

604: Environmental Urban Design for Central Urban Areas in São Paulo, Brazil

Joana Carla Soares Gonçalves

Faculty of Architecture and Urbanism, University of São Paulo, BR

Abstract

The paper brings about the topic of environmental urban design for central areas in the city of São Paulo, Brazil, aiming to achieve environmental and socio-economic benefits to urban revitalization. São Paulo is currently the second largest city in the world with a population of nearly 19 million. This pilot project is both a response to specific dilapidated sites in São Paulo and a template for possible environmental interventions in other cities. The design process takes into consideration parameters of environmental performance of different building typologies for the city block, exploring the environmental and urban potential of the modernist slab and the perimeter block. The impacts of density were tested against five variables selected for the assessment of the urban models: population density; impinging solar radiation; soil porosity for rain water absorption; solar access and daylight availability; and air quality. In parallel to that, the architectural and urban design parameters were: built density; open and public spaces and green areas. The use of advanced simulation tools and analytical studies had a fundamental role in the comparative analysis of the urban models and the design process, which was informed by the overlapping of environmental criteria and design parameters. The main research outcome was the development of a design framework to urban interventions for the improvement of environmental quality in buildings and open spaces, focusing an urban density of 1.000 people per hectare.

Keywords: density, urban design, environmental quality

1. Introduction

The possibilities of urban design in the providing high densities and public spaces with environmental quality has an important role in the future of cities, specially in a scenario of developing economies and population growth (Rogers, 1999). The clarity of public authorities with respect to environmental and socio-economic design criteria has a key role towards urban sustainability. In this regard, the overall objective is to contribute through architectural and urban design guidelines to the wider process of urban sprawl which has been observed in a number of big cities, with relevant impact since the end of 1970s, whilst central areas well served by infrastructure and building stock have been emptied and economically devalued.

Given the current conditions of major big cities in the world, such as São Paulo, ideally the urban sustainability depends on the densification of the city centre, whilst the periphery should be de-densify. With reference to the city of Sao Paulo, now the second largest city in the world with a population of nearly 13 million spread over 1.6 Km², sprawling high-rises are interspersed with shanty-towns, creating an urban environment where the higher built densities of the central areas do not match the population densities agglomerated in the city peripheral ring, which defines the key problem for the local urban sustainability [1].

Sao Paulo has a subtropical, yet polluted, climate and is subject to a wide range of urban micro climates, as a function of its occupation patterns and topography. The city is located at latitude 23°24'S, with altitudes between 720m and 850m

above sea level, 60Km from the sea [2]. Currently, the urban infrastructure is poor, air and water pollution is high and green space is at a premium.

In such a complex and challenging urban context, this pilot project addresses the establishment of a design framework as a starting point for raising questions about the issue of urban renovation and sustainability of brownfields in central Sao Paulo.

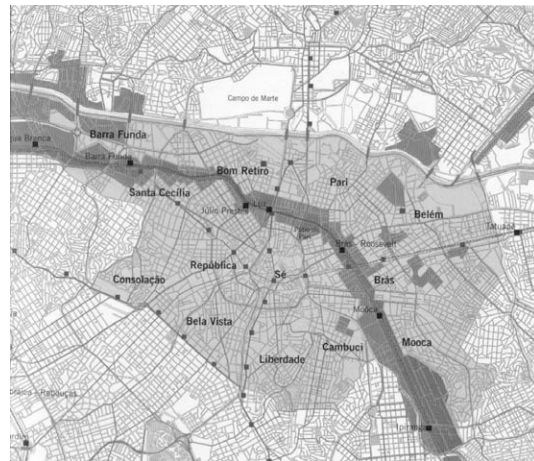


Fig 1. Sao Paulo city centre, crossed by the railway line. The darker areas are identified as brownfields or derelict parts of the urban fabric, with potential for densification due to the infrastructure.

