indexes are not models to be followed, but they should be used as scientific basis for urban planning. Science concerns with knowledge acquired by humanity and there must have support of what has been produced. However, we should not forget that urban planning should favor a continuous re-planning in order to satisfy the needs of the society.

The authors also point out that a minimum rate of 12m² green area/inhabitant, supposedly established by the UN or WHO or FAO, in fact, is not recognized by these organizations.

Fontes (2008), Toledo et al. (2009) and Harder et al. (2006) emphasize that we must have, as a reference in terms of quality for the provision of urban open spaces, the "Carta a Londrina e Ibiporã" (SBAU, 1996), which proposes a value of 15 m²/inhabitant as a minimum index for green areas for public recreation.

Nucci (2008) states that this analysis should not focus only on the quantitative aspect, but on the qualitative issue, because, in many cases, we have the area available, but without conditions of use.

The author adds that after the quantification of green areas, we should recalculate the GAI, indicating the number of areas effectively used by the community according to their qualifications.

Thus, this paper aims to investigate the qualitative and quantitative aspects of existing green areas into three zones (1, 2 and 3) located in the Consolidation Macro-zone of the city of Paranavaí – Paraná state – Brazil – and

to compute the GAI in these areas. The objective is to better understand the reality of these spaces to provide support for the urban and environmental planning consistent with the reality and needs for this city.

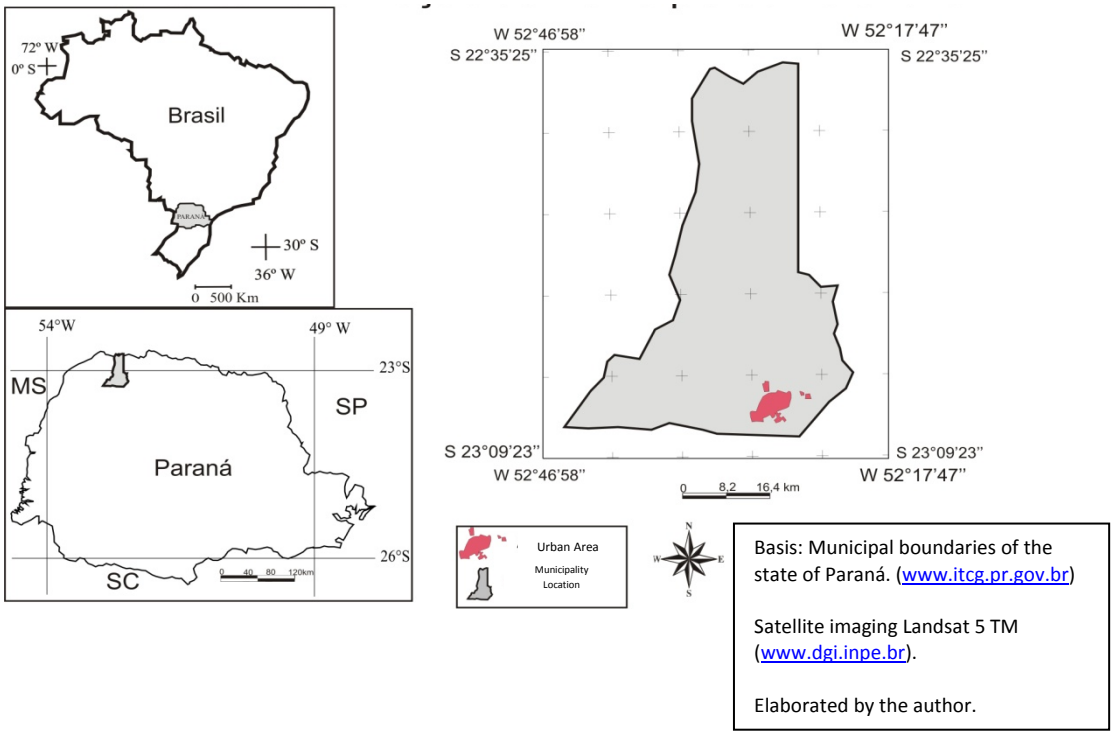
MATERIALS AND METHODS

Paranavaí is a medium-sized city, located in the northwestern region of Paraná state – Brazil (Figure 1), at 503 meters above sea level and with a territorial area of 1,202.151 km². It was founded during the occupation process of the northern region of the Paraná state, which began in the 1920's, due to expansion of coffee culture in the neighbor state of São Paulo (IPARDES, 2011).

