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EMPREGO DO SENSORIAMENTO REMOTO PARA ANÁLISE DO USO E OCUPAÇÃO DO SOLO NO PERÍMETRO IRRIGADO VÁRZEAS DE SOUSA-PB

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1 RESUMO

O perímetro irrigado várzeas de Sousa (PIVAS) é um grande produtor de culturas como coco, banana, sorgo, algodão dentre outras. Tem grande importância para o desenvolvimento econômico da região do alto sertão da Paraíba. Possui características impares como a distribuição de água para todos os lotes por potencial gravitacional. Para a sustentabilidade do perímetro é necessário o monitoramento constante de suas áreas, para se poder desenvolver estratégias que auxiliam no desenvolvimento sustentável. Nesse sentido, o sensoriamento remoto é uma ferramenta ideal por permitir a obtenção rápida e precisa de informações sobre uma área, o que pode auxiliar na tomada de decisão. Partindo desse pressuposto, o objetivo deste trabalho é apresentar um conjunto de técnicas de sensoriamento que possibilitem o monitoramento de áreas irrigadas ou ambientais. Para tanto foi determinado do uso e ocupação do solo, o índice de vegetação por diferença normalizada (NDVI) e o índice de vegetação ajustado ao solo (SAVI) para o PIVAS. Onde se observou que as técnicas de sensoriamento remoto auxiliam na compreensão de áreas no espaço e tempo.

Palavras-chave: monitoramento, manejo, satélite.

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2 ABSTRACT

The floodplain-irrigated perimeter of Sousa (PIVAS) is a major producer of crops such as coconut, banana, sorghum, cotton, among others. It is of great importance for the economic development of the upper wilderness region of Paraiba. It has unique characteristics such as water distribution to all lots by gravitational potential. For the sustainability of the perimeter, constant monitoring of its areas is necessary, to be able to develop strategies that help in sustainable development. In this sense, remote sensing is an ideal tool as it allows for quick and accurate obtaining information about an area, which can help in decision making. Based on this

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assumption, this work aims to present a set of sensing techniques that enable monitoring of irrigated or environmental areas. For this purpose, the normalized difference vegetation index (NDVI) and the soil-adjusted vegetation index (SAVI) were determined for the PIVAS. Where it was observed that remote sensing techniques help understand areas in space and time.

Keywords: monitoring, management, satellite.

3 INTRODUCTION

Irrigated perimeters are areas where the production system depends largely on irrigation systems. In these locations, a wide variety of irrigation systems can be found for a wide range of crops. In the northeast region of Brazil, irrigated perimeters are similar to veritable oases in the backlands, transforming the dry landscape. Furthermore, irrigated areas in semiarid regions are a source of hope for many farmers, enabling the creation of paid jobs and the consolidation of agricultural activities, which are fundamental to regional development (FERREIRA; FILHO, 2021).

The Sousa floodplain irrigated perimeter (PIVAS) covers an area of 6335.74 hectares and is a major producer of crops such as coconuts and bananas. According to Silva *et al.* (2015), PIVAS has 178 5-hectare lots for small producers and 19 corporate lots ranging from 27 to 293 hectares. The large land areas within the perimeters make management and monitoring difficult. Therefore, alternatives and strategies must be developed to assist in the management and monitoring of these areas, fostering sustainable development through the adoption of new techniques such as remote sensing and geographic information systems (GISs).

Remote sensing is a technique that allows information abstraction through the use of satellite imagery. It is used in various applications, such as developing land use and occupation maps or determining vegetation indices. According to Speranza, Antunes, and Inamasu (2018), remote sensing allows the verification of possible variations in plant biomass and assists in verifying production dynamics in an agricultural area. Sousa, Kato, and Aguiar (2019) demonstrated the effectiveness of remote sensing in monitoring annual land use in agriculture.

The objective was to determine land use and occupation for the PIVAS and the NDVI and SAVI indices, demonstrating that remote sensing can be used to monitor agricultural activities and aid decision-making. This technique is simple and inexpensive because of the availability of free images, such as those obtained from the National Institute for Space Research (DGINPE) portal.

4 MATERIALS AND METHODS

The study was carried out for the Sousa floodplain irrigated perimeter (PIVAS) located in the cities of Sousa and Aparecida in the mesoregion of the state of Paraíba in the subbasin of the Peixe and Piranhas Rivers, with access to BR-230 and 430 km from the capital. Images from the *Landsat satellite were obtained for mapping.* 8 OLI/TIRS C2 L1 in the U.S. *Geological Survey catalog Survey* (USGS *Earth Explorer)* of June 14, 2021.

