THE REVITALIZATION OF CENTRAL CITY AREAS AS A MEAN FOR URBAN SUSTAINABILITY - THE SUSTAINABLE URBAN MODULE FOR THE HOT-HUMID TROPICS

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Abstract - The harbour area in Rio de Janeiro, located next to the city centre, is losing its former function due to a transfer of the harbour activities to other places. The area is behind the wharf is already very dilapidated, cut of from the water front by an elevated expressway. On the land side, the area is limited by a ridge dominated by favelas.

As a preliminary study for an international workshop an urban project was developed for a selected area. In this study proposals were formulated to improve the indoor and outdoor quality of the neighbouring favela. Furthermore a new quarter development was elaborated – the Sustainable Urban Module - , suggesting a vivid mixture between traditional European city structures with short ways, a tropicalised environment for pedestrians and cyclists and a dispersed grid of high-rise structures, optimised for natural ventilation. A full game of sustainable technologies, methods and strategies were implemented. The result is an area with high density, intensive mixture of functions, low sealing of the urban soil and an urban structure focusing a high urban quality while reducing the environmental impact. Calculation of different indicators for sustainability will be presented.

Introduction

In 2002 already 82% of the Brazilian population lived in cities. The urban population is still growing, the migration from the countryside to the city is continuing. The consumption of resources by city dwellers generally is much higher compared to inhabitants of rural areas. These two aspects – the vast majority of the population lives in cities and their resource consumption is higher – leads to the conclusion, that the quest of sustainability will be decided in cities.

Cities today are suffering from different environmental problems, like for example the pollution of ground water and soil due to insufficient sewage systems and landfills, air and noise pollution due to an excess of private and public transport based on combustion of oil derivates and a lack of thermal comfort due to urban heat islands caused by insufficient urban planning.

The visibility of these problems is a result of the high population density in cities, which at the same time facilitates the solutions: efficient mass transport systems and sewage treatment plants become economically viable and the concentration of financial resources due to the horizontal and vertical concentration of income per hectare opens the way to more sophisticated solutions in the built environment.

The transition from the industrial society to a service-orientated society liberates many plots of land in inner city locations, former used as production sites. At the same time many downtown areas suffer from structural problems, decreasing its functional and environmental quality. So the newly available areas can be used to bolster up central city areas, implementing sustainable concepts.

The actual port area of Rio de Janeiro, which borders on the city centre, will be gradually liberated from its former functions due to new harbour installations in another location. As part of a Brazilian-German workshop in Rio de Janeiro a proposal for a sustainable revitalization concept was elaborated and since then improved. The idea is the integration of different concepts and technologies, considering the tropical climate of Rio de Janeiro.

This article will focus on the mobility aspect, the possible improvement of the microclimate, including the reduction of flooding, and an optimised urban pattern for tropical cities.