Estimates of the Brazilian Institute of Geography and Statistics (IBGE) report that in 1950, the municipality had a population of 25,520 inhabitants, of which 92.7% resided in rural areas and 7.3% in urban areas (ALCÂNTRA, 1987). Currently the municipality has a population of 81,590 of which approximately 95.2% lives in the urban area and 4.8% in rural areas, reaching an urbanization level of 95.27% (IPARDES, 2011).

The predominant climate of the municipality is Cfa type, Mesothermal Subtropical Humid (Köppen classification), with warm summers, marginal tropical zone and regular rain precipitation in all months without dry seasons. However, due to massive deforestation, climate variations have been occurring, causing disruption of the boundary between climatic zones, causing changes to the coefficient of rainfall variation. Paranavaí is inserted in a semideciduous forest, currently very damaged by continual anthropogenic actions over the years, following the dynamics of urbanization, leaving only residual areas corresponding to a Municipal Park, a park in the region of Córrego Xaxim and some areas of Legal Reserve in private properties, located in the peripheral region of the municipality with difficult access (STIPP, 2006).

Figure 1. Location of Paranavaí Municipality – Paraná state – Brazil



The municipality is divided into urban and rural areas, which were subdivided based on a macro zoning, whose purpose is to establish the ground rules for territorial planning and guidelines for spatial land use to comply with the principles, general objectives, policies and general strategies of the Master Plan (Paranavaí City, 2011, Law No. 3.297/2008).

According to the Municipal Master Plan (Art. 82), the urban area is defined by the composition limits of the following macro-areas:

I – Macro-Urban Consolidation;

II – Macro-Urban Qualification;

III – Macro-Urban Oriented Expansion;

IV – Macro-Urban Large Industries and Services;

The area of this study article comprises Zones 1, 2 and 3, all inserted into the Macro-Urban Consolidation, the oldest region of the urban area with higher population density and concentration of commerce and small businesses (Art. 90).

To quantify the green areas, we classified the study sites, defined as possible green areas, such as squares and public parks. For that purpose, we carried out research at the City Hall of Paranavaí, Secretariat of Urban Planning and Environment and at the City Council.

Afterwards, we performed *in loco* survey to make sure that the green areas were classified as proposed by Lima et al. (1994), except for median strips and traffic circles, areas that do not have the function of leisure with soil permeability lower than 70% (Henke-Oliveira, 2001; Nucci et al., 2003; Buccheri-Filho; Nucci, 2006).

After defining the green areas, we performed a qualitative analysis of these spaces, using the methodology proposed by Harder (2002) to calculate the GAI of usable green areas.

For that purpose, the areas were classified as fully usable (1), partially usable (2) and unfit for use (3). We considered "fully usable", areas with equipment and infrastructure in good conservation; "partially usable", those with equipment and infrastructure in reasonable condition, and "unfit for use", areas lacking equipment and infrastructure.

Data on area were obtained from the Brazilian Institute of Geography and Statistics (IBGE) based on the census of the year 2000.