Image processing and manipulation were performed with QGIS *software* version 3.18.1 with GRASS 7.8.5. The perimeter area was delimited through orthogoreference of a map obtained from the Várzea de Sousa Irrigated Perimeter Department (DPIVAS) that had a scale and grid with coordinates, for which a *Shapfile "Shp " file was created* with the PIVAS perimeter vector. In the classification of land use and occupation, an "RGB" composition of red (R), green (G) and blue (B) was used with bands B4, B3 and B2, respectively, more panchromatic and plugin *semiautomatic classification*. The determination of the NDVI and SAVI was performed with the infrared (NIR) and red (RED) bands. To this end, the digital number was converted to irradiance via Equation 1, and then Equations 2 and 3 were used.

$$L\lambda = \frac{(ML*QCal+AL)}{sin\ (\theta SE)} \quad (1)$$

$$NDVI = \frac{NIR-RED}{NIR+RED} \quad (2)$$

$$SAVI = \frac{NIR-RED}{NED+RED+L} * (1+L) \quad (3)$$

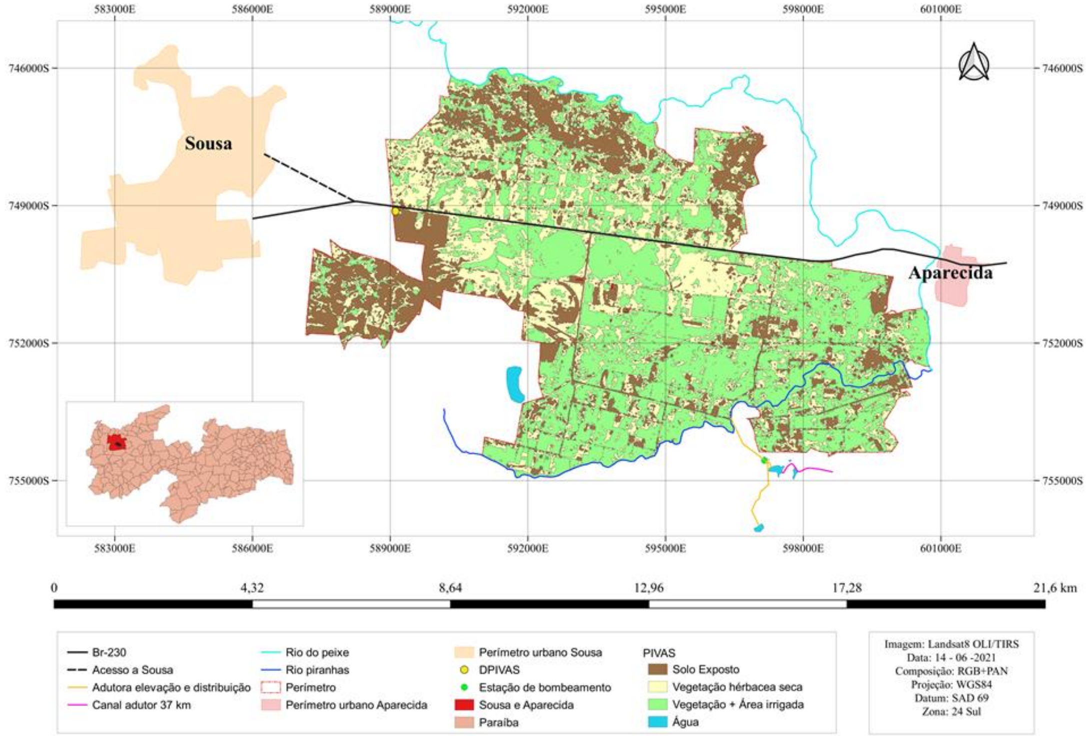
where $L\lambda$ represents the spectral radiation at the top of the atmosphere in (watts/m² srad µm) $^{-1}$; QCAl represents the digital number; ML represents the *Reflectance_Mult_band* (0.00002); *AL* represents the *Reflectance_Add_Band* (-0.1); ϴSE represents the *Sun_Elevation* (65.4381882); and L represents the land cover adjustment factor (0.5).

