

Sustainable Brasilia's University Campus Expansion

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Abstract

The present paper shows the sustainability principles adopted in the urban design of the southern extremity expansion of the Campus of the University of Brasilia, in which will feature a Scientific and Technological Park. From the analysis of a number of environmental conditioners, the structural core of the design was a fragment of Cerrado, aiming to recover the original idea behind Brasilia's implementation. To achieve connectiveness with the larger fragments by green infrastructure techniques were used. We must remind ourselves that the original project stated that human occupation should be adapted to the local topography as well as the draining curves within the Paranoá Lake Basin, even when far from it, in order not to compromise the hydrologic sustainability of the region. The configuration here proposed uses green infrastructure techniques, small bioclimatically treated squares along infiltration channels to reinforce the neighborhood feeling, cycle ways, increased density to diminish displacement and the higher typologies placed on higher ground to avoid interfering in the predominant wind directions.

Keywords: green infrastructure, bioclimatic strategies, hydrologic sustainability

1. Introduction

Lúcio Costa's design for the Capital of Brazil strategically previewed the adaptation of urban occupation to the local topography in the Pilot Plan as well as the draining curves within the Paranoá Lake Basin, even when far from it, in order not to compromise the hydrologic sustainability of the region. However, the constructions altered the topography and removed the vegetal covering of Cerrado *sensu stricto*. The deforestation produced excessively exposed areas, islands of heat, erosion, and gigantic whirlwinds, besides the reduction of the rich local biodiversity and the aggradation of the streams which feed the lake.

The Campus of the University of Brasília was also designed by Lúcio Costa in the sixties. At first, the plan intended to treat the buildings as isolated units around a Major Square which would work as a social center. However, later, in 1963, the units were put together in a single building designed by Oscar Niemeyer, the Central Institute of Science.

Nowadays, due to the super exposition of the main designers of the several later versions, both the buildings and the social areas are scattered, the car circulation axis generate conflicts and automobiles have taken precedence over people. The pedestrian pathways are disintegrated, hostile, many of them unpaved, and they do not offer the minimum environmental comfort conditions or accessibility for the physically challenged.

From the analysis of the existing social-environmental impacts and some other conditioners, the southern extremity expansion of

the Campus of the University of Brasilia (from here on UnB) has adopted the sustainable urban design principles for the future implementation of the Scientific and Technological Park which we have designed.

2. The antecedents of the southern extremity expansion of the UNB campus.

The Campus follows the morphologic principles of the city where it is located, reflecting a functional model marked by the scattering of the buildings and the social areas. Due to this structural model, the pathways are usually dissociated from the alignment of the buildings. The results are hostile pathways, extremely long and exposed to weather conditions. In spite of the eventual problem which may arise, it is still noticeable in the current physical-spatial arrangement of the Campus, a sense of human scale which is close to the standards considered desirable for such research institutions.

Lúcio Costa believed that Brasília should present itself as a cultural irradiation center via its University. UNB was born from this ideal of hope, renewal and progress. The Campus received from Lúcio Costa a proposal of characteristics similar to those of the city where it would be built. Most of the land was free, around 400 ha, as a huge park opened to the general population and landscaped to preserve the native vegetation and "enrichen it through a display of each flower type".

The current Darcy Ribeiro Campus does not fit the idea of a microcosm' separated from the city. It is right next to a residential area and quite close to the Educational and Cultural Centers of the Esplanada dos Ministérios from the federal

administration. Its level of integration to the nearby urban areas is reasonable. The same can be said of the level of agglutination of its buildings – although several gaps and problems demand solution. The scattering of the buildings, the multiple possibilities of displacement for the pedestrians between them and the fact that these pathways are almost always dissociated from the alignment of the buildings are evidently due to this process of structuring.