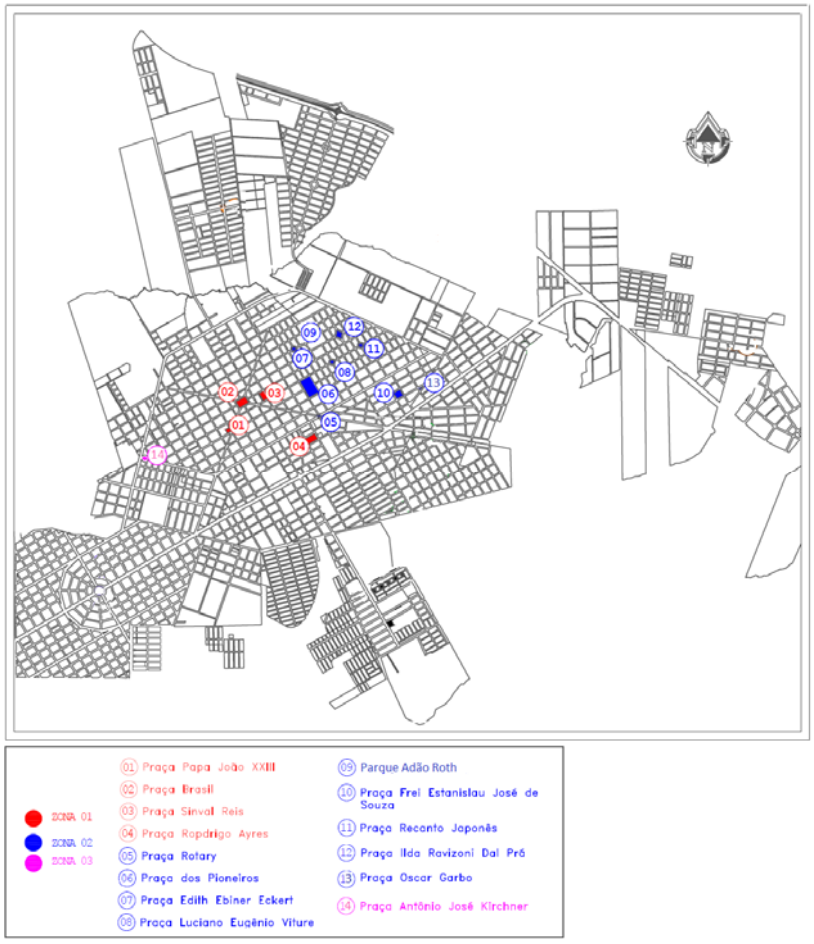
To calculate permeability, we subtracted the total permeable free area from the total area of the region. Through cross-multiplication, we calculated the percentage of permeability.

The computation of the GAI is based on the most used calculation, which divides the sum of these areas in square meters (m^2) by the population of the study area.

RESULTS AND DISCUSSION

We found in Paranavaí, 13 public squares and a municipal park (Figure 2 and Table 2), which, at first, were defined as areas likely to be green areas, based on the classification proposed in this paper.

Figure 2. Distribution of squares and parks per zone



Source: City Hall of Paranavai. (Org.: FREIRE, 2011)

Table 2. Distribution of squares and parks per zone and total areas

Square/ Park	Total area (m²)	Zone
Papa João XXIII	1,584	1
Brasil	9,115	1
Sinval Reis	5,300	1
Rodrigo Ayres	8,920	1
Rotary	820	2
Dos Pioneiros	23,000	2
Edith Ebiner Eckert	1,662	2
Luciano Eugênio Viture	1,662	2
Parque Adão Roth	52,000	2
Frei Estanislau José de Souza	5,910	2
Recanto Japonês	1,735	2
Oscar Garbo	780	2
Ida Ravizone Dal-Prá	4.963	2
Antônio José Kirchner	804	3

Source: Secretariat for the Environment, 2010 (Org.: FREIRE, 2011).

According to the Master Plan of Paranavaí (Paranavaí City Hall, 2011), Zone 1 is inserted in the central region of Paranavaí, an area of concentration of commerce and other services, densely built-up, with its location conditioned to the main flow of vehicles.

Zones 2 and 3 are predominantly residential areas, however with distinct economic levels. Zone 2 is notable for excellent standards of residences, and high socioeconomic status, social housing, while Zone 3 presents social houses and medium to low socio-economic level.

