Abstract

Curitiba city shows the formation of discomfort caused by low temperatures during most of the year, particularly in the winter. The urban-metropolitan region is located in southern Brazil, and it is the coldest Brazilian great city. Confronting the degrees of thermal discomfort to the classification of life conditions and life quality at the sampled places, a coincidence of a double discomfort was verified: by cold and by larger thermal widths, specially where poverty settles down, due to the pattern of social bedding observed in Curitiba. This worsens even more the low indexes of life quality and socioenvironmental vulnerability.

Key words: Urban climate; thermal comfort; life conditions

1. INTRODUCTION

Curitiba, the coldest Brazilian capital, presents the discomfort caused by coldness during most of the year and with more intensity in the winter, making evident the difficulties faced by the population, mainly the poorest people, due to the local climatic conditions. The urban climate shows a considerable variability in the urban spot, with alternations between IFs (Isles of Freshness) and ICs (Isles of Heat) in the urbanized area, which is the study purpose of this brief text. Curitiba is considered an example of urban planning, however, it is situated in Brazil, an emerging country with serious social problems, thus, it presents intra-urban zones with strong social distinctions. In most districts in the geographic periphery, we can notice an association with the sociological periphery, including recently some social mixtures of wealthier classes (private joint properties), real wealth islands surrounded by the prevailing poverty. In this context, the risks concerning the severe climatic conditions clearly express an aggravation of the urban socioenvironmental vulnerability.

In order to work on the life quality of a population, it must be stressed the interdisciplinary perspective and an integrating view (subjective and objective) of the elements that form the environment and the urban life, as they reflect straight on the capability of individuals to adapt to local climatic conditions. In this way, the relationship between the urban climate and the life quality in the city makes the following question arise: Would it be, then, the intra-urban thermal climate / comfort in the AU-RMC an intensifying factor of the social vulnerability of the population according to life conditions?

2. CURITIBA: PLANNING VERSUS URBAN DEVELOPMENT

AN exception among the Brazilian cities, Curitiba has had a permanent and institutionalized process of urban planning since 1943. However, the countryside mechanization in the 1970s, associated with the creation of the Industrial City of Curitiba – CIC, attracted a great number of immigrants in search of working opportunities. The migratory movement was revived in the 1990s, stimulated by the efficient city marketing and by the arrival of car assembling companies. Curitiba that, up to then, would gradually develop, coalesced with the neighbor municipalities, forming a spot of demographic high density occupancy and intense functional relationship – the Urban Agglomerate of the Metropolitan Area of Curitiba (AU-RMC), with about 2.800.000 inhabitants, and an area of 1.051,31km² (IPARDES, 2008). The effects of this change have appeared in the greatest complexity of the social organization of the space as well as in the intensity of socioenvironmental alterations. Along the Structural Shafts, created in order to direct the city growth and the flow of vehicles, the division of the city in zones made possible the construction of high buildings which form urban canyons altering the thermal areas, the natural lighting, the ventilation and the air quality. Thus, the space configuration of Curitiba today, characterizes itself mainly for the massive haut bilduings along the Structural Routes, which has extremely changed the pre-existing urban system, bringing about an important environmental impact in the urban landscape and in the environmental comfort aspects.

The model of urban planning carried out has shown itself as a limited one in relation to the socioenvironmental problems made evident, many times negligent in the natural resources and strongly excluding. It contradicts the conveyed image of “Ecological City” and “Social Capital”, for the rivers are polluted, the irregular occupancies abound in hydrical sources, floods are more and more frequent, the environmental discomfort and the atmospheric pollution are worsen by the urban geometry and by the spatial organization of the region intensely urbanized. The Center-South region, lacking parks and free leisure equipments is exactly where the lower income population of the city can be found, where the most severe floods and the highest indexes of urban criminality occur (Mendonça, 2002).

