

A sense of comfort in open space around owner-built houses: the case of Campinas, Brazil

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ABSTRACT: This paper presents a pro-active study conducted in two urban areas with predominantly owner-built houses in the region of Campinas, Brazil. The investigation is part of a continuing research on the self-built housing phenomenon of this region. Thermal comfort was assessed in open spaces around owner-built houses. Private, semiprivate and public open spaces were evaluated through: technical measurements (air velocity and temperature), observations (use of spaces, presence, type and density of vegetation, shading and ventilation conditions), iconography (drawings of perception of open spaces) and photographic records. A sense of thermal comfort was assessed through a questionnaire applied to a group of self-builders of the two areas. The study includes both an investigative and a pro-active phase. The population is involved in judging their own settlements as they are today and are encouraged to introduce changes through the planting of trees and ground cover on streets, reserved public areas and private backyards. The main goals of this pro-active study are the possibility of introducing affordable comfort in owner-built residential regions, empowering the population with simple solutions to improve their quality of life and testing methods and materials that are most appropriate for participatory design actions. Results show that open and communal spaces are not fully valued by this group of population. Vegetation is present, but does not substantially influence the sense of thermal comfort. In relation to appropriate methods for participatory design, 2D drawings must be straightforward and uncluttered to obtain a coherent response. The study also shows that a sense of comfort is not only measurable technically speaking, but includes visual and psychological elements where vegetation is a key factor.

Keywords: Open Space, Owner-built houses, Urban setting, Vegetation, Thermal Comfort

1. INTRODUCTION

Cities are composed of built-up areas (houses, apartment buildings, shops, schools factories etc.), open spaces (parks, rivers, urban squares, plazas and unused land or lots) and urban integration spaces (roads, streets, walkways, etc.). Quality of life of the city's inhabitants depends on the proper distribution of and detailing of these uses and spaces. The amount of natural elements, in the form of urban vegetation and landscaping, which permeate urban tissues influence directly thermal conditions in large urban conglomerations and indirectly the quality of life in cities [1, 2]. Housing quality is measured primarily through the expressed satisfaction of users and this can be related to the presence of vegetation in residential areas. In developing countries satisfaction rates with housing conditions cannot be directly related to environmental qualities, since they are mostly a reflection of home ownership. This is the case in Brazil where, due to economic and social patterns of development, slums and owner-built houses in outlying subdivisions grow in urban areas without control over construction standards or comfort

conditions. Open spaces in the proximity of such rudimentary houses are also mere leftover areas without intentional purpose or user interventions.

Llardent [3] defines open spaces as urban open-air areas, used primarily by pedestrians for recreational, sport and relaxation activities. If essentially composed of vegetation (trees, bushes, flowers and ground cover), they may be considered green areas. To contribute to the quality of life of inhabitants, such areas must be of a certain size to allow recreational uses. The relation of open to built-over areas must be at a recommended proportion set by city codes. Open spaces also have an additional important aesthetic function in the urban landscape.

Open urban space and its environmental quality influences urban climate and especially ventilation conditions in cities, which in turn affect pollution levels and relate to health conditions of inhabitants [4]. In tropical climates ventilation is an important factor for thermal comfort and buildings should be positioned to capture predominant winds and provide indoor spaces with cross ventilation.

Sustainability indicators are important mechanisms to determine open and built-up space

proportions. Proper orientations of buildings, distances between constructions are included in indicators and standards for impermeability of urban soils are set. Topographic interventions as well as surface and under-ground drainage conditions must also be regulated. Many indicators are related to green areas, their relative size and distribution in urban built-up areas.

Open spaces in urban areas with predominantly owner-built houses in Brazil are mostly places with undefined uses. Vegetation is lacking or only in the form of a sparse ground cover which thrives naturally in the tropical climate of many regions of Brazil. The small residential lots are devoid of quality open spaces, since the population sees their land as an opportunity for additional building activities.