Quantitative analysis

To define these spaces as green areas, we carried out a verification process, divided into stages, namely: 1) analysis of the existence of minimum permeability 70%, 2) analysis of predominant tree species, 3) analysis of the recreational function.

This verification process was used only in the public squares of Paranavaí, considering that, we observed that the Municipal Park meets the three abovementioned requirements, without the need of a specific study.

Permeability

Of the 13 squares, five had the minimum permeability of 70%, which are: Praça Rotary (100%), Praça Edith Ebiner Eckert (84%), Praça Recanto Japonês (85%), Praça Ida Ravizone Dal-Prá (100%) and Praça Oscar Garbo (72%).

Predominant tree species

Having the minimum permeability is not enough, so an area has to have a predominance of trees, because even if a site presents a good permeation rate, but is devoid of the benefits provided by tree species, it will not act as a green area, and vice-versa.

In this study, we found squares with total absence of trees. This applies to the Praça Ida Ravizone Dal-Prá that despite having 100% of area permeable, it is an area with no arboreal vegetation and totally devoid of any infrastructure, where grass thrives.

On other squares, in spite of having afforestation, undergrowth predominates. This condition is seen in Praças Rotary, Edith Ebiner Eckert and Recanto Japonês Rotary.

Thus, of the five public squares that have a permeable area equal to or greater than 70%, only one showed a predominance of natural vegetation, that is, Praça Oscar Garbo.

Recreational function

The function of green areas should not be restricted to environmental benefits, but extended to social aspects. Leisure is a basic need for human beings and therefore constitutes one of the social rights of citizenship (Article 6 - Brazilian Constitution).

In this analysis, we found that the Praça Oscar Garbo offers the recreational function, since it has equipment and/or structures for leisure.

Thus, we classified as green areas the Praças Garbo Oscar and Parque Adão Roth, both located in Zone 2, with a population of approximately 8,456 inhabitants, resulting in a GAI of 6.2 m²/inhabitant for this zone. The absence of spaces classified as Green Areas used in this study resulted in GAI 0 (zero) m²/inhabitant for Zones 1 and 3, showing an imbalance in the supply of green areas for the three zones.

Urban afforestation is a public asset and, therefore, should have equitable distribution and accessibility to the population. The Organic Municipality Law (Paranavaí City, 2011, Article 111, II, III, V) argues that the policy for urban development implemented by the Municipal Government should ensure “access for all citizens to adequate conditions of housing, public transportation, sanitation, road infrastructure, health, education, sports,

leisure and economic opportunities existing in the municipality. In addition to security and protection for landscaping, architectural, cultural and historical assets, and aesthetic quality and reference of natural landscape aggregated by human action".

Qualitative analysis

The qualitative analysis consisted of evaluation of equipment and/or structures found in the two green areas, according to the methodology proposed by Harder (2002).

Oscar Garbo Square

Law No. 2.404/2003 (Paranavaí City Hall, 2011) established the toponym for the square. It is a triangular-shaped square located in a residential region and presents concrete paths only on the outer edge, without connection with its center, devoid of any coating (Figure 3). Lighting was recessed and the poles are well distributed without touching the trees. It has old and damaged garbage bins. Until early this year, it had a restroom unfit for use due to poor condition. In addition, there was a shed (deactivated long ago) where locals used to play bocce.

The shed was demolished and a gym for the elderly was built in its place. The restroom was also removed; however, nothing was inserted in its place. Lack of security and maintenance are the factors that generate social repulsion to an area. Just a handful of older men who faithfully frequent the square to play cards on the concrete tables, which has earned the square a nickname of "Square for the Old-Timers".

Figure 3. Square Oscar Garbo

Adão Roth Park

Formerly "Parque Ouro Branco", the park in question received the toponym Adão Roth by Law No. 2564 of December 31, 2004 (Paranavaí City Hall, 2011); however, currently it remains commonly referenced to by the former name. It houses the residence of former Mayor Ulysses Bandeira, which is currently used as the Regional Office of the Brazilian Institute of Environment (IBAMA).