The process of occupation of the Federal District is synonymous with the environmental degradation of the Cerrado Biome. The original landscape was characterized by the predominance of Cerrado, occupying the greatest part of the land, followed by field. On the river shores, the closed canopy forest was continuous and dense. [1]

The Cerrado *sensu stricto* is characterized by the presence of short twisted trees, with irregular ramifications, and usually presenting evidences of burnings. The shrubs and subshrubs are scattered, with some species presenting perennial underground organs which allow them to sprout again after burning or being chopped off. During the rainy season, the subshrubs and herbs become exuberant, due to its fast growing. The Forest Engineering Department of UnB conducted a research of the flowers in the area, aiming to use the remaining trees from the Cerrado *sensu stricto* in the regeneration process and landscaping of the place. The preliminary characterization detected the importance of this portion of the ecosystem to favor the connectiveness between major fragments, called *stepping stones*. (Barradas, 2007).

The fragment of Cerrado within the Campus, where the building shall be constructed, served as an element of orientation to the urban structure of the Scientific and Technological Park and as an inspiration to the landscaping and bioclimatic aspects of the architecture, crossing the two blocks of the building.

Fifty years after the construction of the Paranoá Lake Dam, it is estimated to have lost almost 2,5 km² of its surface. The comparative analysis of aerial photographs from 1964 and 1991 reveal that an even greater area, 12,7 km² along the tributary rivers is aggraded due to the urban sprawl around the lake, taking over even environmental protection areas, in spite the legislation. The storm water galleries, which ultimately run to the lake, contribute significantly to the aggradation of the Paranoá Lake, regardless the use of energy dissipaters.

2.1 Brasilia's Climate

Brasilia has weather conditions similar to the Tropical Wet during the rainy period and to the Tropical Dry, in the dry season. Due to its continentality and altitude (Central Plateau 1000 meters above sea level), the daily temperature variations are remarkable, especially in the dry season.

The wind flux has different directions according to the season. In the dry season (from April to

September), the East wind prevails, with a secondary one to the *southeast direction* (September) and its velocity usually ranges from 2 to 4 m/s. In the wet season (October to April), the East wind prevails, with secondary ones to the *northwest* (December) and *northeast* (January) directions and their velocity usually ranges from 2 to 5 m/s. The Northwest quarter presents the highest incidence of winds and, in January, the prevailing winds vary between the Northeast and North quarters. The Northeast wind is the second most frequent during the year, except in December, when the secondary wind is the North. The absence of wind occupies over 33% of the year, being more frequent in the hot and humid period. The three prevailing directions, East, Southeast and Northwest were considered for the analysis.

However, during the whole year, there is a predominance of the East direction (January to April and September to November). These have conditioned the openings to obtain cross ventilation as well as the necessary protection to avoid dust filled wind.

3 Results: the sustainable planning of the southern extremity expansion

The expansion project we accomplished counts with an area of 55,4 ha which will provide a constructed area of 339.000 m². The project aims to follow up Lúcio Costa's ideology, in which the north-south pathways, with cycle ways and pedestrian sidewalks, green infrastructure and native vegetation, improve the aesthetic quality of the environment and the quality of the air, with an ultimate improvement of the thermal comfort.

The urbanization process uses mid-size plots in order to enhance the accessibility, prioritizing similar and regular shapes and avoiding residual areas, which contribute to the identity and helps spatial orientation. The designed urbanization stands out because of its sense of human scale and integration to the surrounding urban areas. The in-campus cycle ways system should be an stimulus to its expansion to the outer spaces, as a counterpoint to the excessive use of automobiles in Brasília.

The remaining Cerrado *sensu stricto* trees are used in the regenerative process and landscaping of the place. This vegetation is associated to the topography, the depth and permeability of the soil and also to the presence or lack of water. It favors the connectiveness among larger fragments of Cerrado and can be the orientation element for both the urban structure of the Scientific and Technological Park and the landscaping and bioclimatic aspects of the CRAD building; designed by the same team that presents this paper.

Vegetation can affect the microclimate reducing air temperature, when compared to the temperature of the surrounding hard surfaces. They also provide shadows, which, in the climate of Brasília, are the most desirable bioclimatic

strategy, and can divert the predominant winds in order to be used for cooling.

The predominant direction of the airflow is approximately (+- 10°) to the long axis of the central area of the project. It was thus designed a cooled air circulation channel surrounded by a green infrastructure which not only provides shadow and vegetation but also retains the drained water.

The evapotranspiration will be the main heat dissipation strategy, followed by the sensitive heat flow. Heat retention will be practically non existent.