The houses built by owner families represent a large percentage of residential constructions in countries like Brazil [5, 6]. Since the 1970s this building activity is considered important to reduce the large housing deficit of developing countries [7, 8, 9]. These settlements, after consolidation, have fairly high densities in relation to occupation rates of the residential lots.

Most self-built houses are one to two story constructions and thus, the inhabitants per urban area are low. With a high built-over area and a lack of gardens, private and public, these regions can be shown to have poor environmental comfort (thermal, acoustic and lighting) conditions. Also, the quality of the urban landscape can be considered poor.

Most of owner-built settlements start out in outlying suburbs of typical growing Brazilian cities. They are occupied with few essential urban infrastructures. Thus, roads are not paved, sidewalks are missing, street lighting is only minimal and parks and public green areas are merely reserved open space. These spaces are often fragmented in the settlements, complying only in total area to the local code stipulations. Since these regulations are expressed as percentages, subdivisions are approved without investments into the quality of such open spaces.

Owner-builders are primarily concerned with providing a home for their families and will quickly, after acquiring a residential lot, invest energy and resources in the construction of small houses. Attention is not shown to public open spaces or leftover areas on the residential lot. Functional indoor area is the primary concern of the self-builder population.

Large official government housing projects in Brazil, based on a repetitive model of small houses, have a similar urban landscape. Although some urban infrastructure is supplied in these developments, the lack of variety in the housing types creates a monotonous cityscape. Here too vegetation is sparse and the population will soon occupy any open space on their lots with new and added constructions, transforming the original house [10, 11].

While such official settlements, at the outset, have some street planting, in the form of young trees, introduced by the developer, owner-built communities are characterized by a general look of abandonment, dominated by weeds and large areas of bare earth. In

their more advanced stages of development construction densities increase, but urban vegetation will not have appeared to modify the townscape, as is common in middle class suburbs.

Vegetation can be shown to be a prime factor, especially in hot climates in providing shade and reducing solar radiation. Trees affect positively CO₂ levels in urban areas. Roots avoid erosion on steep slopes and increase the permeability of soil, replenishing the natural water table. Vegetation, as an element in bioclimatic architectural design, can provide passive cooling, through shading of walls (trees, pergolas), introduction of a second skin (in the form of creepers and ivy) and ground cover around the building.

The importance of the natural element in relation to the comfort conditions of buildings and urban areas depends on the types of plants (species), the foliage, area of treetop and tree distribution density. The preservation of the vegetation cover in urban areas, on the other hand, depends on the population's attitudes towards natural elements, the stimulus to plant, maintain and care for gardens and parks. In Brazil some studies have shown that urban vegetation is not valued or preserved [12]. Also the population attributes problems to trees. They cause damage to garden walls and foundations, invade sewage and water systems and clog drains. Trees produce "dirt" in yards, which increases domestic chores. Thus, trees are indiscriminately cut down. Most of these problems may be traced to the wrong choice of plants and their proximity to buildings. This type of evidence called for a further investigation to ascertain the low-income population's attitudes towards open space and vegetation, and develop programs to improve the urban landscape and its comfort conditions.

For this purpose two low-income, owner-built settlements of the City of Campinas in the State of São Paulo, Brazil were analysed in relation to the quality of their open spaces. The study is part of an on-going research of owner built settlements in the region [13]. The presence of vegetation was documented and the use of public open areas observed. Thermal comfort conditions were measured. The study also evaluated the potential for pro-active programs to improve the comfort conditions and urban landscape of such settlements, especially through the planting of shade giving trees and heat absorbing ground covers in private and public open areas.

2. CHARACTERIZATION OF SETTLEMENTS

The two self-built suburbs are called "São Luiz" and "São José". They represent typical examples of owner-built developments around cities like Campinas. Such subdivisions have grown since the 1980s in Brazil, when the country abandoned its national housing policy. Both settlements are situated in outlying areas of the municipality, not part of the continuous urban tissue. Remaining rural areas surround them and their accessibility is precarious with only one paved road connection to the rest of the

city. Both areas were subdivided and sold by the city's social housing company (COHAB-Campinas) in 2000 and are regulated by special codes for low-income families. These regulations permit subdivisions based on small lots of 125 square meters with an 8-meter front.