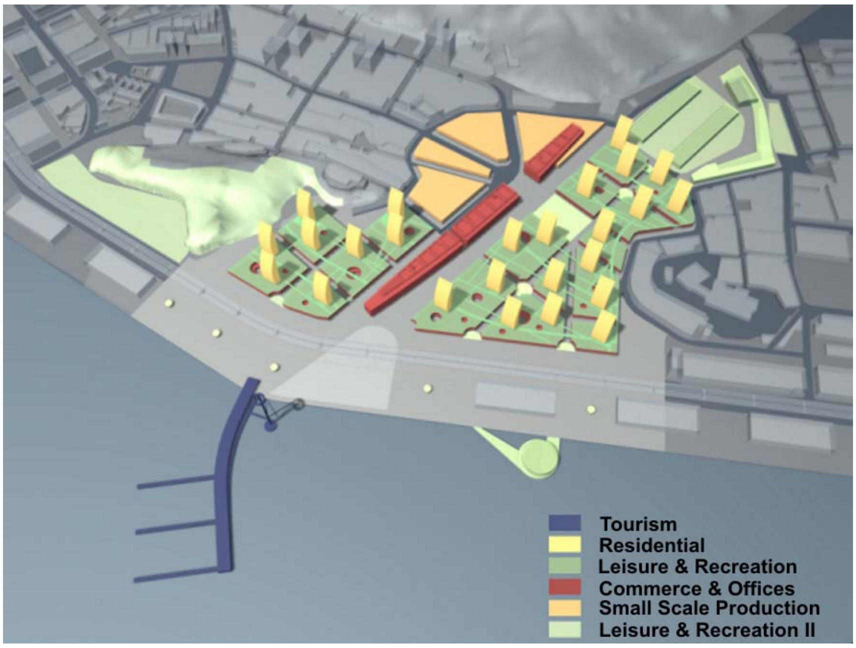
Urban pattern & Sustainability

The urban planning of cities in the hot and humid tropics suffers generally from a decisive contradiction: considering the quality of urban space and an optimisation of urban transport through a minimization of distances and high density of the population (economic viability of public mass transport systems), the best solution is based on traditional European city layout. This layout, with a balanced mix of functions, like small scale industry, commerce, residences and leisure, allows pedestrian precincts in the city centre.

Focusing on natural ventilation, the best passive solution for providing thermal comfort in the hot and humid tropics, the city layout should be based on a low density grid, which clearly contradicts the aims mentioned before.

Furthermore exists a second seemingly contradiction: to improve the microclimate huge green areas, the so-called “lungs of the city” are necessary. This reduces significantly the density of the population, putting into risk the viability of several public services.

With all this contradiction in mind, a new model was developed for a limited area of the harbour in Rio de Janeiro, called the “Sustainable Urban Module”.



It is based on the implementation of three horizontal layers: the first layer, situated at the level of the terrain, composes typical traditional European urban elements, creating an huge pedestrian precinct. The three-storey high quarters provide space for commerce, offices and indoor-leisure activities.

The second layer, on top of the first layer, is composed of an huge sky park, taking advantage of the generally function-less rooftops. The individual rooftops are equipped with 80 cm of soil, therefore an intensive green roof, and interconnected with small bridges.

The third layer is composed of residential towers, based on a low density grid, taking advantage of the natural ventilation.

The decision of the allocation of commerce, offices and indoor-leisure in the first layer and residential in the third layer was taken out of the understanding, that due to high internal loads in non-residential functions the avoidance of air conditioning under the prevailing climatic conditions in Rio de Janeiro is almost impossible. So the aspect of natural ventilation loses importance for these functions. The residential towers on the other hand take advantage of an undisturbed natural ventilation, with relatively high wind speeds and cooler temperatures due to the altitude. Literally situated in a park, these buildings take furthermore advantage of the improved microclimate and an extremely reduced infrared radiation from surrounding surfaces.

Table 1 - Distribution of areas

Function	Area in m²	in % of total
Small scale industry and training	46,640	9,1
Offices & Commerce	204,480	39,9
Residential	68,640	13,4
Leisure 1	115,710	22,6
Leisure 2	75,090	14,6
Tourism	2,530	0,5
Total area	513,090	100

[1] IPLANRIO, 1996

About 915 residential units (average size: 75 m² (IPLANRIO, 1996)) will offer a new home for 3,000 – 4,000 people. This means an urban density of 132 habitants per ha, which is considerably high, considering a participation of residential areas of only 13.4% of the total (see table 1).

Mobility & Sustainability

The traffic concept is based on two pillars: first, it counts with a huge traffic reduction due to the central localisation of the area and due to a mixture of functions in the "sustainable urban module". The access for car and lorry traffic is subterranean, relieving the surface as far as possible from traffic problems. Access for emergency vehicles is guaranteed on surface and subterranean.

The Instituto Perreira Passos IPP estimates a settlement of up to 110,000 additional people in the whole port area, as a result of the revitalization of the area. Taking into consideration, that the alternative area for the city expansion, Barra da Tijuca and Recreio, is situated around 40 km from the city centre, this means an considerable impact on the energy consumption for transport and on emissions, principally due to a total lack of efficient mass transport systems between the actual expansion area of Rio de Janeiro and the city centre.

Calculating, that one third of the new residents stop using their cars to go to work during 240 days per year, this would save millions of kilometres and litres of gasoline per year (average consumption 10l/100km, average distance 80 km per day). This also avoids tons of CO_2 and the emission of heat energy through motors, which helps to reduce (a little) the problem of inner city heat islands. The reduction of a considerable amount of cars per day in the centre also reduces problems like traffic jam and noise emissions. The values shown in table 2 do not yet include further benefits due to the creation of many jobs close to existing neighbourhoods.

