COMPARISON OF THERMAL IMAGES AND NDVI OF MULTISPECTRAL HIGH RESOLUTION IMAGES, A CONTRIBUTION TO THE STUDY OF URBAN CLIMATE

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I. INTRODUCTION

In recent years, environmental and climate issues has aroused interest in different sectors of our society. These issues have a direct influence on the quality of life in our cities, and the consequences of continued expansion and modification of the environment are daily experienced by the urban population, which effectively feel their negative effects. According to Oke (2006) the need for weather information is increasingly being demanded for citizens' knowledge, construction and urban planning, energy conservation, transport and communications, health and air quality, stormwater management and wind, security and emergency measures.

According to Voogt and Oke (2003), the surface temperature has a direct influence on the air temperature of the lower layers of the urban environment, it is critical to balance the surface energy, helps determine the internal climates of buildings, and affects the energy exchanges that compromise the comfort of city residents.

These interactions between surfaces and atmospheric changes caused by urbanization often lead to a thermally modified climate that is warmer than the surrounding non-urbanized areas, especially at night. This phenomenon, known as "heat island" urban, already being studied by remote sensing using satellite imagery (Nichol, Fung et al., 2009). However, studies which were used aerial thermal images are scarce, especially in Brazil. Therefore, it is important to pay attention to the fact that the information obtained by remote sensing should take into account the relationship between these images and the properties of real surfaces because the surface temperature resulting incorporates the effects of radiation from the surfaces and their thermodynamic properties including its moisture, thermal transmittance and emissivity, the entry of solar radiation and atmospheric, and the effects of the proximity of the surface and its relation to the transfer from the surface (OKE and Voogt, 2003).

This study makes a comparison using thermal images captured with a high-resolution thermal camera with NDVI index (normalized difference vegetation), a contribution to the study of urban climate.

II. PRESENTATION OF RESEARCH

Study area

Piracicaba city, is between from geographical coordinates latitude 22º 42' south and longitude 47º 38' west of Greenwich. Is 138 km away (straight) from the capital of the State of São Paulo, at an altitude of 540 meters.

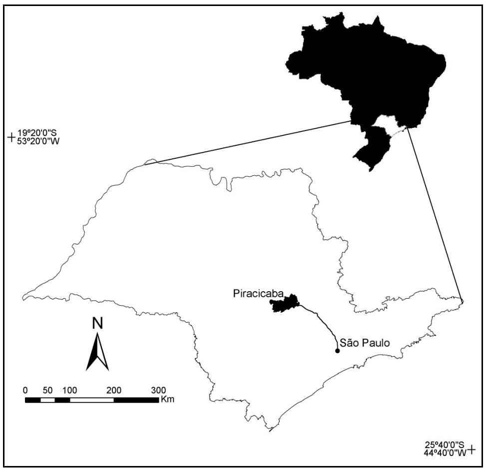

Figure 1. Location of Piracicaba, Sao Paulo. Prepared by the author.

Normalized Difference Vegetation Index (NDVI)

The vegetation indices are linear transformations of the reflectance of two or more bands of the electromagnetic spectrum which can be obtained by sum and difference ratio of bandwidth (such as the Normalized Difference Vegetation Index - NDVI) (BARET; Guyot 1991 ; Goward et al. 1991; Wiegand 1991). The NDVI is used to characterize large areas in terms of vegetation density, allowing you to have an overview of the region and, from there, locate possible areas of study. The vegetation index NDVI according to Deering et al. (1975 cited in Moreira, 2005) consists of an equation which has as variables the bands of red and near infrared, as follows:

$$\textbf{NDVI: IR – R / IR + R} \qquad (1)$$

Follow,

IR: near Infrared

R: Red

Thermal Camera

Understanding the relationship between scale and remote sensing data, and use of a thermal scale thermographic camera, and then with the observed temperatures in urban environments, can also allow the extrapolation of the data to estimate the impact of temperature on urbanization throughout the metropolitan area, and the ability to forecast the expansion of heat islands by assessing the impact of growth and microclimate.

Many studies have been emphasized in the variation of temperature in urban areas through the use of high resolution remote sensing (ELIASSON, 1992; Quattrochi & Ridd, 1998). Analysis of vegetation in urban environments by means of high spatial resolution using thermal infrared remote sensing data. Other studies also add the technique to examine the soil using thermography and surface weather observations to describe the residential environments. This method quantifies the thermal variation based on the type of urban land use, using the techniques of thermography and data processing of satellite images. These techniques can easily be applied to other cities and used to describe the thermal environment of residential areas, and generate results that can be provided for urban planners and policymakers.