With the bulky group of Cerrado trees preserved and the ones to be introduced, the temperature is expected to drop up to 3° C, as well as the solar radiation, to be reduced in 30% (thermal load analysis – Ecotec v.5). The percentage of waterproof surfaces is limited to the pedestrian pathways and cycle ways. The parking lot areas are partially permeable because they're made of interlocking blocks. All these factors combined affect heat reflection, absorption and retention, and result in more thermally comfortable open spaces.

There is a concentration of trees on the west direction in order to avoid solar incidence over the buildings. The new urban typologies were placed according to the declivity: four floors on the higher level, 3 on intermediary levels, and two on the lower ones. The low energy consumption is assured by the urban arrangement and the disposal of the major elements, which allow natural light access to all the buildings and guarantees cross-ventilation, by establishing narrow blades in the constructions.

According to the integrated view for environmentally sound management of water cycle, we point out the solution for the alternative anaerobic sewage treatment systems followed by wetland, with aquatic plants (post treatment) incorporated to the landscape design in order to establish a moist environment and provide multiple recreational opportunities for people. [2]

The natural drainage system incorporated to the urban design provides financial economy concerning the cost of maintenance for net, galleries and energy dissipaters. In the final project, green infrastructure techniques (Table 1), such as infiltration channels, green fence, rain gardens, storage tanks for harvesting rainwater and biological treatment of water residues in the lower ground, above the contour line 1000 of the Paranoá Lake. The control of surface runoff water is performed as close as possible to where the rain water hits the ground. The reduction of runoff water happens through the infiltration of the excess water underground, by evaporation and evapotranspiration – and by the temporary storage of rainwater, allowing its reuse and slow later discharge. As a result, the altered area has a behavior similar to the pre-urbanized hydrologic conditions, meaning less surface runoff, lower levels of erosion and water pollution, and consequently, less investment to mitigate the downstream impacts.

The energy gain in the constructed urban structure decreased, which in turn contributes to a higher humidity level and rain fall rate, as well as the vertical and horizontal ventilation shift. All such changes in the urban climate are noticed by the population in terms of environmental comfort, having remarkable consequences in terms of human performance (individual) and public hygiene (social).

The results achieved by the urban configuration was obtained by means of small squares, bioclimatically treated, along infiltration channels to reinforce the sense of neighborhood, cycle ways, parking lots inside every single plot, higher density areas to diminish displacements and the use of higher typologies on higher ground to avoid interfering with the predominant wind directions. At the same time, it is possible to obtain a better microclimate with the environmentally sound water management and by placing the waterways and vegetation in the same direction as the eastbound prevailing winds. [3] or [4]

The maximum temperatures don't go over 29° C, when humidity is over 80%, at any time of the year. In the dry period, the relative humidity varies between 22% in August, and 42% in May. In July, all the occurrences of temperatures above 29° C happen at a humidity level below 30%. In the hot and humid period, the relative humidity varies between 34.4% in October and 49% in December. The main bioclimatic strategies recommended for the cold are thermal mass and passive solar gain. During hot periods, ventilation, thermal mass for cooling and evaporative cooling are the indicated strategies. The use of artificial systems is necessary only in 0,99% of the hours in a year, in the case of discomfort due to cold, and in 0,08%, in the case of heat. (ABNT NBR 15220)

Fig 1 – Green infrastructure techniques applied to the urban design: bioswales, green fences, storage tanks and residual water treatment.



| TABLE 1 ENVIRONMENTALY SOUND WATER MANAGEMENT | |
|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| STRATEGIES | GREEN INFRASTRUCTURE TECHNIQUES |
| <p>Integrated rain garden along the pathways and cycle ways in order to allow water infiltration without the need for a standard drainage system</p> | |
| <p>Residual water treatment by wetland</p> | |
| <p>Scientific and Technological Park with water mirror and storage tanks for harvesting rainwater.</p> | |
| <p>Bioswales implemented along the recovered forest and pedestrian pathways</p> | |
| <p>Both the new buildings of the Scientific and Technological Park, and the Recovery Center for Degraded Areas will receive green roofs.</p> | |

3.2 Environmentally sound water cycle management - Green Infrastructure techniques

Strategies:

- Rainwater garden integrated to the water infiltration channel, with no necessity for buried sewer systems.
- Residual water treatment by wetland
- Scientific and Technological Park square with water mirrors and storage tanks for harvesting rainwater.
- Bioswales implemented along the recovered forest and pedestrian pathways.
- Both the new buildings of the Scientific and Technological Park, and the Centro de Recuperação de Áreas Degradadas – CRAD (Recovery Center for Degraded Areas) will receive green roofs.