The project, which is both a response to specific dilapidated sites in Sao Paulo and a template for possible environmental interventions in failed urban sites elsewhere, brought together Brazilian

and British expertise in the field of sustainable urban design in the period of 2005-2006. The team comprises researchers from the University of Sao Paulo, Brazil, the University of Cambridge and the University of East London, with support from the British Academy. Following the one-year international collaborative project further detailed urban and environmental studies were carried out by the Brazilian partners for another year.

In the context of this research project, the definition of environmental sustainability is based on the following objectives: 1-efficient consumption of resources (water and energy); 2-less polluted urban environments; 3-environmental comfort within buildings and outdoor spaces; 4-efficient transportation in terms of energy consumption, environmental impact and mobility; and 5-ecological niches. The local environment is considered as an important cultural force as well as a major economic factor.

Ideally, the a city like Sao Paulo, the utopian of urban sustainability calls for a broaden approach, which could be achieved by bringing together the strategies for densification in the city centre and its surroundings, whilst the periphery should be de-densify and the continuous existing axis, such as railways, rivers and even highways, in conjunction with existing and new green areas, can be transformed into green corridors for ecological niches within the built environment, creating a sustainable urban net of contrasting urban nods, connected by green corridors. Nevertheless, the scope of this research project is directly related to the means of densification central areas by means of urban design.

Two sites of different morphological configurations were chosen as case studies due to their strategic geographical position close to the city centre, positioned along the railway line where urban revitalization is a key socio-economic and environmental issue. All the urban differences between the sites were taken as potential variables to demonstrate the possibilities of developing Sustainable Urban Spaces through environmental interventions in different conditions, which are repeatable in other parts of São Paulo and in other cities.

A series of technical studies demonstrated the relationships among urban density, built form and sustainability, focusing on the consequent impacts on environmental variables, such as solar access, urban air flow and the potential for energy harvesting in the buildings' envelop.

2. Objectives: creating sustainable urban spaces in the city centre

The main objective of this research project was the definition of models for urban design in brownfields, departing from a set of environmental criteria for buildings and open spaces, to test the related impacts of density and built form. In addition to that, the environmental improvements should lead to social and economic benefits.

Having said that, based on a series of environmental criteria, the challenge of the urban design exercise was to demonstrate, the

possibilities of introducing higher densities in existing contexts within the limits of the local infrastructure and the environmental quality of both public space and housing units, taking as case studies these two areas in the city: the case neighborhoods of Barra Funda and Luz.

The Barra Funda project is about the creation of a new community in an urban brownfield site, whereas the Luz project lends itself to interventions in a more consolidated urban tissue, where infrastructure and a certain degree of mixed use is already implemented. The two areas of interest: an open brownfield with empty sites and the derelict but consolidated urban blocks, are connected by the railwayline. However, the continuous open space which could be a linear park is actually a physical barrier and a brownfield itself, in stead of an inviting urban corridor.



Fig 2. The two areas of intervention: Barra Funda at the top left and Luz at the bottom right, conncted by the railwayline.

3. Areas of intervention: the city centre of Sao Paulo

3.1 The neighbourhood of Barra Funda

Figures [3]:

- Urban area: 5.953.000m²
- Population density: 21 people/ha
- Total built area: 2.822.963m²
- Average plot ratio: 0,65

Located in the northwest part of the city, the area of intervention is 5 kilometres distant from downtown, reaching the margins of Tietê river.

Historically, the urbanisation process of the northwest region started with the implementation of the railway together with the development of industrial activities. The immediate consequence upon the urban configuration was the formation of relatively big sites to accommodate industrial buildings and warehouses.

The brownfield site in Barra Funda neighborhood is inserted in an area classified by the local government as one of the sites for the "Urban Operations". The areas that recieve such classification are defined byt the city as potential sites to undertake substantial interventions, considering changes of its urban configuration as well as economic and social characteristics by means of public and private partnerships [4]. This specific proposal for intervention in Barra Funda failed in many aspects; it did not generate significant changes in the region, it did not attract entrepreneurs, some of the new buildings are still empty and the people who live and work in the

area do not have many options of services in the immediate surroundings.

