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Sensing in Detection Parameters Physical Spectral in Urban

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ABSTRACT

The emissivity and Difference Vegetation Index Normalized (NDVI) are important spectral physical parameters in the study of land surfaces. This article aims to analyze the spectro-temporal point of view the influence of NDVI values in the emissivity of the surface of the urban area of Recife / PE. The work is characterized by multispectral Landsat-5 TM satellite images, the spatial and temporal variation of surface emissivity and (NDVI) in the urban area. The methodology involved the implementation of radiometric correction models, atmospheric and SEBAL Algorithm (Surface Energy Balance Algorithm for Land). We used two images referring to the dates 10 June 1984 and 29 August 2007. The maximum value found for the surface emissivity was 0.982 for 1984 and 0.985 for 2007, the minimum value was 0.971 for the year 1984 and 0.970 in 2007, the average and fashion will not suffer change in 1984 0.974 and 0.973 respectively. The Difference Vegetation Index Normalized presented average values of 0.28% in 1984 and 0.23% for the year 2007. According to the results found there was a decrease of 5.1% of the vegetation cover in relation to the year 1984 being the values of higher emissivity in Pina mangrove in 2007.

Keywords: satellite image, NDVI, emissivity, urbanization

INTRODUCTION

The emissivity is a factor that indicates a surface to issue Energy Efficiency, When Compared to hum black body at the same temperature. According Pacheco (1989) an emissivity composition varies with the physical, chemical and biological the natural surfaces. However, the spectral range detection, environmental irradiance and a kinetic temperature are factors that may affect Your Measurement Process. In land surfaces, the spectral emissivity ($\varepsilon\lambda$) in thermal infrared band (8-14 mm) varies mainly in water Presence of Function in OU soil in vegetation cover. The emissivity varies to soil 0.85 to 0.99, depending on

the type of soil and moisture YOUR while que in the vegetation has value around 0.98 (Salisbury and D'Aria, 1992). To Lillesand and Kiefer (2000) WHEN one vegetation green and healthy THIS one emissivity varies from 0.96 to 0.99. The knowledge of the emissivity and A pre-requirement essential in Materials Characterization From The Thermal Image Analysis, How Also in Surface Temperature Estimation obtained sensed Data From the spectral range to thermal infravemelho (Pacheco, 1998).

Vegetation indices calculated Operations From Between bands correlate hum set of radiometric behavior recorded simultaneously in different spectral BANDS one Special Situation vegetation linked with development, phenological stage and / or phytosanitary condition. The NDVI and An index que identifies a green presence of vegetation on the surface and characterize the spatial distribution, as Also identify YOUR Evolution not over time. These combined INFORMATION CAN be very important to identify phenomena that may be occurring in a particular area, especially those related to degradation processes. The NDVI has been widely used in Global Studies How discriminator hum vegetation, because it can be easily correlated to certain Such parameters as biomass, leaf area, productivity, photosynthetic activity, green cover percentage, between Other (Elvidgee Chen, 1995). The NDVI can be correlated with other data such as, For example, vegetation cover percentage (Asrar et al, 1989 ;. Baret and Guyot, 1991). This index has been widely used in various operational applications, including mapping, USE classification of land, Change detection and environmental monitoring (Cihlar et al., 1997).

Van Grien and Owe (1993) demonstrated that there is a strong correlation between effective indicators of vegetation, such as Vegetation Index (NDVI), and the emissivity of the surface. Value and Caselles (1996) proposed a theoretical model to estimate the emissivity of continental surface in the infrared range (10.5 to 12.5 mM), relating emissivity values found in the literature with data "Normalized Difference Vegetation Index" (NDVI) obtained from sensors "Advanced Very High Resolution Radiometer" (AVHRR) on board satellites of the TIROS-N / NOAA series.

Lopes and Rizzi (2007) modeled the emissivity of the Earth's surface in mountainous regions from the Modis sensor data, concluded that the areas of forests and pastures showed concordant emissivity values with typical values found in the literature.

The SEBAL was developed by Bastiaanssen (1995), and uses the surface temperature, the hemispherical reflectance of surface vegetation index and some additional data surface, normally obtained in automated meteorological stations. This algorithm has been widely used in various irrigated areas of the globe, such as the basin of the Bear River (Allen et al., 2002).