The developments occupy a square kilometre area, which is divided into less than 20 residential blocks (Figures 1 and 2). The shape of these blocks is long and narrow and a north-south orientation along the long axis is predominant. This condition gives residential lots a predominantly east-west orientation. The centre of the subdivisions has public areas reserved for institutional uses (schools and day-care centre). Smaller open spaces are located at the fringe of each settlement and are intended for a health centre and public green areas. These reserved areas are triangular and narrow in form, thus not ideal for the intended use. Small houses appear quickly in the developments and often take many years to gain a roof or exterior finishing (Figure 3).

2.1 Presence of vegetation

Observations to evaluate the presence of urban vegetation show that trees are rare on sidewalks and absent on public land, designated for recreational purposes, called "green areas". Figures 1 and 2 show that only 26% of the streets of the first settlement and 24% respectively of the other area have some form of urban tree planting as indicated by the shaded lots. In the "São Luiz" settlement the so-called green area has absolutely no trees, and in the "São José" subdivision the green area has 10 small trees, which do not seem purposely planted according to a landscape plan. 21% and 25% respectively of the tree species present in the settlements is represented by and a local type called "Ficus Benjamina", all of seedling size. Other tree types are also found, such as *Cássia Ferruginea*, *Tabebuia Impetiginosa* and *Schinus Molle*. "Ficuses" are tree species not considered appropriate for urban street planting, due to the rapid growth pattern and large powerful surface roots, which break concrete pavements and invade drains, water and sewage pipes. On the other hand the treetops may reach a 30m diameter and have dense foliage, giving good shade.

The density and size of the treetops may interfere with predominant winds in narrow streets, already lined with 2m high lot walls. Shade and ventilation are two essential aspects for urban thermal comfort in the local predominantly hot and humid climate. Thus, the location of such trees, when mature may influence the comfort conditions of some areas and houses in their proximity. Since trees, like the "Ficus" also grow to a height of approximately 18 m, they often interfere with the urban electrical distribution wires and telephone systems and maintenance crews trim the centre of the tops to allow lines to pass freely. Such trimming weakens the stability of the trees, permit tree rot and cause accidents from falling branches and tree trunks.

2.2 Recreational uses

The two settlements have no provision for recreational activities; since the so-called green areas do not have playing fields or play equipment, sand

boxes, benches, walkways and landscaping. But despite this lack of provision by the developers or even the population through spontaneous interventions, children will make good use of the open spaces (Figures 4). The lack of football fields can be observed through the demarcations of ball playing areas on streets.

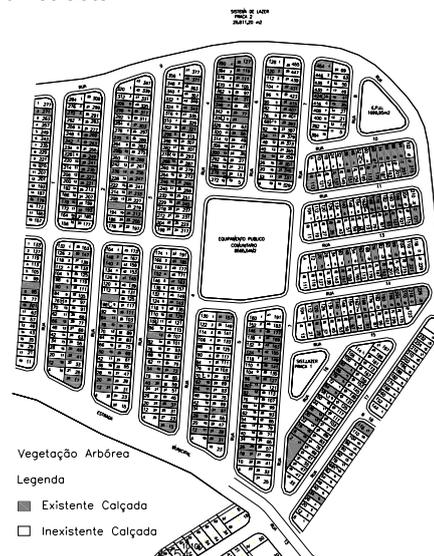


Figure 1: "São Luiz" subdivision plan - residential lots (grey shaded areas) with urban vegetation.