5 RESULTS AND DISCUSSION

The land use and occupation classification identified a total of 2,823.62 ha of vegetation and irrigated area, 2,157.94 ha of dry herbaceous vegetation, 1,322.45 ha of exposed soil, 29.47 ha of water surface, and 2.26 ha of built-up area. The identification of different soil classes depends on the resolution of the satellite image, which provides greater detail. According to Messias (2012), the lower the spatial resolution is, the better the degree of detail in the image. When higher-resolution images are used, care should be taken in terms of identification and the number of samples collected; lower resolutions ensure better detail and a greater number of classes. The Landsat 8 images used have a resolution of 30 meters. Therefore, to avoid ambiguity due to the difficulty in distinguishing areas with native vegetation from irrigated areas, the two classes—vegetation and irrigated areas—were combined.

According to Silva and Medeiros (2020), land use and occupation mapping helps identify the expansion of cultivated and uncultivated areas, enabling the evaluation of land use over time. Figure 1 shows the land use and occupation map of the Sousa floodplain irrigated perimeter, Paraíba. The images from July 14, 2021, allow the evaluation of land use, which can be compared with images from before or after that date, thus verifying the transformations that have occurred in a given location.

Figure 1. PIVAS land use and occupation map.

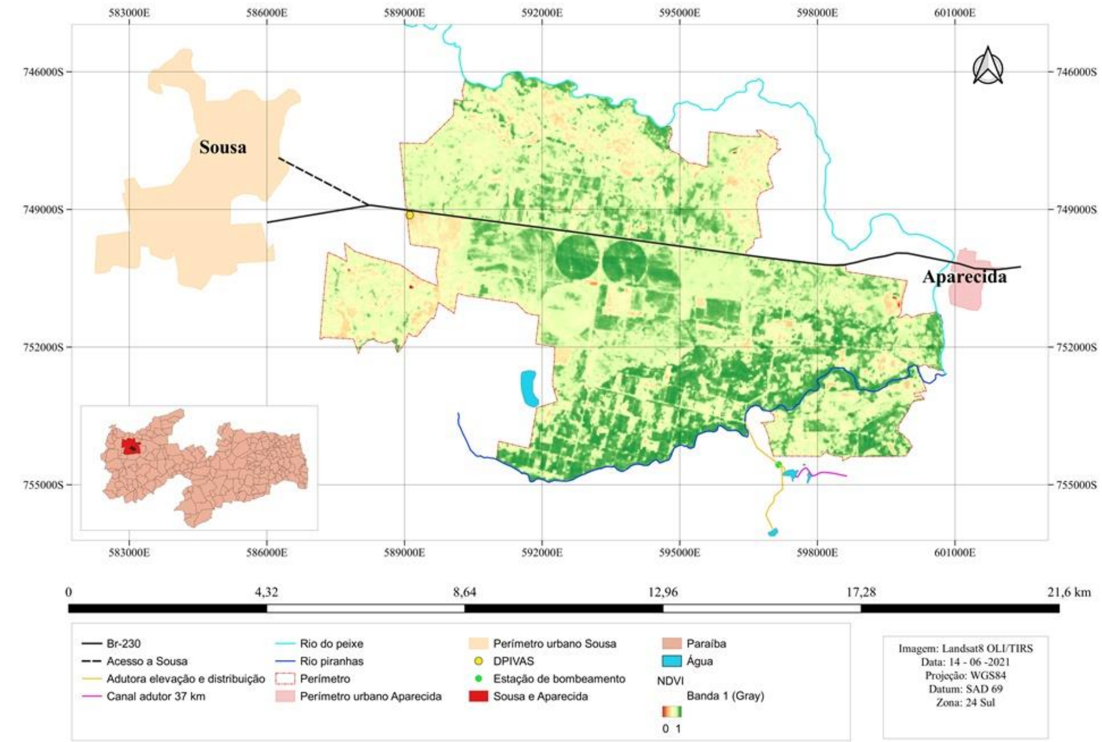


Source: Author (2021).

Figure 1 also shows that the circular areas represent central pivots, whereas rectangular and quadratic areas with well-defined corners are likely irrigated plots. According to Pordeus and Barros (2019), PIVAS has a low soil deterioration rate because of the conservation concerns of most irrigators. However, a large fraction of exposed soil can be observed. Therefore, land use and classification aid in monitoring areas and verifying their expansion over time, as well as their environmental degradation.