With respect to infrastructure and transportation, the area is well served in comparison to other parts of the city. The second biggest station for public transport in the city sits in the area, Barra Funda Station, with underground, train and bus terminals. Therefore, the public access from other locations of the city and also from the metropolitan area is facilitated through different means of transportation. Places and buildings destined to cultural and leisure activities are major points of people's attraction.

A big brownfield site in Barra Funda, with microclimatic conditions of hot-dry climate (due to the effects of urbanisation) [7], was chosen for a national design competition, held in 2004, promoted by the Municipal Administration of Sao Paulo and Brazilian Institute of Architects to be the platform of the urban development entitled "Bairro Novo" (New Neighborhood) [8].



Fig 3. The brownfield site in the neighbourhood of Barra Funda, featuring new office towers with no urban context.

The competition brief aimed to create new areas and public amenities and facilities, to promote new uses for underutilized areas and buildings, to generate identifiable quality to the landscape, to indicate environmental conservation areas and to propose plans for both public and private intervention. Within this context the area of intervention for the research project has the central station in the centre, covering 72 hectares.

3.2 The neighbourhood of Luz

Figures [3]:

- Urban area: 4.335.573 m²
- Population density: 61 people/ha
- Total built area: 3.501.000 m²
- Average plot ratio: 0,81

The urban and architectural patterns and the socio-economic problems of the neighbourhood of Luz is found all along the old tissue of the city centre and its immediate surroundings.

The city centre has currently over 30% of the built space of the downtown neighbourhood unoccupied, being mainly in buildings taller than eight storeys in an area that has gone through a process of physical degradation and economic devaluation for the last three decades [5].

The interest in the neighbourhood of Luz comes from its location in the downtown, where is placed the best urban infrastructure in the city, with a significant number of tall buildings dating from 1940-1960s, in great need for retrofit [6].

Together with the tall buildings, a number of low rise constructions and parking lots (of none architectural value and little economic value) create a hybrid and compact urban fabric, where

public space is reduced to the sidewalks and streets, whereas the core of the urban square blocks are dark, not ventilated and not accessible open spaces.

Recent plans of the local government have been announced, bring the intentions of major urban transformations. The announced masterplan included the demolition of buildings encompassing 105.000m² of currently built area (not precisely identified).

In parallel to that, the local government has also declared that an area of approximately 25 city blocks in the neighbourhood of Luz will receive special public incentives for housing developments, targeting the needs of low income (social housing) and middle class families.



Fig 4. The neighbourhood of Luz, showing the poor quality of the open space mainly occupied by cars, and the derelict residential tall buildings.

The area of intervention established for this research project encompasses 12 hectares, including two perpendicular avenues that cross the city centre, within walking distances from two major transportation hubs: Julio Prestes and Luz stations.

Whilst the aims of the intervention planned by the public sector are still unclear, the research project contributes with criteria and urban design proposals for the improvement of the overall environmental quality of the site. Besides the immediate benefits for the local living and working population, it is expected that the combination of new public spaces, environmental quality and the opportunity for higher density, in such a consolidated urban area, will result in a more social mixed community and mixed-use developments.

4. Research pro-design

4.1 General procedures

The process of the research pro-design consisted in a number of activities: detailed diagnosis of the physical, environmental and socio-economic existing conditions of the sites, research meetings, definition of performance criteria, design workshops, and technical assessments involving the use of advanced simulation tools for comparative analysis.

Based on a fixed pre-determined density (1.000 people/hectare), the insertion of three different architectural typologies within the existing context were tested in the empty sites, creating three

different configurations of public space and reshaping the built form: the perimeter block and the slab modernist building. . A comprehensive diagnosis of the supporting capacity of the existing infrastructure gives the basis to the definition of increased densities scenarios. In this context, the target of 1.000 people/hac represents a referential figure, which is justified by the presence of local infrastructure, specially public transportation in both areas.