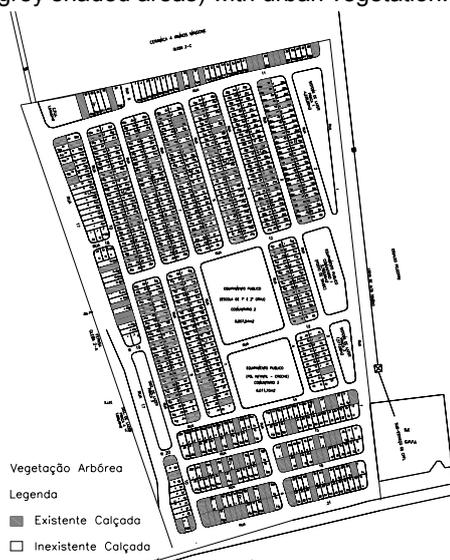


Figure 2: "São José" subdivision plan - residential lots (grey shaded areas) with urban vegetation.



Figure 3: View of a typical owner-built house in Campinas

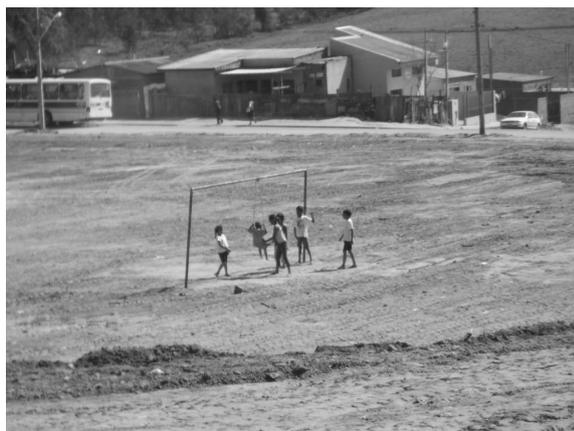


Figure 4: Introduction of a make-shift swing on an open area reserved for institutional uses.

3. URBAN THERMAL COMFORT AND VEGETATION

In a previous study different tree species were investigated in relation to their influence on thermal conditions in urban streets [14]. The most common tree types used in urban planting in the city of Campinas were investigated. In the present study the following species were observed and the influence on urban thermal comfort was measured. The species were: *Cássia Ferruginea* (*Sibipiruna*), *Tabebuia Impetiginosa* (*Ipê Roxo*) and *Schinus Molle* (*Aroeira Salsa*), with their popular names shown in parenthesis. "Ficuses" were not included in the technical measurements since the samples in both communities were still very small not providing measurable shade.

Temperatures (air (T_a) and radiant (T_g)), air movement (v) and relative humidity (rH) were measured under the tops of chosen trees in the streets of the two owner-built communities. Trees were chosen according to their characteristics of size (height and diameter of the top) and location on the sidewalks of streets. Further measurements were made in locations without urban tree planting, in full sun, at a 3,5m distance from the nearest shade. Measurements took place between the hours of 9:00 and 15:00 at 15-minute intervals. The equipment used was: Testo 175-T2, Testo 405-V1, Testostor 175-2, as well as a globe thermometer.

The results (averages) of the technical measurements are shown in Table 1. Temperatures in un-shaded areas were consistently higher, reaching 42°C (T_g) when compared to those under tree foliage. Relative humidity was consistently higher under treetops. From the results in Table 1 the first tree species (*Cássia ferruginea*) reduced the temperature consistently; this is due to the density of the foliage and the size of the trees found in the areas. From these results the importance of urban vegetation becomes clear and efforts are necessary to stimulate the population in planting good urban street vegetation, maintain their residential open green spaces with good ground cover and landscape recreational areas.

Table 1: Measurements under urban tree species in owner-built settlements in the city of Campinas, Sp. Brasil

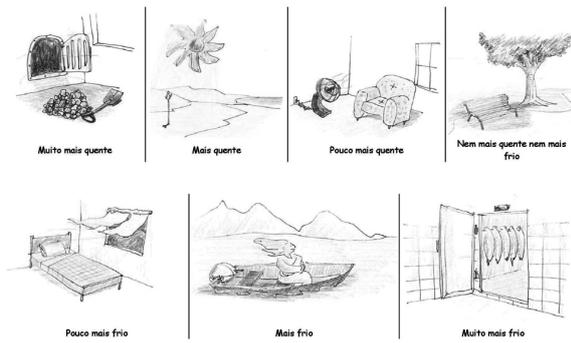
Espécie e Dia	Tg (°C)		°C		rH (%)	
	Média Dia Sol	Média Dia Sombra	Média Dia Sol	Média Dia Sombra	Média Dia Sol	Média Dia Sombra
<i>Cássia Ferruginea</i> 21/11/2005	42,47	31,29	32,52	28,86	34,89	43,42
<i>Tabebuia Impetiginosa</i> 22/11/2005	38,69	33,94	33,76	32,2	39,23	43,9
<i>Schinus Molle</i> 23/11/2005	38,98	34,6	32,78	31,77	46,00	49,46