3. THE STUDY OF THE URBAN CLIMATE / THERMAL COMFORT AND LIFE CONDITIONS IN THE AU-RMC

Through the interdisciplinary focus and the theoretical subsidies, as the proposal of the Urban Environmental System (SAU), by Mendonça (2004), the present study links the urban climate and the environmental comfort / life conditions of
The spatial analysis was carried out from the cartography of the elements in the urban site (hypsometry, declivities, direction of the relief wellsprings and surface winds), the urban fact (soil usage, housing socio-spatial distribution), and from its correlation which resulted in the city spatial division in sectors, guiding the generation of the field monitoring net. In comparison, by means of the temporal analysis, the local climate has been characterized according to the dynamic aspects of the atmosphere, contextualizing the experiment. The values of the air temperature and of the air relative wetness, collected in situ in 16 selected places, in August 2006, were compared with the data obtained through satellite images and meteorological stations, by the spacialization, analyzed by means of comparative graphics and evaluated according to the thermal comfort models by Sorre (1984), Givoni (1992) and Aroztegui (1995). The comparison of the two analyses, spatial and temporal, which resulted respectively in the characterization of the Urban Environment and in the characterization of the climatic conditions / thermal comfort, has made possible the identification of the thermal comfort in terms of life conditions / quality in the AU-RMC.

### 3.1 The Urban Environment

Curitiba is a whole, a result of a continuous interaction. The urban fact not only develops itself on the support of the site and modifies it, but is also modified by it. Thus, the site geomorphology and the urban models, the cultural and socio-economical factors strongly relate to each other. The urban environmental division in sectors has the purpose of understanding the group of these interrelationships of the elements that form the urban landscapes, and results in the differentiation of the intra-urban climate.

The relationship between the classes of soil usage and the classes of socio-spatial distribution of housing (life conditions and quality), resulted in a composition of 23 sectors of urban characteristics relatively homogeneous, which appeared distributed like a mosaic, recurring in different places of the urban spot. A second correlation, this time between the urban fact and the site characteristics, permitted the selection of the places to be studied in more detail and the definition of the monitoring points. In this way, the study of the AU-RMC aimed at characterizing the intra-urban environments with different conditions of thermal comfort, considering the following factors: the urban fact (which includes the urban construct and the social perspective of the urban zone), related to the natural aspects (the site and the atmospheric conditions).

How would the spatial distribution of the urban thermal comfort be?

### 4. THE INTRA-URBAN CLIMATE AND THE THERMAL COMFORT

The AU-RMC climate and time analysis carried out for the 2006 winter indicated that in Curitiba, because of its dimensions and the heterogeneity of the natural and construction characteristics, it is not depicted a priori only one isle of heat, as proposed by Oke (1978). Its urban structure and form differ from those of the traditional cities, the CBD, and the urban densitie reduces itself gradually in the surrounding area. The AU-RMC, on the contrary, is characterized by a constructed topography oriented by the linear disposition shafts in the city center, and by the multi-center urbanization as a whole, mixing different degrees of urban density and green areas distributed in an uneven way, and this reflects itself in the variability of the intra-urban climate.

The Surface Infrared Thermography (TIS) (Fig. 1) for August 20th, 2006, taken at 10.00 o’clock, obtained by satellite Landsat 5 image, presents a complete and detailed view of the climatic conditions in the AU-RMC intra-urban dimension, constituting an important subsidy for the evaluation of the influence of the various elements in the production of the urban climate. The AU-RMC TIS has made evident the urban spot, where the surfaces are warmer due to the mineralized soils (with more albedo), with temperatures between 16° and 20°, constituting an IC of abo ut 7°K of intensity in relation to its immediate rural vicinity, at the moment of the image registration. The freshness isles were accentuated on the urban parks, the green areas and the places around the rivers. The aquatic environments, due to thermal inertia and evaporation, presented milder and homogeneous temperatures. The highest temperatures (19° and 20°C), occurred in some areas of high urbanizing degree and big asphalted surfaces, as the airports in São José dos Pinhais e Bacacheri and the industrial sectors in CIC, in Araucária and in São José dos Pinhais, and the main transport shafts.