Table 2 – Benefits due to Sustainable Mobility in Revitalized Central Areas, e.g. Harbour Rio de Janeiro

Yearly Reduction in	Whole area (40,000 hab.)	Whole area (110,000 hab.)	Module (3,500 hab.)
Driven kilometres	256 Mio	704 Mio	22.4 Mio
Gasoline (in l)	26 Mio	70 Mio	2.2 Mio
CO_2 (in tons) [2]	917	1,605	51
Heat emissions (in MJ) [2]	7,142,400	33,503,023	1,066,005
Cars in the centre/daily	13,300	37,000	1,167

[2] Frischknecht et al, 1995

Improved microclimate and flood reduction

Calculations by Schmidt (2002) compare the precipitation and the potential of evapotrans-piration in Rio de Janeiro. The precipitation sur-passes the potential of eva-potranspiration only in January (3%), February (5%), March (1%), April (13%) and December (8%). Assuming that the horizontal surfaces of the area have a sufficient storage capacity, between natural soil, extensive and intensive green roofs, almost the whole yearly precipitation could be evaporated, cooling down the micro-climate and relieving the sewage system.

Table 3 shows the relations between different types of unsealed surfaces and sealed surfaces. The pier area was ignored. An improvement of the micro-climate of this area is definitely necessary for any use during daytime, but any intervention has to be carefully planned. Traditionally composed of sealed surfaces, a different treatment might de-characterize the arid aspect of this important urban element and has therefore to be carried out very carefully.

Table 3 – Horizontal surfaces of the "Urban Sustainable Module" (without pier)

Surface	Area in m²	in % of total
Natural soil	70,000	26.5
Green roofs – extensive (20 cm substrate)	23,300	8.8
Green roofs – intensive (80 cm substrate)	75,150	28.4
Trees (area covered by trees)	40,000	15.1
Unsealed area	208,450	78.8
Sealed	56,050	21.2
Total area	264,500	100

Table 4 shows the potential of cooling in the "Sustainable Urban Module" through the evaporation of the monthly rain fall in Rio de Janeiro. It considers only unsealed surfaces, assuming that these surfaces can store the whole precipitation to at least the amount which can be evaporated.
The evaporation on sealed surfaces has been neglected, due to an unknown runoff rate. This does not mean it should not be considered, it definitely has a positive effect on the micro-climate.

Table 4 – Monthly Cooling Energy trough Evaporation of Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dez
Precipitation in mm [2]	156	139	127	111	79	52	53	51	65	90	100	153
Pot. Evap. In mm [2]	152	133	126	98	79	63	68	86	99	117	133	142
Max. Evaporation mm /m²	152	133	126	98	79	52	53	51	65	90	100	142
Max. tons of water / month	31,684	27,724	26,265	20,428	16,468	10,839	11,048	10,631	13,549	18,761	20,845	29,600
MWh of cooling / month	21,133	18,492	17,519	13,626	10,984	7,230	7,369	7,091	9,179	12,514	13,904	19,743

[2] after SCHMIDT (2002)

The cooling energy of 151,554 MWh per year improves significantly the micro-climate of the "Urban Sustainable Module". This effects directly the cooling load of the buildings – helping to avoid air conditioning in the residential areas and reducing the cooling load in offices and commerce.
For more concrete figures about the exact economy, complex simulation runs are planned for the future.

Conclusion

In many cases sustainable elements of actual city planning are of mere cosmetic nature. To make a real difference, we do have to develop new paradigms.

The “Urban Sustainable Module”, here the version for the hot-humid tropics, gives an idea of the potential of a consequent rethinking of the way how to design cities for the future.

The two pillars of a modern sustainable traffic management – reduction as far as possible and implementation of efficient public transport systems – save time, energy and reduce significantly emissions.

Green roofs and trees are no longer aesthetical elements for architecture, they take over important functions for an improved micro-climate.

Degraded areas in city centres, almost totally abandoned by the formal society and seen as a mayor problem, can suddenly be considered a chance for the implementation of a booster for sustainable concepts, a seed of sustainability in the heart of the cities.

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