A group of six topics were considered for the assessment of the proposed built forms for the urban design intervention: 1. population density, 2. energy, 3. water, 4. solar access and daylight availability, 5. air quality and 6. noise.

The urban parameters that influenced the choice for the architectural typologies in the creation of the built form were: 1. built density (as a consequence of the population density); 2. the nature and the urban qualities of the open and public spaces; 3. possibility of introducing green areas and trees (for outdoor's comfort); and increasing soil porosity (for rain water absorption) in the open spaces.

Results from a series of complementary environmental assessments were crossed with design parameters (for buildings and open spaces), in the design proposals for the two areas of intervention. Such analyses were driven to establish balanced design solutions between environment and design strategies for the creation of sustainable urban spaces.

The environmental assessment combined different tools, bringing together advanced computer simulations, local measurements, simplified analytical techniques and design explorations. The performance assessments were carried out either based on international or national benchmarks, or in relative terms, when the issue of benchmarks is not appropriated.

Fig.5 The overall design method, including the five different environmental topics of performance.

Investigation on use and state of conservation of buildings guided the proposal for buildings' demolished, necessary for the creation of public spaces and insertion of new buildings (this step of the research is especially significant in the site of Luz, where it is identified a more consolidated urban tissue). In parallel to that, with the map of buildings' use all the spaced and related occupation removed by the demolition had to be brought back in the new urban design, in addition to the extra population density.

After the removal of a number of existing builings, the Barra Funda site resulted in a open field equivalente to the creation of a complete new neighbourhood (72 hectares), whereas the Luz consolidated character of the site was remained, demanding a careful introduction of new buildings on each urban block.

The environmental performance of the built form was tested based on the initial environmental parametres, which the role in the project is:

- energy: harvesting of direct solar radiation for water solar pannels,
- water: absorption of rain water in the open space,
- air quality: benefits of green areas and air flow around buildings,
- solar access and daylight availability: thermal and visual comfort and energy efficiency in buildings' and outdoors' comfort,
- noise: acoustic comfort in buildings (with openable windows) and open spaces.