It can be noticed that the zones of greatest warmth are not the most urbanized in the city center, and not even those of the structural roads, which can be explained by the shading of buildings that impede the surfaces from being reached by the direct solar radiation at that time of the day. Even though, the temperatures are very high in these areas, due to the anthropogenic heat production, a bigger roughness and the thermal mass of the buildings.

The climatic conditions presented themselves differentiated in the several intra-urban landscapes analyzed. Regarding urban characteristics, it was noticed the influence of the surface covering according to the soil usage (mineralized, with vegetation, etc), the geometry, the urban structure and density, and the anthropogenic warmth.
Figure 2 shows the temperature data collected at 6 o'clock and the daily thermal amplitude data, on August 21st, 2006. It can be noticed some coincidence among the places that showed the lowest temperatures and those with greater daily thermal amplitudes. The greatest degrees of discomfort for coldness on this day, took place in the municipalities of Almirante Tamandaré, São José dos Pinhais and Fazenda Rio Grande; the greatest thermal amplitudes also occurred in these municipalities.

By comparing the thermal discomfort degrees to the life conditions and life quality in the sampled places, it has been made evident, despite the image of ideal city created for Curitiba, that the thermal comfort is not guaranteed in the same way for all inhabitants (Fig. 2). This is due to: a) The urban development in Curitiba having lead, generally speaking, to the intensification of the population vulnerability in relation to the environmental comfort, due to restrictions of the urban plans of Curitiba, added to real-estate speculation, which resulted in a process of social stratification, by means of the progressive urban move to the suburbs; b) the not so wealthy population (that is induced to occupy the suburbs), have less resources to protect themselves against the climate; c) the urban climate formation, according to the literature, includes the formation of the urban warmth isle, being expected the temperatures to be lower in the suburbs, which, even generally speaking, is confirmed; d) in the suburbs, the thermal amplitude tends to be bigger than in the urban center, due to the thermal inertia of the constructions; and e) the socioenvironmental vulnerability in relation to the thermal comfort, in the AU-RMC, relates to the greatest discomfort for coldness / thermal amplitude.

5. CONCLUSIONS AND REFLECTIONS

In Curitiba, therefore, there is a strong relation among the geographic periphery, the social periphery and the thermal discomfort. It has been made evident, thus, a strong relation between life conditions and life quality and, still, the social vulnerability in Curitiba. However, in case the global heating is confirmed, even if the discomfort for coldness should diminish in the AU-RMC, other problems related to the climate will affect the less wealthy people, reinforcing again the vicious circle of the socioenvironmental vulnerability.

One of the results found relates to the thermal comfort evaluation criteria themselves: the intra-urban landscapes of the AU-RMC presented relevant differentiations, not only regarding the cold discomfort, but also in relation to the discomfort for greater thermal amplitudes, indicating the necessity for the inclusion of the thermal amplitude as a thermal comfort evaluation criterion in subtropical climates. In general, this aspect has been forgotten or disregarded in the studies in this field.

Although generally neglected by professionals in charge of the planning and administration of cities, the understanding of phenomena related to urban climate should serve as subsidy for the urban planning. Factors as indexes of green areas, soil permeability proportion and a good distance of buildings from one another, associated to their height restrictions, can give higher comfort levels and as a result, a reduction of power consumption on artificial climatização or lighting in buildings.
The urban climate / thermal comfort as an intensifying factor of the social vulnerability is not even considered during the preparation of urban plans. However, the urban planning and the actions which control the socioenvironmental problems, should consider the city with a view of the whole, systemic, complex, dynamic and integrated, for, according to Mendonça (2004), although the urban planning has a direct effect on the physical environment, defining the soil usage and occupation, it will be effectively interfering in the space social relations, with consequences on the cultural socio-economical dominion, as well as on the urban climate.

References

Note: The scale of colors shows a decreasing order of social conditions (better conditions in the middle, in green)