International Journal of Computer Science and Software Engineering (IJCSSE), Volume 4, Issue 6, June 2015
ISSN (Online): 2409-4285 www.IJCSSE.org Page: 156-159

# Reflections on Temporal Analysis with Landsat 5 e 8 Images – The Use of the NDBI to the Evaluation of Urban Expansion between 2010 e 2014, in the Maricá City, in Rio de Janeiro – Brazil

**Elizabeth Maria Feitosa da Rocha de Souza**

Department of Geography, Federal University of Rio de Janeiro, Laboratory Espaço de Sensoriamento Remoto
Rio de Janeiro, RJ 21941-916, Brazil

*elizabeth.igeo@ufrj.br*

**ABSTRACT**

This article proposes to evaluate the use of Normalized Difference Built-up Index, to identification of the urban areas from satellite images Landsat 5 e 8, indicating the advantages and problems faced. The results show a great difference between the scenes TM, Landsat 5 e OLI do Landsat 8. The Radiometric difference interfere directly in the calculation of NDBI. The areas with urban expansion are overestimated in 2010 and underestimated in 2014 when are compared the indexes generated with Landsat 5 TM sensor images and OLI Landsat 8. Some areas for exposed soil and wetlands are regarded as urban land in the Landsat 5. In this situation it is suggested to use the same kind of images, ie imagens Landsat 5 and Landsat 8 from different periods; or do the normalization between scenes.

***Keywords:*** *Remote Sensing, Urban, Landsat Image, NDBI, Mapping.*

## 1. INTRODUCTION

Urban spatial areas have expanded in an accelerated speed during the last decades, because is necessary knowledge about the speed of its expansion, as well as the location of new areas. The use of Remote Sensing has been used in several studies to analyze the population and measurement of urban growth on natural resources. According to FIGUEIREDO (2005), Remote Sensing is "the process of capturing information of phenomena and land features, by means of sensors without direct contact with them, associated with methodologies and storage techniques, processing and analysis of this information." One such study methods are the Normalized Difference indices, existing both for Mapping of the forest areas, water and / or urban areas. According to XU (2000) a popular method for the definitions of urban areas started with conventional multispectral classification. However, this may not produce satisfactory accuracy, normally less than 80 percent, due to spectral confusion of the heterogeneous urban built-up land class.

This study evaluates the response of the Normalized Difference Built-up Index – NDBI in a seaside town in Brazil with great urban expansion in the last five years. The NDBI was developed by Zha et al (2003) para identificar áreas urbanas e construídas, sendo usado para o mapeamento de áreas urbanas com sucesso. to identify built-up areas, it is used for mapping urban areas with sucesso.

The urban environment is a completely heterogeneous environment, making their analysis a challenge. However, it stands out from the natural environment, to cause much impact in space, as in the landscape.

The objective of the research is to evaluate the use of NDBI in estimating the growth of urban areas in the city of the Maricá (in Rio de Janeiro state - Brazil), with TM Images, from Landsat 5 satellite and OLI images from Landsat 8 satellite.

## 2. STUDY AREA

The city of Marica belongs to the metropolitan area of Rio de Janeiro, with a population of 127,519 inhabitants according to Census data, from the Brazilian Institute of Geography and Statistics - IBGE in 2010. The value corresponds to 1.07% population in the state's metropolitan region of Rio de Janeiro. More than 50% of the population is aged between 30 and 49 years, The city was a área with 362 km² and has a concentration of the 351,5 inhabitants per km². In 2014 year, the estimated population was of the 143.111 people representando um aumento de pouco mais de 10% of the total population in only 4 years. Among the reasons for this increase is the geographical condition of the city that stands out for its proximity to the sea and has extensive coastline. The resident population can travel to neighboring cities (Rio de

Janeiro, Itaboraí, São Gonçalo and Niterói) to work and return home on a daily pendulum motion. The Figure 1 shows the geographical location of the Marica city.


*Fig. 1. Study area*

The search for a better quality of life, and the opportunity to live close to the sea have attracted new residents to the city, over the past 5 years.