In this context, this study aims to analyze the point of spectro-temporal view the influence of Vegetation Index (NDVI) values in the emissivity of the surface of the urban area of Recife / PE.

MATERIALS AND METHODS

The study object is the urban area of the city of Recife, the state capital of Pernambuco, located on the east coast of Northeast Brazil comprising an area of 218km2 Figure 4.1. The city is located at latitude 8 03`14 "South and longitude 34 52`51"

west of Greenwich, with much of the urban area located on a tidal river plain, its average altitude varies between 4 and 10 meters approximately.

The city's climate is characterized by being hot and humid (AS`) with autumn winter rains, following the Koppen classification. The region studied, to be located in low latitudes Zone, shows average monthly temperatures around 25 ° C, and the months of January and February the hottest with temperatures above 26ºC. The months of July and August have temperatures at or below 24 ° C. The relative humidity presents annual average of 84% (National Institute of Meteorology-INMET).

Figure 1 - Location of the area under study highlighting the urban area of Recife. Fonte: Autor, 2016.
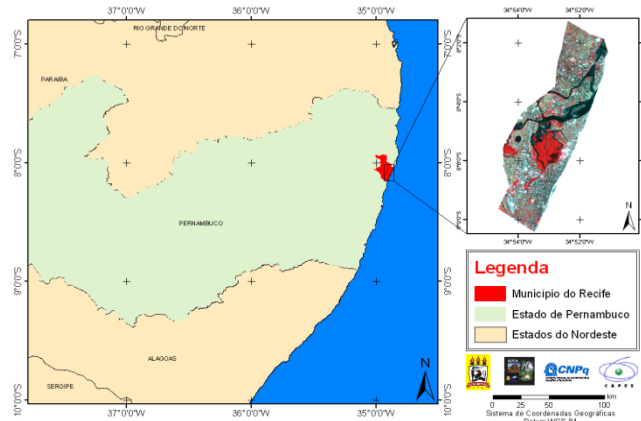
This study used two images of Landsat-5 satellite TM, composed of seven spectral bands, obtained free of charge on the website of the National Institute for Space Research (INPE). The passage of the satellite study area took place on June 10, 1984 and August 29, 2007, in orbit and point 215/66. For pre-processing of satellite and application of selected indices of images was used ERDAS Imagine 9.3 software (Department license Geographical Sciences, Federal University of Pernambuco-UFPE). Final assembly of the layout was done in ArcGIS 9.3 (license from the Department of Geographical Sciences UFPE) program. It was employed part of SEBAL Algorithm (Surface Energy Balance Algorithm for Land), developed by Win Bastiaanssen (1995). The methodology followed Silva et al. (2005) and Bastiaanssen (2000), as described below.

Step 1 (radiometric calibration)

The radiometric calibration process is based on the conversion of the digital number, ND, each pixel of the image in monochrome spectral radiance. The radiance is the solar energy reflected from each pixel area per unit time, solid angle and wavelength, measured at Landsat in bands 1, 2, 3, 4, 5 and 7. For 6 band (10.4 to 12.5 m), called thermal band, this radiance is the energy emitted by each pixel. In the process, we used the following relationship, as shown by Markham & Baker (1987):

$$L_{\lambda i} = a_i + \frac{b_i - a_i}{255} . ND$$

Where Lλi is the spectral radiance of each band , a and b are the minimum and maximum spectral radiances, ND is the pixel intensity that ranges from 0-255 , and the index corresponding to the spectral bands 1 , 2, 3 , 4, 5 , 6 and 7.

Step 2 (spectral reflectance)

After the calculation of the spectral radiance of each band, cos Z and the spectral irradiance not top of the atmosphere , ensure the Planetary estimated spectral reflectance , defined as the ratio between the solar radiation flux reflected EO radiation flow incident solar , obtained Second Equation one (BASTIAANSSEN , 1995; Allen et al 2002; Silva et al., 2005) .

where RPI is planetary reflectance of the i band , Kλ is the spectral solar irradiance at the top of the

atmosphere, Z is the solar zenith angle and dr is the inverse of the square of the relative distance Earth - Sun (in astronomical unit - AU), given by Iqbal (1983)

$$d_r = 1 + 0,033 \cos \left(\frac{2\pi}{365} DSA \right)$$

where DSA is the sequential day of the year

The zenith angle was obtained with the following formula

$$CosZ = \cos \left(\frac{\pi}{2} - E \right)$$

where ： E is the elevation angle of the sun, obtained in the header of each image.