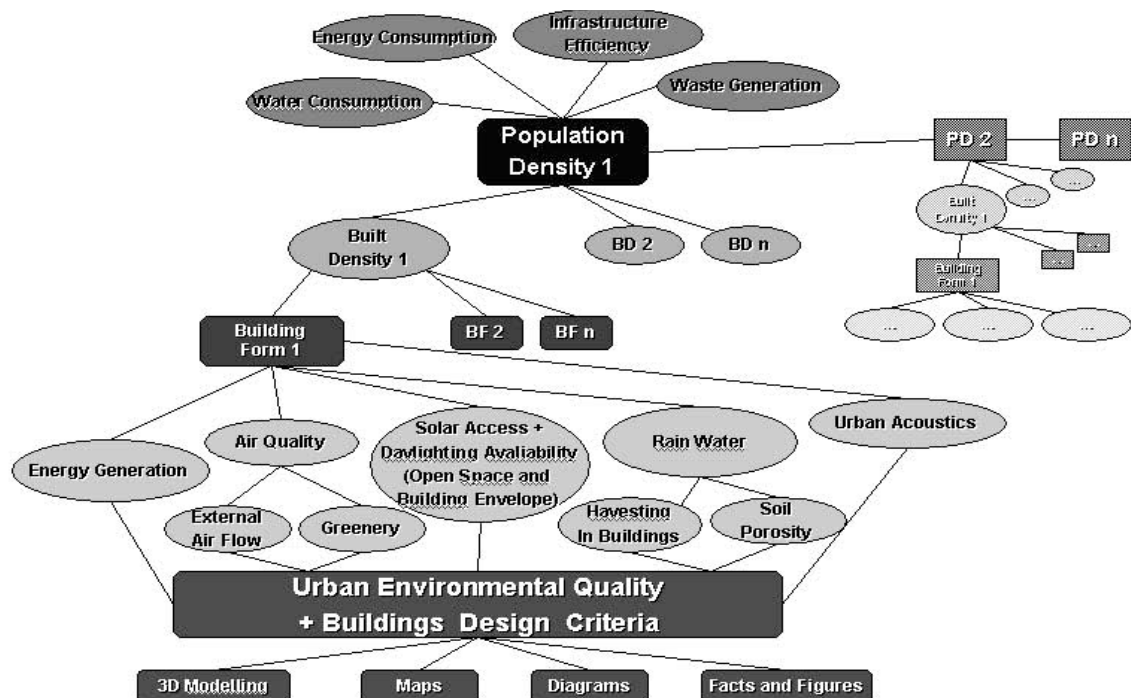




Fig 6. The Luz site of intervention, the territorial occupation of the built form (very little open spaces and no green areas within or around the city blocks).

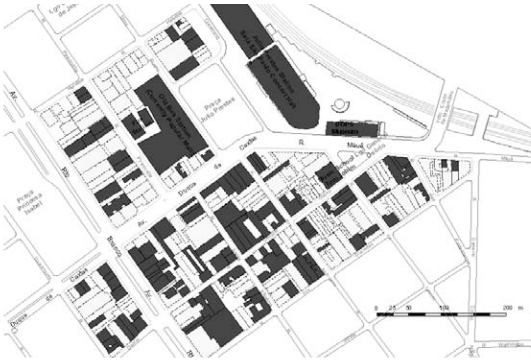


Fig 7. The Luz site of intervention, criteria for demolition: height < 15 m, with no architectural value and poor physical conditions (the buildings highlighted are the remaining ones).



Fig 8. The Barra Funda site, the urban fabric composed mainly of industrial buildings and warehouse (the majority is derelict and empty) and some spots of green areas disconnected from the big park (in the south, at the edge of area of intervention).

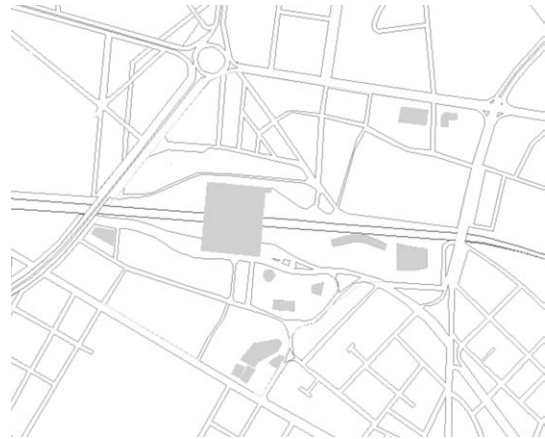


Fig 9. The are of intervention with the removal of the factories and warehouses. Remaining buildings: the station, the cultural centre Memorial da América Latina, and the tall office buildings.

4.2 Design Project: Definition of urban the models and site planning of the new buildings

The elaboration of the urban design proposals were inspired by and referred to theoretical as well as design references, however, considering a conceptual and preliminary approach of the impacts and performance of density and its relation with the other environmental and urbanistic variables.

Prior to the arrangements of urban design, the design performance of different architectural typologies were examined, exploring the environmental and urbanistic attributes of the slab building (typical from the Brazilian modernist) and the perimeter block (typical European urbanism, with the courtyard).

In order to achieve the pre-determined density target, both interventions to each area, one introducing the slab building and the other one the perimeter block, were conceived with 10 storeys.



Fig. 10. Physical model for testing the perimeter block and the modernist slab in the Luz site.

4.3 Environmental and Design Assessments

In this phase a group of simulation tools and analytical methods were applied for the testing of the design proposals. The evaluations refer to the environmental performance of buildings' as well as open spaces.

The software applied in the assessment procedures were: Ecotect for shading analysis, Radiance for daylight availability and impinging solar radiation, *Obstrução* (FAUUSP) for the prediction of energy consumption of buildings and ENVI-met for urban microclimate.

It is worth highlighting that regarding the aspects of the design to which the use of simulation tools were not appropriate (or possible) either

analytical methods or qualitative criteria were applied. This was the case of air-flow around buildings, which were drawn based on theoretical references.