## 3. Conceptual Review

### 3.1 Landsat 5 Images - Sensor TM, Landsat 8 Images Sensor OLI and Urban Mapping

The Landsat Program was started in 1972 by NASA and provides images free for evaluation of land resources and regional analyzes. The Landsat program consists of a series of eight satellites. In the present study we used images of Landsat 5 (TM sensor) and Landsat 8 (OLI sensor). The Landsat 5 has polar orbit and circular, sun-synchronous, the area of imaging is the 185 km, with scenes of 185km x 185km. The spatial resolution of the TM sensor is 30m, and the in the thermal band 6, has 120m. The Sensor TM has radiometric resolution of 8 bits and spectral resolution with 7 optical bands: three in the visible portion of the electromagnetic spectrum (blue, green, red); three in the portion of infrared (near infrared and middle), and a band in the thermal infrared.
On February 11, 2013 was launched Landsat 8 now with 11 bands and the same spatial resolution, equal to the Landsat 5 (except for the thermal bands now 100m).

The new satellite has two main sensors and features improvements in spectral resolution, with the addition of new bands that have caused changes in the intervals within the spectrum of channels of all bands. There was a major innovation on the radiometric resolution now with 12 bits. To respond effectively to the challenges of planning and urban management, with regard to informations on the urban environment, it is increasing the use of remote sensing imagery for mapping and characterization. Despite the limitations common in spectral medium spatial resolution images (as in the case of TM and Landsat OLI sensors 5 and 8, respectively) is possible to use this imagens to generate other descriptors and indices to facilitate the mapping of the urban environments. Despite the spatial resolution around 30m allowing a wide spectral mixture of the objects in land, with the use of this images is possible to do the mapping of the differentes urban levels (1. intense urban - with many people e homes, 2. medium urban - medium agglomerations without buildings, and 3. rarefied urban - with few houses).

### 3.2 NDBI and Urban Analysis

The Radiometric Indices, are measurements able to identify in the digital images the relative abundance of some objects and the location of certain types of formations, such as: built-up areas, vegetation and wetlands.
Among the most common indexes, the Normalized Difference Built-up Index - NDBI is a radiometric index created to allow the identification of urban and built-up areas, based on the increase in spectral response of the areas built between bands near infrared and mid infrared. It can be used for mapping of urban areas when the specialist has few time, or as a descriptor to aid the study of urban heat islands. The calculation of NDBI occurs as presented in Equation 1.

$$NDBI = (Band\ IVM - Band\ IVP) / (Band\ IVM + Band\ IVP) \quad (1)$$

Onde: IVM – mid infrared e IVP – near infrared.

XU (2002) extracted urban built-up lands of Fuqing City in southeastern China by a combination of signature analysis and supervised classification. Zha *et al.* (2003) proposed the Normalized Difference Built-up Index using TM4 and TM5 and applied it in extracting urban areas of Najing City of China from a Landsat TM image.
The index-derived map was further filtered using the NDVI to remove the vegetation noise, as the vegetation information was mixed with the extracted built-up lands.
There is great potential to use such content in support of urban mapping and how rating descriptor.

## 4. METHODOLOGY

The methodology begins with the review literature seeking to apply the equation of the index after the acquisition of satellite scenes, with access to Earth Explorer website. The table 1 show the images used in the study.

*Table 1: Image specifications*

| ***Year*** | ***Sensor/satellite*** | Image/ID |
|---|---|---|
| 2010 | TM (Landsat) | LT52170762010110CUB00 |
| 2011 | TM (Landsat) | LT52170762011225COA01 |
| 2013 | OLI (Landsat) | LC82170762013134LGN02 |
| 2014 | OLI (Landsat) | LC82170762014041LGN00 |

The necessary adjustments were made in every scene. After was made the reprojection of the scenes through Arcgis 10.0 software. A colorful composition subsequently was created in order to highlight the urban areas in the periods. Finally the index was applied with the equations 2 and 03.

$$NDBI\ Landat\ 5\ (2010) = (Band\ TM5 - Band\ TM4)/(Band\ TM5 + Band\ TM4) \quad (2)$$

$$NDBI\ Landat\ 8\ (2014) = (Band\ \text{OLI}\ 6 - Band\ \text{OLI}\ 5)/(Band\ \text{OLI}\ 6 + Band\ \text{OLI}\ 5) \quad (3)$$

This step was generated with the function "raster calculator" in Arcgis 10 software.

## 5. RESULTS

The Figure 2 highlights the scenes Landsat 5 and Landsat 8 in the city of Marica, in the years 2010 and 2014, both in colorful makeup highlighting, in green, forests and pastures and red and white tones urban and bare soil areas.