By means of the letters of the planetary reflectance of each of the six reflective bands 5 Landsat TM was obtained vegetation indices , temperature and emissivity of the surface whose procedures are described in Silva et al . (2005) .

Step 3 (albedo at the top of the atmosphere)

Is the computation of planetary albedo (nothing will), that is, the albedo unadjusted atmospheric transmissivity , which is obtained by linear combination of the monochromatic reflectance of reflective channels of TM- Landsat 5 and 7 ETM.

$$\alpha_{toa} = 0,293 \, \rho_1 + 0,274 \, \rho_2 + 0,233 \, \rho_3 + 0,157 \rho_4 + 0,033 \, \rho_5 + 0,011 \, \rho_7$$

Step 4 (Albedo of the surface)

In step 4 obtains the corrected albedo or surface albedo of the atmospheric effect by the equation:

$$\alpha = \frac{\alpha_{toa} - \alpha_p}{\tau_{sw}{}^2}$$

Where αtoa is the planetary albedo , αp is the solar radiation reflected by the atmosphere , which varies between 0 , 025 and 0.04 , but for the SEBAL model (Surface Energy Balance Algorithm for Land) is recommended to use the value 0.03 , Tsw is atmospheric transmissivity passing the clear sky conditions and obtained by equation (Allen et al., 2002) :

$$\tau_{sw} = 0,75 + 2.10^{-5} \, z$$

Where z is represented by the average altitude of the city of Recife , since it is somewhat variable . an average of 10 meters for the analyzed area was used .

Step 5 (vegetation indices: NDVI , SAVI and LAI)

The vegetation index by (NDVI) is obtained by dividing the difference of the band of red with the band near infrared and the sum of the same according to Equation 3 (HUETE , 1988)

$$NDVI = \frac{(\rho 2 - \rho 1)}{(\rho 2 + \rho 1)}$$

Where v is the band iv red is the band of near infrared

For the calculation of Adjusted Vegetation Index for Ground Effects (Soil Adjusted Vegetation Index - SAVI) which is an index that seeks to mitigate the effects of the " background" of the soil, it is used the expression (HUETE , 1998)

$$SAVI = \frac{(1 + L)(\rho_{b2} - \rho_{b1})}{(L + \rho_{b2} + \rho_{b1})}$$

Where L is a constant value equal to 0.5 .

To calculate the Leaf Area Index - LAI is necessary to model the corrected SAVI (SAVI_ SZ), which eliminate the negative values.

The Leaf Area Index (LAI) is defined by the ratio of the area of all vegetation per unit area used by this vegetation . The LAI is an indicator of biomass each image pixel and it is calculated by the following empirical equation obtained by Allen et al . (2002).

$$IAF = -\frac{\ln\left(\frac{0,69 - SAVI}{0,59}\right)}{0,91}$$

To calculate the emissivity is necessary to use the corrected IAF model where eliminate negative or equal to zero.

Step 6 (Emissivity)

To obtain the surface temperature , it used the reversed Planck equation, valid for a blackbody . Since each pixel does not emit electromagnetic radiation with a black body, there is the need to introduce the emissivity of each pixel in the spectral domain of the thermal band imaged by thermal channel (εNB) . In turn, when the calculation of the long-wave radiation emitted by each pixel is to be considered the emissivity in the field of broadband $\varepsilon 0$ (5-100$\square$m) . According to Allen et al . (2002) εNB the emissivities and $\varepsilon 0$ can be obtained , for NDVI > 0 and LAI <3 , according to:

$\varepsilon_0 = 0,95 + 0,01$ IAF

$\varepsilon_{NB} = 0,97 + 0,00331$ IAF

For pixels with $\varepsilon_{NB} = \varepsilon_0 = 0,98$

RESULTS AND DISCUSSION

The atmospheric transmissivity of the city of Recife, obtained based on their local altitude was 0.7502, thus being considered constant, to simplify, throughout the study area. The emissivity of the surface for days June 10, 1984 and August 29, 2007, showed values around 0.974, respectively, featuring no change.