The determined NDVI highlights vegetated and irrigated areas, thus assisting in better map compression and, consequently, local uses and occupations. According to Ribeiro *et al.* (2017), the NDVI is effective in differentiating different corn growing seasons, allowing the identification of different crop stages. Therefore, the NDVI technique aids in monitoring cultivated areas in space and time, in addition to inferring plant health. Fontana *et al.* (2019) reported that the NDVI can indicate diseases or nutritional deficiencies in a cultivated area. Figure 2 illustrates the determined NDVI, where the delineation of irrigated areas can be observed, such as pivots and square and rectangular plots.

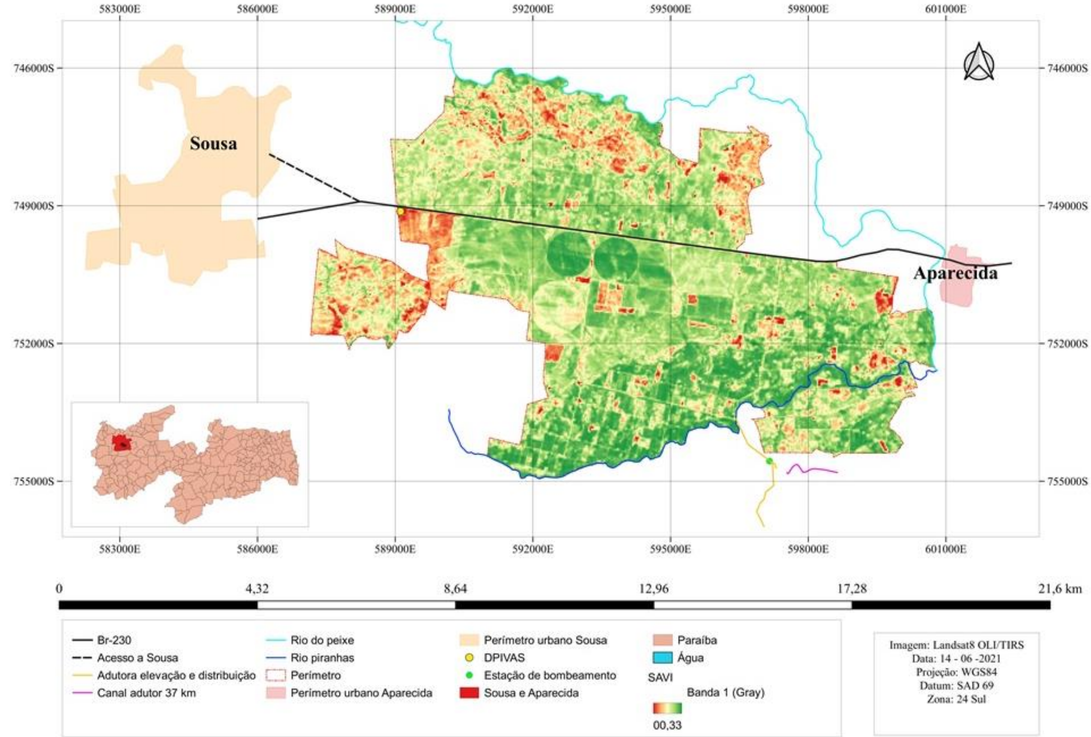
Figure 2. PIVAS normalized difference vegetation index.



Source: Author (2021).

In contrast, SAVI is a soil-adjusted index that promotes greater prominence of nonvegetated areas. According to Galvincio *et al.* (2016), SAVI also presents satisfactory results for monitoring vegetation dynamics. Figure 3 shows the determined SAVI. The red areas highlight the exposed soil.

Figure 3. Soil-adjusted vegetation index (PIVAS).



Source: Author (2021).

Comparing the results of the different procedures, it is clear that the use of satellite imagery and classification techniques, as well as the NDVI and SAVI, are tools for supporting decision-making and assisting in the monitoring, inspection, management, and planning of land use and occupation. Furthermore, owing to the characteristics of the NDVI and SAVI, it is possible to identify areas with greater or lesser plant vigor or vegetation cover. Pordeus (2017) reported that PIVAS cultivates a wide variety of crops, such as coconut, mango, and guava. Therefore, each area will have a different NDVI depending on the vegetation cover; therefore, the use of higher-resolution images can aid in monitoring these crops.

6 CONCLUSION

Remote sensing provides a wealth of information about the surface area of agricultural land, with an emphasis on irrigated land. Therefore, it can aid in area monitoring and sustainable development strategies. The NDVI and SAVI allow for the enhancement of green areas, enabling the monitoring of irrigated land.

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