Fig 2 – Biowales



Fig 3 – Scientific and Technological Park Square – storage tanks.

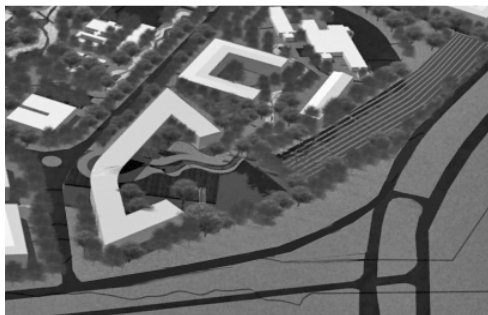


Fig 4 – Urban design



The Green Infrastructure used in this environmentally sound approach to rain water management and in the landscaping of the site is based on aspects which strongly condition the existence and development in a scale compatible with the project.

The most used typologies are

1 – Rain gardens, with adequate vegetation and with no direct infiltration to the soil (only evaporation, evapotranspiration and overflow).

2 – Stormwater hedgerows – rain gardens compacted in small urban spaces which receive the superficial runoff between sidewalk and the street.

3 – Bioswales – swaled drainage courses, slightly sloped and serially interconnected so that the water overflows from one to another. They drain the water to the rain garden where the vegetation contributes for filtering the pollutants, before they reach Paranoá Lake.

4 – Green fences, used in places with accentuated slopes; the retention of runoff water happens progressively and only overflow water passes from one to the other.

5 – Sedimentation basin (or Settling basin or Dewatering Basin)

4. Final Considerations

The visibility of the project, located inside the Campus of the University of Brasília (the only public University in the city), the excellence of knowledge produced by its researchers, the renowned social insertion of its professors and the opening of the new technological center demanded innovative processes and products, specially concerning the treatment of the water and the use of native vegetation.

The compromise with the hydrologic sustainability of the Paranoá Lake Basin, valuing the social interaction around the water and the preservation of the Cerrado Biome enables the approximation of the urban population and the original environment and vegetation. This newly urbanized area behaves as if it would previous to human interference, in terms of water usage, mitigating the possible negative consequences.

The conditioning strategies used can be condensed as follows:

Minimize cuts and landfill; Zoning of activities; Active presence of the vegetation for cooling and shadowing; Adequate plant species (recovery of the natural forest); Soil permeability – aquiferous capacity of the soil and natural gravity drainage.

The green infrastructure techniques give rise to small bioclimatically treated squares along the infiltration channels, which reinforces the neighborhood sense and acclimate the cycle ways and the pathways. The squares also allow the proposed densing and the placement of higher typologies on higher ground to have a harmonious behavior with the prevailing winds

An involving space is thus created, with a favorable microclimate due to the thermal inertia of the water mirrors, channels and lakes and the evapotranspiration (fountains, cascades, water circulation in underground channels in order to use the shadow to obtain cooled air). The sprinkling and micronization (in direct radiation zone) are also a part of it.

The 1.300m² model-building for the Centro de Recuperação de Áreas Degradadas (Recovery Center for Degraded Areas) announces the beginning of the sustainable transformation and the passive use of natural energy (sun and wind) in the Campus. The native cerrado forest integrates the architecture and landscaping, surrounds the patio and cools the air with garden coverings and green briseé soleil humidified with micronized water. The pre-molded concrete structure makes the construction process faster, durable and with less residues.

The area is an example of occupation which inserts the population of the city in a system of pathways and cycle ways surrounded by trees, offers good conditions for pedestrian mobility, thus emphasizing its sustainable features, provides adequate lighting, furniture and aesthetics, not to mention the lack of noise and pollution.

The expansion of the Campus thus projected recreates a space with no boundaries, democratic and widely accessible, which promotes diversity, interaction and urban feeling, following the principles of sustainable construction. [5]

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