Table 01 shows the statistical values of NDVI and emissivity of the surface of the whole scene in the days June 10, 1984 and August 29, 2007. The results of emissivity and NDVI obtained in this work, characterized by Table 1 and Figure 2 show If consistent with the values found in the literature (HUETE 1988, PACHECO, 1989).

Figure 02 shows the spatial and temporal values of emissivity sueprfície and NDVI (Difference Vegetation Index Normalized) for the years under study. The NDVI images at the bottom of the figure shows the dark green shade represented by the class> 05% more present in 1984 along with the light green with ranges from 0.3% to 0.5%, the yellow tint is the intermediate values ranging from 0.2% to 0.3%. The lowest values were found in his shade in the water indicated the areas with white shades.

Analyzing image emissivity top of the figure, it appears that the dark green shade represented by the class > 0.975 is more present in 1984 along with the light green with ranges between 0.974 to 0.975 yellow hue is the intermediate values ranges from .973 to .974. The lowest values were found in his shade in the water and nearby areas indicated by the orange hues.

The values of NDVI elucidated a decrease of 5.1% in its average between 1984 and 2007. The 2007 image showed the maximum value of NDVI 0.95 concentrated in the mangrove Pina (Figure 2 - circular) but almost whole area showed numbers lower values. The highest values of emissivity>

0.975 were evidenced in 1984 corroborating the results of NDVI values, presenting more present in areas where the vegetation is presented is more spatially distributed. In relation to and in 2007 there was a strong correlation between the emissivity and NDVI in mangrove area pina (Figure 2 - loop), indicating by this that the higher emissivity values concentrated in the higher intensity areas the NDVI values.

Table 1 – Statistics of surface emissivity values (minimum, maximum, mean and mode)

NDVI	Min	Max	Média	Moda
1984	-0,83	0,80	0,289	0,289
2007	-1,088	0,95	0,238	0,238
Emissivity	Min	Max	Média	Moda
1984	0,971	0,982	0,974	0,973
2007	0,970	0,985	0,974	0,973

The results of this study proved consistent with the literature showing the spatial, spectral and temporal variation of these parameters with the presence of water in the soil / vegetation and the spatial distribution of vegetation. It found a strong correlation between the values of emissivity and NDVI for the years studied, showing that, in areas where the vegetation is more present emissivity has the highest values.

Figure 2 -. Image of NDVI (Difference Vegetation Index Normalized) and emissivity in the respective years 1984 and 2007 .
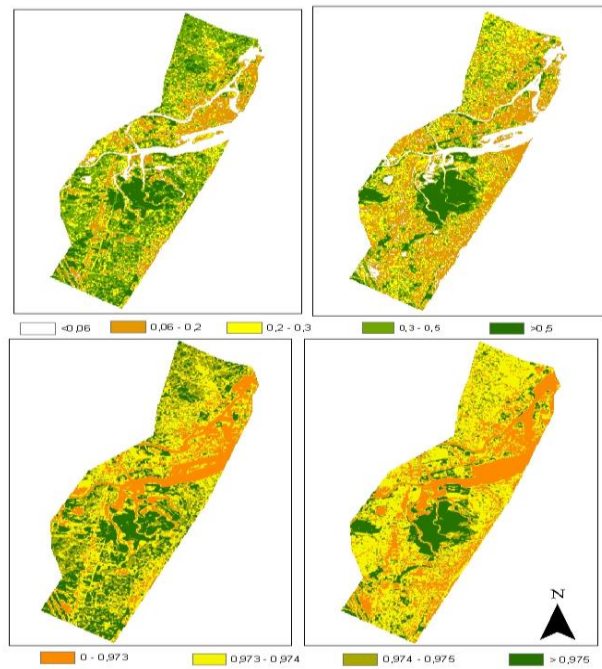
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