4. PROACTIVE STRATEGIES

Natural elements in the built environment are considered important and the literature on urban landscapes is rich in detail data [3, 15, 16, 17]. Nature, especially in the form of vegetation contributes to a feeling of well being and improves health and comfort conditions of the population in urban communities. However with ever increasing construction activities in cities the presence of vegetation is steadily declining within the urban tissues and programs are necessary to guarantee the planting and maintenance of urban vegetation through systematic, permanent and even automatic ways.

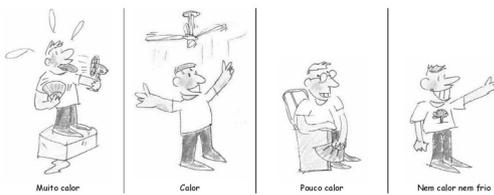
The technical observations and measurements described above showed that interventions in open space are necessary in the typical owner-built settlements in the city of Campinas. To develop participatory and proactive programs and test their potential for bringing about a change in attitude towards open space (private or public) a questionnaire was applied in the two owner-built communities. This survey asked questions on the population's relation to natural elements, their use of parks and their perception and knowledge about environmental comfort. The questionnaire used iconography to ascertain the population's feelings on comfort issues, as shown in Figure 5. From a pre-test it became clear that such iconography must be carefully chosen to avoid induction of response or wrong interpretations of drawings and their message.

From the survey it also became clear that the population felt that tree planting is an obligation put upon them by the local city administration, thus a chore they do not like or value. Spontaneous intervention on bare open spaces is extremely rare and inconsistent. Open areas on private lots are also not seen as gardens but as potential construction opportunities. Most people recognized that they feel uncomfortably hot most of the time and were able to identify the basic elements of indoor thermal comfort (good ventilation and vegetation) in the iconography tested.

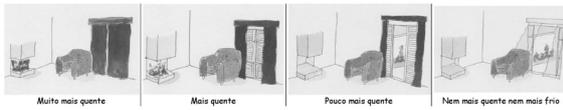


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Environmental comfort iconography not understood by owner-builder families



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Iconography on perception of feelings of thermal comfort used in questionnaire

Figure 5: Iconographies tested and used in questionnaire survey in owner-built residential settlements

As a further development the research project proposes a proactive program with two distinct objectives. The first goal is to create an awareness of users (families) of their role in relation to the preservation of open space. Iconography as shown in Figure 5 will be used for this purpose (the open space vector). The second goal is to stimulate gardens and the planting of trees, thus value vegetations as an aesthetic and comfort element. Educational folders and posters with instructive iconography will be used for this purpose (the green vector) as shown in figure 6.

The proactive program will also use drawings with a group of owner-builders, which represent the

specific situation of the family's residential lot. Figure 7 shows drawings of the house of Figure 3 in its present and possible future state of development. Thus images will be individualized to obtain a better user identity with the situation and allow a closer relation to the potential of improving this or avoid deterioration. Such images will be used during interviews. The known condition is emphasized and explored through participatory actions.

O que aconteceu com o meu quintal?

Na hora de cimentar o seu quintal, pense um pouco nas vantagens e desvantagens...

Eu resolvi cimentar tudo...

FICOU BOM PORQUE...

- Ficou tudo lisinho e fácil de limpar, acabou com o barro e o pó.

MAS...

- A Casa ficou muito mais quente, parece até que o sol bate no chão e entra de novo para a casa...
- A criança reclama que o chão está muito quente e não dá para brincar.

