

THE USE OF SATELLITE DATA FOR URBAN MONITORING  
IN THE SÃO PAULO METROPOLITAN AREA

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ABSTRACT

Researchers from INPE and USP have been working in monitoring urban São Paulo for some time. The main projects involve the monitoring the urban growth and the study of the urban heat island of metropolitan São Paulo. In this paper we are going to describe the two projects without going into details, which can be gotten in two other papers included in these proceedings. These papers are "The Use of Landsat Data to Monitor the Urban Growth of São Paulo Metropolitan Area" by Niero et al. and "Use of Infrared Images in the Delimitation of São Paulo's Heat Island" by Lombardo et al.

1. USE OF METEOROLOGICAL SATELLITES IN THE STUDY OF SÃO PAULO'S HEAT ISLAND

It is important to try to understand the relationship between the type of urban land use and the urban heat island as well as between the heat island and pollution. The understanding of these relationship could lead to a better control of urban land use and, in consequence, to better urban climates and quality of life. It could also lead to better projects of artificial towns, which are so common in fast growing countries like Brazil. Of course, to understand the relationship between the heat island and land use, it is necessary to study the physics of the heat island. It is also necessary to study the heat island in places where it exists; this kind of study could help the meteorologists in constructing better models of the island and pinpointing its causes. This was the reason for starting the heat island project in INPE.

In the study of the heat island, meteorological measurements may be taken in situ. This kind of in situ measurements has been performed by many researchers in the Northern Hemisphere. It is possible to refer, among others, to Chandler (CHANDLER, 1965) and Shitara (SHITARA, 1964).

The in situ measurements can become very expensive and time consuming in the case of monitoring the heat island for long periods of time or in large areas. This was probably the reason which lead some researchers to use airplanes and satellites in this kind of monitoring. A paper about the use of satellites is that of Matson et al. (MATSON et al., 1978). The satellite images overcome some of the limitations of in situ measurements since they are widely available, inexpensive and are taken during all the year. Of course they have their own limitations; the values of temperatures obtained are less precise due to atmospheric effects and to the difficulties of determining certain parameters like emissivity; atmospheric effects, in particular, can, under certain conditions, make it absolutely impossible to get any usefull information from infrared images alone.

In the beginning of the project to study São Paulo's heat island, the researchers involved thought of using in situ measurements. Afterwards it was decided to switch to satellite images due to the difficulties enumerated above. In the present study it was used as much ground truth as possible. The satellite radiometers, for example, are calibrated using surface reference temperatures (instead of the on board references). The reference temperatures are chosen in areas easily identifiable in the images and where the temperatures are homogeneous. Besides the reference temperatures, other temperatures measured in situ are used to check whether the results are good or not. The correction of atmospheric effects is made with the help of radiosondes. The general procedure to get a temperature image is similar to the one given by Chahine (CHAHINE, 1980) and is described in Lombardo et al. in these proceedings.

To perform studies of heat island one must first obtain temperature images from the count images received from the satellite. Putting these images in a graphical terminal and positioning the cursor in a point of the image, one can get the temperature of the point with a certain precision (0.5° C). In the delimitation of the heat island, we also use images of intervals of 1° C.

The result of our study is that there is a big heat island in the center of the city and smaller islands in industrial areas and secondary centers. It was noticed that the land use characteristics of the secondary centers are similar to the characteristics of the main center. The difference between the temperatures in the heat island and in the skirts of the city is of about 5° C. The temperature of urban parks is lower than in the areas surrounding the park. For more details, the reader is referred to Lombardo et al. in these proceedings.

## 2. MONITORING OF URBAN GROWTH IN METROPOLITAN SÃO PAULO

The monitoring of urban growth in São Paulo presents problems which are similar to the ones presented by the study of the urban heat island. One can make the monitoring by in situ observations, but these observations are expensive and time consuming. For this reason, researchers in INPE decided to study how good LANDSAT images are to monitor urban growth in São Paulo. Their results are encouraging and are presented by Niero et al. in these proceedings. The greatest problem found by Niero et al. was to separate urban from rural areas in the rural-urban fringe. This problem can be solved by studying many images at different periods, bearing in mind that rural areas present greater temporal variation than urban areas.

## 3. CONCLUSION

It is hoped that both the heat island and the urban growth projects associated with studies of urban land use will be useful to urban planners working with metropolitan São Paulo. The study of urban growth in a city like São Paulo is important, for example, to help in the control of growth toward protected areas (like parks, sanctuaries, reservoirs, etc.). The heat island project may be useful in allocation of urban space, specially if associated with studies of pollution.

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