Fig. 11 Luz site: Slab buildings within the existing context (solar studies, summer 9:00h).



Fig. 12 Luz site: The perimeter block within the existing context (solar studies, summer 9:00h).

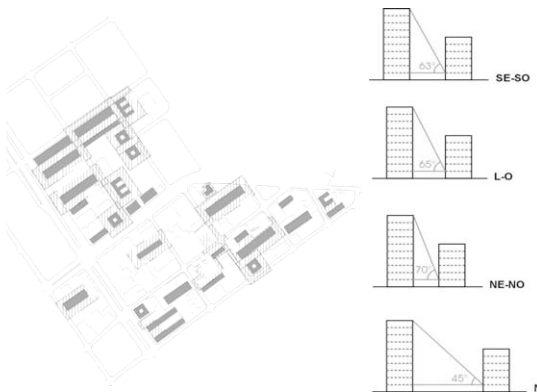


Fig. 13 Luz site: The criteria for solar access according to the different orientations (2 hours of solar access in the winter solstice).

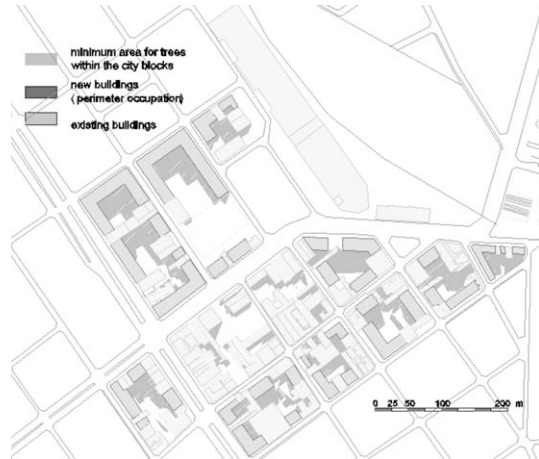


Fig. 14 Luz site: The delimitation of the green areas within the urban blocks, based on the shading analysis, to preserve the solar access in the public areas in the winter days.



Fig. 15 Barra Funda site: the referential area for the "new neighbourhood" and the site of intervention (testing of the urban design models) around the station (bottom right).

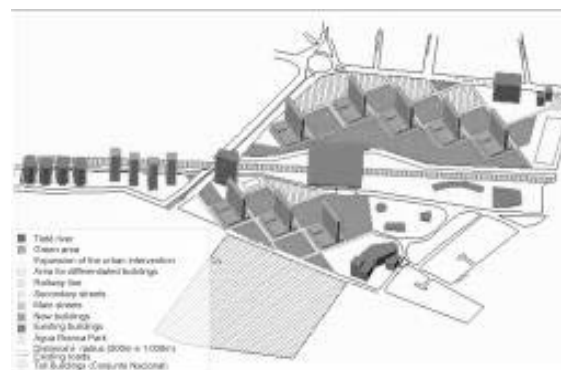


Fig. 16 Barra Funda site: the slab building with the podium in the open site with the few existing buildings.

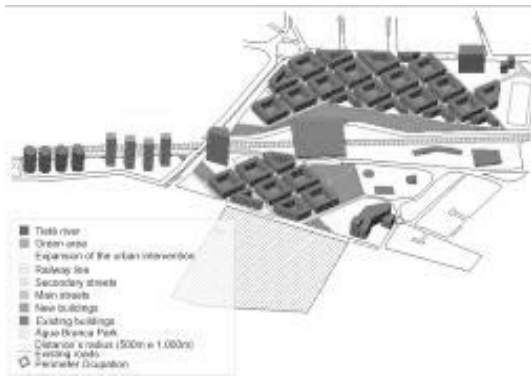


Fig. 17 Barra Funda site: the perimeter block in the open site with the few existing buildings.

5. Final considerations

The issues of urban density and its advantages to urban sustainability, together with the shortage of good quality social housing in consolidated urban areas, are of major interest of the public and private sectors of Latin American cities, given their cultural, environmental and socio-economic particularities.