The first implementation works began in 1998, with the construction of kiosks, restrooms, bocce courts and fields, courts and fields for soccer and sand volleyball and some rides made of eucalyptus. The works were carried out by

the State Government in partnership with the City Hall of Paranavaí. In 2003, they built a walking track, refurbished the restrooms, lighting was introduced, trees were planted around the track, in grass fields and riparian areas and level curves were isolated within the Park (Municipal Department of Environment, 2011).

In 2004, water galleries were made and the park underwent a renovation process. Currently, it is in a state of total abandonment, where grass thrives. Equipment and/or structures, in general, are in precarious condition. Rides and kiosks are damaged, the walking track, besides narrow, competes for space with brushwood. The restrooms are filthy and vandalized; the bocce court is wrecked and unusable.

Due to lack of security and the constant practice of illegal activities in its area, this park has become one of the areas with most social repulsion in the city, not fulfilling, effectively, its social function (Figure 4).

Figure 4. Park Adão Roth

This analysis shows that neither of the two green areas was classified as fully usable, because both have serious maintenance problems of structures and/or equipment associated with lack of security, compromising their effectiveness to exercise their social functions. Thus, the GAI found in these three areas after the qualitative assessment was 0 (zero) m²/inhabitant.

One of the most determining factors for this result was the lack of security in the areas studied, since the equipment and/or structures are subject to constant actions of vandalism and illicit activities, which prevents the population from frequenting these spaces.

Henrique (2006) highlights that the deterioration of squares and parks, because of the abandonment and lack of maintenance, leads the population to perceive these sites as violent and dangerous places, which ends up driving residents away. Furthermore, the low GAI found for each of the zones associated with the accelerated urbanization process, without a planning to ensure the maintenance and expansion of Green Areas, winds up affecting directly the environmental conditions in the areas and, therefore, the quality of life of population in the city of Paranavaí.

CONCLUSIONS

In the three areas studied, the GAI remained below the minimum of 15 m² per capita, markedly in Zones 1 and 3, which, according to the quantitative analysis, showed a rate far below the minimum recommended. This highlights the lack of green areas in the city, despite the many benefits they provide to the environment and life quality of the city, demonstrating that the relation between urbanization processes and vegetation is inversely proportional, because as the former expands, the latter shrinks radically.

The qualitative analysis showed a more serious condition, since the GAI of the three zones was reduced to 0 (zero) m²/inhabitant after analyzing the conditions of use of the three areas, which revealed damages to all equipment and infrastructure, characterizing them as fully unusable.

Thus, it is necessary to emphasize the importance of green areas due to their various functions in order to seek understanding and recovery of such benefits, and to encourage the creation of mechanisms to preserve and expand green areas in cities.

Important to underscore that the spatial distribution and accessibility of these spaces must occur in an equitable manner, taking into account the need of all residents, not only part of population. Therefore, besides the obvious need of maintenance, it is also necessary, a more equitable deployment of these areas in the city of Paranavaí.

REFERENCES

ALCANTRA, J.C. **Política Local – Um estudo de caso: Paranavaí, 1952 – 1982**. Tese (Mestrado). UNICAMP, 1987; p. 291.

BARBOSA, R. V. R. **Áreas Verdes e Qualidade Térmica em Ambientes Urbanos: estudo em microclimas de Maceió (AL)**, 2005. Dissertação (Mestrado em Ciências da Engenharia Ambiental) – Escola de Engenharia de São Carlos, Universidade de São Paulo, São Carlos, 2005.

BRASIL. Constituição (1988). **Constituição da República Federativa do Brasil**. Brasília, DF, Senado, 1998.

BUCCHERI-FILHO, A.T.; NUCCI, J. C. **Espaços livres, áreas verdes e cobertura vegetal no bairro Alto da XV, Curitiba/PR**. In: Revista do Departamento de Geografia, 2006, n. 18, p. 48-59.