Eu resolvi colocar só grama...

FICOU BOM PORQUE...

- A grama acabou com o barro e o pó.
- Ficou bonito, asseado, e as crianças tem espaço para brincar
- Resolvi cimentar um pedacinho perto do varal, onde a gente pisa muito

MAS...

- Em horas de sol forte o quintal e a casa ainda ficam muito quentes
- Dá um certo trabalho cuidar da grama

Eu resolvi colocar grama, uma horta e plantar árvores...

FICOU BOM PORQUE...

- Eu colho uma porção de frutas, legumes e verduras do meu quintal e não preciso comprar.
- As crianças tem um balanço na árvore, faz tanta sombra que elas brincam o dia todo.
- A casa ficou muito mais fresquinha...

MAS...

- Eu acho que as folhas fazem um pouco de sujeira
- Parece que tem muita formiga...

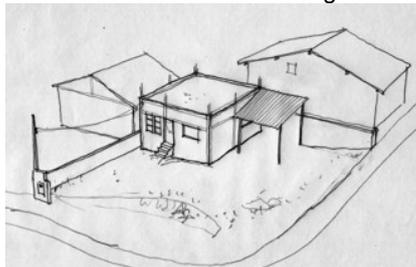
Campanha de conscientização ligada ao projeto "DATAHABIS: Difusão e Aplicação de Tecnologia em Áreas Habitacionais de Interesse Social para a Construção de Ambientes Saudáveis e Sustentáveis em Campinas-SP"
 Coordenadoras: Lucila C. Labaki e Silvia A. M. G. Pina
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 Faculdade de Engenharia Civil, Arquitetura e Urbanismo
 Universidade Estadual de Campinas
 Fevereiro de 2006

Figure 6: Example of educational material used in proactive program to stimulate the planting of trees.

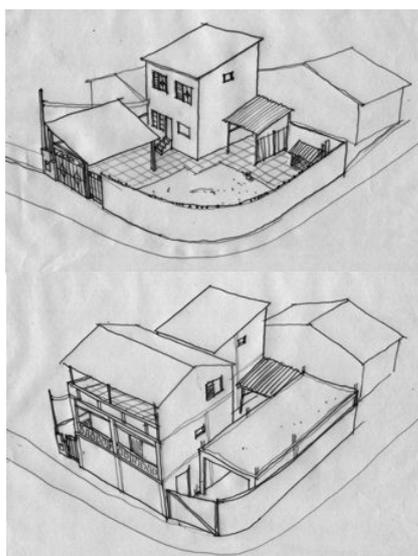
5. CONCLUSION

Although many studies exist which explore participatory methods in urban planning and design processes, few examples have explored the personalized approach through drawings. From pre-tests we have obtained a good response and understanding of the programs purpose. Increased awareness of the population's role in their community and its physical setting was obtained in pre-tests. Most participatory processes create unattainable expectations. Participation often cannot bridge the gap between population (users) and surveyors (designers and planners). Understanding of proposals is often erroneous or very low. Detail information is often lost in the conversation or written material presented in such processes. As Kaplan [15 (p. 124)] showed: "The discrepancies between what experts know and take for granted and what people know and hold dear must be examined. Incorporating participation is an effective way to recognize that experts and affected groups have different knowledge, perceptions, and needs." We believe that

the presentation of a specific individual situation (familiarity), in its present and future form, will increase interest and bring clarity in urban issues. Community issues may become apparent when the individual situation is shown as an accumulative process. Causes of discomfort and the arid landscape can be explained and discussed in a more direct way. Actions can be detailed to intervene positively and simply in the known physical environment. In our approach we believe we have made a step in the direction of closing the gap between different knowledge and perceptions and provided a means of simple but effect ways of improving owner-built communities through the preservation of open space and introduction of valuable urban vegetation.



Drawing showing the present situation of owner family construction situation



Drawings, showing the effect of additional construction activities on the typical residential lots.

Figure 7: Iconography to increase awareness in relation to open space on residential lots

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