In both sites the perimeter block proved to accommodate higher densities (departuring from the target of 1.000 people/ha), in buildings of 10 storeys, and open spaces within the urban block protected from the urban noise, whilst the four buildings' façades are exposed to high levels of urban noise, as opposed to the slab buildings, which the main façades are recessed from the streets.

It was observed that for subtropical climate of São Paulo, hybrid aspect of the urban fabric, including building spacing and heights, offered advantages with respect to the environmental performance. In addition to that, in the case of the Luz project, the rough aspect of the built form (which was kept as the major big existing buildings remained in the design proposals) preserve the essence of the irregular cityscape built over more than 50 years, as opposed to the regular and planned urban blocks, which are typical of European cities. In doing that, the proposals improve the quality and the performance of the built environment, without disconfiguring the urban-cultural identity.

On a more methodological analysis, as there is not one optimum solution in dealing with the environmental variables in the development of the design proposals, a scale of environmental priorities must be established, if necessary, accordingly to the local needs.

6. Future developments

Continuing from the resulting framework, future developments of the research project will refine the studies of densification in consolidated and derelict urban areas, enlarging the case-study area of Luz, and exploring the environmental performance of not yet tested building typologies, such as the tower block (the squared base tall building) within the overall context of the city morphology.

With respects to the methodological approach, the design framework will be re-evaluate to insert urbanistics and socio-economic criteria.

In this respect, a number of qualitative aspects from the architectural and urban design will be incorporated in the assessment method: the possibilities of social interaction and economic dynamics in the public spaces, the urbanistic characteristics of the public space created by the built form, the impact on the cityscape and urban identity, and the attributes of the landscape and the vegetation as a major design factor to create an "architecture from the place".

In order to develop an overall critical review of the design proposals about the related socio-economic benefits, invited specialists will assess the urban design proposals.

Design developments of the architectural typology of the housing blocks, within the urban design proposals come to conclude the design of the built form for more sustainable neighbourhoods.

7. Acknowledgements

Many thanks to all the graduate students from FAUUSP who took part in the research project: Alessandra Prata, Anarrira Buoro, Andrea Bazarian, Anna Christina Miana, Carolina Leite, Érica Umakoshi, Mônica Marcondes, Norberto Moura, Paula Shinzato, Rafael Brandão e Luciana Schwandner. Also thanks to Professor Koen Stemeers from the Martin Centre, University of Cambridge; and Professor Susannah Hagan from the University of East London, for the participation in the workshops. Finally, we would like to also thank the British Academy for financially supporting the first year of this research work.

8. References

- [1] Empresa Municipal de Urbanização, EMURB, "Ação para o Centro de São Paulo", São Paulo, 2004.
- [2] SVMA, Atlas ambiental de São Paulo (2004).
- [3] IBGE, CENSO (2000), Ed no. 10, Brasília (2000).
- [4] São Paulo. Lei 11.774/95 da Operação urbana Água Branca (1995).
- [5] N. Somekh, N. Campos, "C.M. Desenvolvimento Local e Projetos Urbanos". In: IX Encontro Nacional da ANPUR - Ética, Planejamento e Construção do Espaço, v.1. p.173 - 184, Rio de Janeiro, 2001.
- [6] M. Ruth Amaral de Sampaio, J. de Lira, R. Rossetto, A. Bosetti, L. Sampaio, N. Winge, "A promoção privada de habitação econômica e a arquitetura moderna 1930-1964". Rima Editora, São Carlos, 2002.
- [7] D. Duarte, J. Carla Soares Gonçalves, L. Marques Monteiro, "Environment and urbanization: Microclimatic variations in a brownfield site in Sao Paulo, Brazil", in: PLEA 2006, Geneva.
- [8] D. Duarte, J.Gonçalves and M.Rosa, A starting point in urban renovation and sustainability of brownfields in central Sao Paulo, Brazil. In: PLEA 2005, Beirut, Lebanon.