CAVALHEIRO, F.; DEL PICCHIA, P. C. D. **Áreas Verdes: Conceitos, Objetivos e Diretrizes para o Planejamento.** In: 1° Congresso Brasileiro sobre Arborização Urbana e 4° Encontro Nacional Sobre Arborização Urbana, Vitória/ES, 1992. Anais. p. 29-38.

COSTA, R. G.S.; FERREIRA, C. C. M. **Análise do Índice de Áreas Verdes (IAV) na área central da cidade de Juiz de Fora, MG**. In: Revista Sociedade Brasileira de Arborização Urbana. (REVSBAU), Piracicaba – SP, v.4, n.1, p.39-57, 2009.

FONTES, N. **Indicadores, índices e padrões relativos a sistemas de espaços livres.** In: 1º Simpósio de Pós-graduação em Geografia do Estado de São Paulo- SIMPGEO-SP, Rio Claro, 2008.

HARDER, I. C. F. **Inventário Quali-Quantitativo da Arborização e Infra-Estrutura das Praças da cidade de Vinhedo (SP)**. Dissertação (Mestrado). Escola Superior de Agricultura Luiz de Queiroz. Piracicaba, SP, 2002.

HARDER, I. C. F.; RIBEIRO, R. C. S.; TAVARES, A. R. **Índices de área verde e cobertura vegetal para as praças do município de vinhedo, SP.** In: Revista Árvore. Viçosa – MG, v. 30, n.2, p. 277 – 282, 2006.

HENKE-OLIVEIRA, C. **Planejamento ambiental na Cidade de São Carlos (SP) com ênfase nas áreas públicas e áreas verdes: diagnóstico e propostas**. Dissertação (Mestrado em Ecologia Recursos Naturais), Centro de Ciências Biológicas e da Saúde/UFSCar, São Carlos – SP, 1996.

HENKE-OLIVEIRA, C. **Análise de padrões e processos no uso do solo, vegetação, crescimento e adensamento urbano. Estudo de caso: município de Luiz Antônio (SP).** Tese (Doutorado em Ciências). Universidade Federal de São Carlos. São Carlos, São Paulo, 2001.

HENRIQUE, W**. A cidade e a natureza: a apropriação, a valorização e a sofisticação da natureza nos empreendimentos imobiliários de alto padrão em São Paulo.** In Revista GEOUSP - Espaço e Tempo. São Paulo, n. 20, p. 65 – 77, 2006.

IPARDES. Instituto Paranaense de Desenvolvimento Econômico e Social. **Caderno Estatístico do município de Paranavaí**. Disponível em : < http://www.ipardes.gov.br/ cadernos/Montapdf.php?Municipio=87700&btOk=ok>. Acesso em: 15/08/2011.

LIMA, A.M.L.P.; CAVALHEIRO, F.; NUCCI, J.C.; SOUZA, M.A.L.B.; FIALHO, N.O ; DEL PICCHIA, P.C.D. **Problemas de utilização na Conceituação de termos como espaços livres, áreas verdes e correlatos**. In: II Congresso Brasileiro sobre Arborização Urbana, 2, São Luiz/MA, 1994. Anais. p. 539-553.

LOMBARDO, M. A. **Ilha de Calor nas metrópoles: o exemplo de São Paulo**. São Paulo, HUCITEC, 1985. 244 p.

LOMBARDO, M. A. **Vegetação e clima**. In: Encontro Nacional sobre Arborização Urbana, 3, 1990, Curitiba. **Anais.** Curitiba: Impresso na Fundação de Pesquisas Florestais do Paraná, 1990. p. 1 – 13.

MASCARÓ, L. E. A. R de; Mascaró, J. L. **Vegetação urbana**. Porto Alegre: L. Mascaró, J. Mascaró, 2002. 242p.