Connections between urbanization and climate in the region have been studied previously (LOUGEAY et al., 1994), but it is unclear to what extent the new residential developments will have an impact on the local climate. Transects mobile in urban, residential and rural areas has shown on clear days and calm air, the existence of large thermal gradients across the urban and rural areas, the details of rural thermal patterns associated with new developments, is not yet fully investigated (Brazel et al. 1,999, Stabler et al. 2005).

Using a handheld thermal camera FLIR Company, ThermaCAM SC640 model, capture frames of 640 x 480 pixels, an overflight was conducted to acquire thermal images.

Figure 2. Thermal camera from FLIR, model ThermaCAM SC640. Source: FLIR SYSTEMS.

The fly over the study area, was held on July 14, 2008, in a height from ground of 1500 meters, between the hours of 11:30 and 12:00 were made two (2) tracks on the study areas. Below the figures 3, show the thermal image and a visible image.

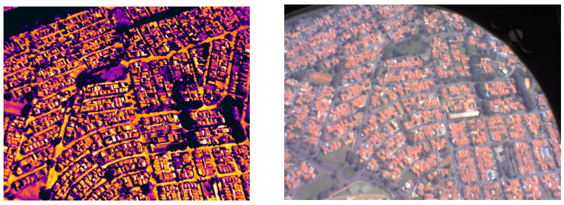

Figure 3. Thermal image acquired with the camera FLIR model ThermaCAM SC640 (left) and the same image RGB (rigth). Prepared by the author.

III. RESULTS AND CONCLUSIONS

Thermal images and NDVI

Were allocated on the image Normalized Difference Vegetation Index (NDVI) 50 points, these points were selected among the classes of coverage, impervious (asphalt and cement floors) built (ceramic tile, metal tile), lawn, vegetation, permeable (bare dark and exposed soil of course). These same points were located in the thermal image and extracted temperatures. Figure 5.3.1-1 shows the points collected in the NDVI image and temperature collected in the thermal image.

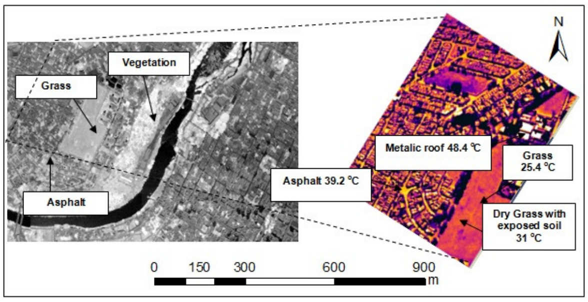

Figure 4. NDVI of the study area 1 (left) and image acquired with the thermal camera (right), with temperatures of some classes of cover, ex.: Asphalt, grass, vegetation, metalic roof, dry grass with exposed soil. Prepared by the author.

The chart below shows the comparison between the values of the pixels of the image collected NDVI and temperature obtained by the thermal image.

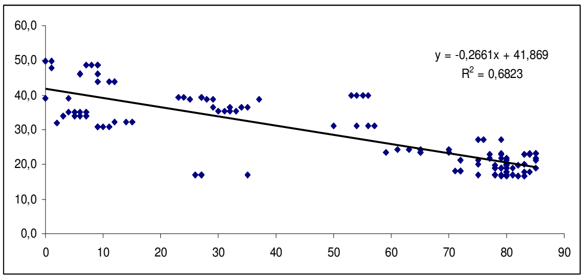

Figure 5. The linear regression graph shows a comparison between the values of the pixels of the image NDVI collected and the temperature obtained by the thermal image, resulting in an R^2 of 0.68. Prepared by the author.

Considerations

The vegetation index (NDVI) and correlated with images acquired by a thermal camera, obtaining an R2 = 0.68. It was possible to use multispectral images for the development of an equation to calculate the temperature contributing to preliminary studies of the thermal field of medium-sized cities. The thermal camera, although still a high cost equipment, but the use to analyze the heating provided by metal roofs and other roofing of the urban fabric is underexplored. Importantly, the presence of woody vegetation helps to mitigate the effect of the temperature and the urban heat island. The greening of the city districts indirect economic benefits such as saving electricity, maintenance of pavements and reduced flooding, mitigating the effect of the heat island phenomenon and air pollution.

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