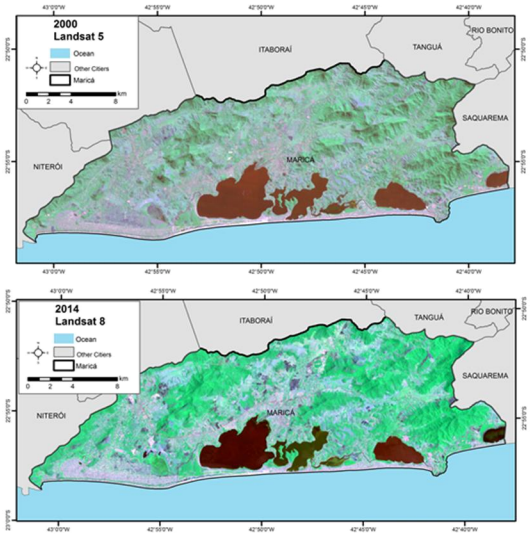


*Fig. 2. Marica in 2000 and 2014*

It's can see the differences in the colored composition result of the differences in radiometry of the images, coming from the different sensors. Figure 3 shows the differences in the widths of the bands in both sensors.

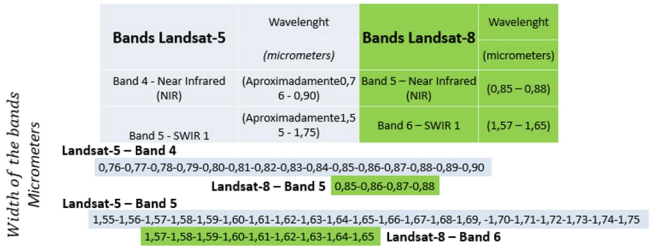


*Fig. 3. Comparation between width of bands – Landsat 5 and Landsat 8*

It's important remember that in the supply of the new images from Landsat 8 new bands changed the width of the other infrared bands compared to Landsat 5.
When generating the NDBI for scenes in 2010 and 2015 without prior treatment of the scenes (or normalization) the result is overestimated for 2010 and underestimated for 2014 as shown in Figure 4.

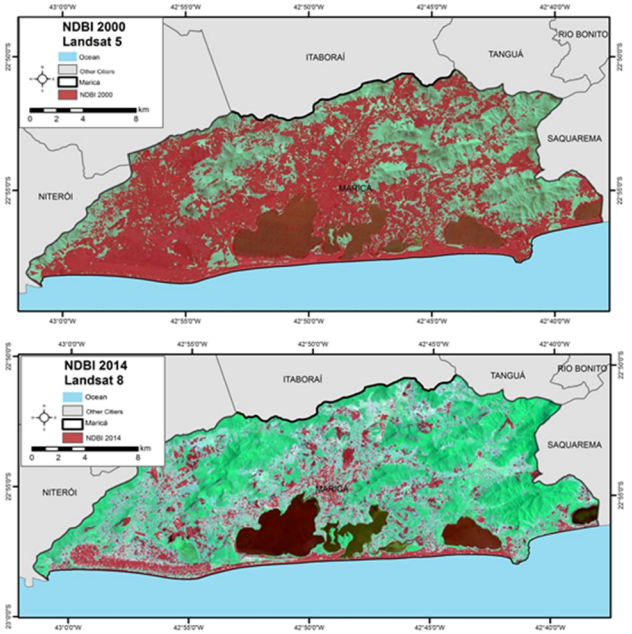


*Fig. 4. Comparation between NDBI form Landsat 5 and Landsat 8 to Marica City*

After the result obtained show problems, a new assessment to diagnose the effectiveness of the index, using the same set of the TM scenes in other dates. Thus they were created new indexes now comparing the years 2010 and 2011 for the Landsat 5, and 2013 and 2014 for Landsat 8. Figures 5 and 6 highlight the results for both periods.

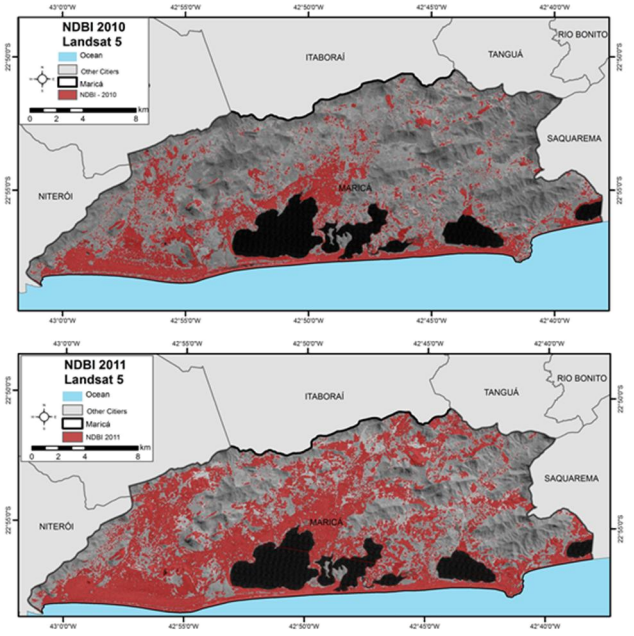


*Fig. 5. Comparation between NDBI form Landsat 5 between 2010 e 2011 to Marica City*