MONTEIRO, C. A. F. **Teoria e Clima Urbano**. São Paulo: IGEO/USP, 2003. 192p.

NUCCI, J. C. **Qualidade ambiental & adensamento urbano: um estudo de ecologia e planejamento da paisagem aplicado ao distrito de Santa Cecília (MSP)**. São Paulo: Humanitas, 2001. 142p.

NUCCI, J. C.; WESTPHALEN, L. A.; BUCCHERI-FILHO, A. T.; NEVES D. L.; OLIVEIRA,F. A. H. D.; KROKER, R.**Cobertura vegetal no bairro de Curitiba/PR**. Artigo publicado na Revista GEOUERJ, número especial - Rio de Janeiro, 2003 (CD ROM).

CÂMARA MUNICIPAL DE PARANAVAÍ.**Lei Orgânica**, de 04 de abril de 1990. Paranavaí, 1990. Disponível em: < http://www.leismunicipais.com.br/cgi-local/orglaw.pl?city=Paranava%ED&state=pr>. Acesso em: 30/08/2011.

_____. **Lei Municipal nº 2.404**, de 07 de abril de 2003. Denominação de Praça Pública. Disponível em: <http://www.cmparanavai.pr.gov.br/index.php?sessao= c2e8251608ltc2> Acesso em: 30/08/2011.

_____. **Lei Municipal nº 2.564**, de 31 de dezembro de 2004. Denominação de Denominação do Parque Ouro Branco Adão Roth. Disponível em: <http://www.cmparanavai.pr.gov.br/index.php?sessao= c2e8251608ltc2> Acesso em: 30/08/2011.

_____**. Lei Municipal nº 3.300**, de 20 de novembro de 2008. Dispõe sobre o Parcelamento do Solo no Município de Paranavaí, Condomínios Horizontais e dá outras providências. Disponível em: <http://www.cmparanavai.pr.gov.br/index.php? sessao=c2e8251608ltc2> Acesso em: 30/08/2011.

_____. **Lei Municipal nº 8**, de novembro de 2008. Dispõe sobre o Plano Diretor e define princípios, políticas, estratégias e instrumentos para o desenvolvimento municipal e para o cumprimento da função social da propriedade no Município de Paranavaí e dá outras providências. Disponível em: <http://www.cmparanavai.pr.gov.br/index.php?sessao=c2e8251608ltc2> Acesso em: 30/08/2011.

ROMERO, M. A. B. **Princípios bioclimáticos para o desenho urbano**. São Paulo: Projeto, 1988. 128p.

SAYDELLES, A. P. **Estudo do campo térmico e das ilhas de calor urbano em Santa Maria-RS. Dissertação (mestrado). Universidade Federal de Santa Maria**, RS. 2005.

SECRETARIA MUNICIPAL DE MEIO AMBIENTE. **Histórico Parque Adão Roth.** Paranavaí, 2011.

SOCIEDADE BRASILEIRA DE ARBORIZAÇÃO URBANA – SBAU**. "Carta a Londrina e Ibiporã"**. Boletim Informativo, v.3 , n.5, p.3, 1996.

STIPP, M. E. F. **A ocupação do solo e a problemática da arenização e voçorocamento no município de Paranavaí.** São Paulo, 2006. Dissertação (Mestrado) - Faculdade de Filosofia, Letras e Ciências Humanas da Universidade de São Paulo.

TOLEDO, F. S.; SANTOS, D. G. **Espaços livres de construção**. In: Revista Sociedade Brasileira de Arborização Urbana. (REVSBAU), Piracicaba – SP, v.3, n.1, p.73-91, 2008.

TOLEDO, F. S.; MAZZEI, K.; SANTOS, D. G. **Um índice de áreas verdes (IAV) na cidade de Uberlândia/MG**. In: Revista Sociedade Brasileira de Arborização Urbana. (REVSBAU), Piracicaba – SP, v.4, n.3, p.86-97, 2009.