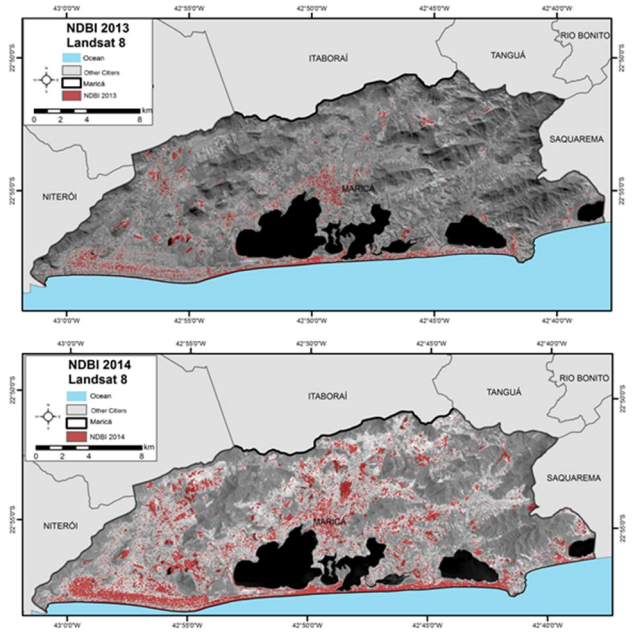


*Fig. 6. Comparation between NDBI form Landsat 8 between 2013 e 2014 to Marica City*

In either case you can check the growth of urban sprawl between the respective years using the same sensor. In all cases it is important to consider the radiometric differences for all images.

This file can be used as a mask (descriptor) during a phase of classification and mapping urban areas accelerating the process for the expert.

## 6. CONCLUSIONS

It is important to consider the differences of radiometric images when working with indexes such as the NDBI. Despite the finding in increasing urban sprawl between years that are subsequent it is important assess the degree of certainty of the results as to the delimitation of urban areas. The urban boundary indicated by the index, often requires editing and adjustment of the files before the use in the standings, in a mapping of landuse for example.

In future steps will be evaluated scenes of different seasonal periods to identify the best combinations for generating the NDBI as well as, the analysis into new areas.

The city of Marica is in growing urban expansion and requires constant monitoring, especially in support of zoning and urban control carried out by federal governments, and local governments.

## REFERENCES

[1] FRANÇA, A. F. et al. 2012. "Índices NDVI, NDWI e NDBI como ferramentas ao mapeamento temático do entorno da lagoa Olho D'água, em Jaboatão dos Guararapes-PE". In IV Simpósio Brasileiro de Ciências Geodésicas e Tecnologias da Geoinformação.

[2] [2] Xu, H., X. Wang, and G. Xiao, 2000. "A remote sensing and GIS integrated study on urbanization with its impact on arable lands: Fuqing City", Fujian Province, China, Land Degradation & Development, 11(4):301–314.

[3] [3] Xu, H., 2002. "Spatial expansion of urban/town in Fuqing and its driving force analysis", Remote Sensing Technology and Application, 17(2):86–92

[4] ZHA,Y.;GAO,J.NI,J. 2003 "Use of Normalized Differenet Built-up index in automatically mapping urban areas from TM imagery". INT. J. Remote Sensing. Vol.24, pp583-594.

## AUTHOR PROFILES

**Geógrafa,** Geographer , formed For the Federal University of Rio de Janeiro (2004 ) , MA in Geography For the Federal University of Rio de Janeiro (2007 ) and PhD in Geography from the University Federal Fluminense. acting areas: Remote Sensing, and urban areas, Spatial analysis of urban areas and Data Collection Techniques in the field . Teacher Adjunt Department of Geography of the Federal University of Rio de Janeiro , with a postgraduate doctorate in geography and Collaborator Professor of the Post-graduate Program in Geography UFRJ.