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Digital Image Processing by TerraAmazon Software in Environmental Preservation Areas in the Brazilian Amazon

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1. INTRODUCTION

Remote sensing is the technique of obtaining information about an area or phenomenon by capturing and interpreting data obtained by sensors installed on air or space platforms, such as satellites (LIU, 2015).

These sensors collect electromagnetic or infrared information that is processed and analyzed to generate images, maps or three-dimensional models, which allow studying and monitoring the Earth's surface, the environment, the atmosphere, the ocean, among others (SALAZAR, 2019).

The processing of satellite images involves the use of computational techniques and algorithms to transform the information captured by remote sensors into useful data for analysis and decision making (ZANOTTA et al, 2019).

These techniques include geometric image correction, which adjusts for distortion caused by factors such as the satellite's orbit, atmospheric conditions and the sun's inclination, as well as calibrating the scale of pixel values (D'ALGE, 2007).

It can also include the fusion of images of different spectra and resolutions, which allows combining information from different bands and improving the detection of features and patterns of interest (FREITAS et al, 2008). In addition, it may involve the extraction of specific information, such as the identification of urban areas, forests, water bodies, among others, through image classification, segmentation and texture analysis (BORATTO et al, 2013).

Satellite image processing is widely used in several areas, such as mapping, environmental monitoring, precision agriculture, natural resource management, risk analysis, among others (SHIRATSUCHI et al, 2014).

Given the above, this work aimed to process images digitally using the TerraAmazon software in orbit/point: 225/66 and 226/66, generating a model report to be used by professionals, students in the area and the like.

2. MATERIAL AND METHODS

The TerraAmazon software was used for almost the entire process, and for image geoprocessing, 2 adjacent clean image scenes of orbits/point 225/66 and 226/66 were downloaded from the Instituto Nacional de Pesquisas Espaciais (INPE) site of the Landsat- 5 and Landsat-8, TM sensor, and the Landsat-5 images from orbit/point 225/66 and 226/66 were, respectively, from 06/15/2010 and 06/06/2010.

Furthermore, the images with the least amount of clouds possible were chosen and all the spectral bands offered by the site were downloaded. Images 226/66 and 225/66 are the scenes provided by each orbit/point, and their respective dates between 2000 and 2010 are also provided, with as little clouds as possible.

The same process carried out for Landsat-5 was carried out for Landsat-8, with the same orbits/point used for Landsat-8, with the change only in the year of imaging the area from 09/12/2019 to 225/ 66 and 03/09/2019 and download the images.

3. RESULTS AND DISCUSSIONS

Restoration and atmospheric corrections

The corrections were made for the Landsat-5, TM sensor, the restoration served to correct the distortions introduced by the sensor in the scene generation process and to obtain an enhanced image. The Import Raster was done by selecting the composited image and performing the contrast through the PDI plugin with the downloaded scene loaded. Since the radiometric and spatial characteristics of the image have changed, it is necessary to perform the radiometric correction first and then the other image correction processes.

Atmospheric correction is a technique used to reduce atmospheric interference in data. This is done by applying correction coefficients that adjust the intensity of light that is detected by the sensors. This technique is especially useful for data collected under varying atmospheric conditions, such as at different altitudes or weather conditions. Thus ensuring accuracy of data collected by remote sensors and to improve the quality of images and information they provide. This is particularly important in applications such as environmental monitoring, climate studies, natural resource management and urban planning, where data accuracy is critical for making informed decisions (SOUZA et al, 2005; SOARES et al, 2015; GAIDA et al, 2020).

RGB colored compositions

For image compositions in TerraAmazon, it is necessary to export the image. Afterwards, with bands 1, 2, 3, 4, 5 and 7 restored, the RGB color compositions of false color and natural color are performed, using only 3 bands.

After exporting the scenes, the Raster Composition is now made, which is the composition of the image. Bands 3, 4 and 5 restored were selected, bands for the false color composition of the landsat 5 sensor TM, and for that it is necessary to know the spatial resolutions of the selected sensor bands, since all must have the same spatial resolutions.

To start composing the image, export the folder with the first orbit/point to work on. The bands were ordered in the sequence 5 (R-red), 4 (G-green) and 3 (B-blue), which means the sequence of the RGB color channels. It was necessary to insert an output name for each new composition, and remove the black background from the image by entering the value zero. After processing, click on "Ok" to view the result with the composition of the scene in false color.

Highlight application

The best possible contrast enhancement was made in the two scenes already with false colors for the best visualization of the image details, and the contrast enhancement applications are made on top of the pixels of each band related to its respective color channel, which aims to make scenes 225/66 and 226/66 better distinguished, such as vegetation, soil, water, cities and others. Therefore, it was necessary to first select the bands. In Import Raster, the previously composed image was selected, leaving the image's view and theme selected. To perform the contrast, we entered the PDI plugin with the loaded image.

To open the tool, access Image processing, which is on the Image processing toolbar, and right after Contrast. You must in New ROI to acquire a sample of the image, now you can start the process. On the toolbar, select the Linear contrast type, and the Minimum and Maximum value of the bands can be configured on the toolbar as well, or if you prefer, by clicking with the right button of the mouse in the contrast area, you can define the maximum value and with the left button the minimum value, this for each band. Clicking on the extreme points of the distribution. And in the same way that we did for the blue channel band, we will do it for the green and red channel bands.

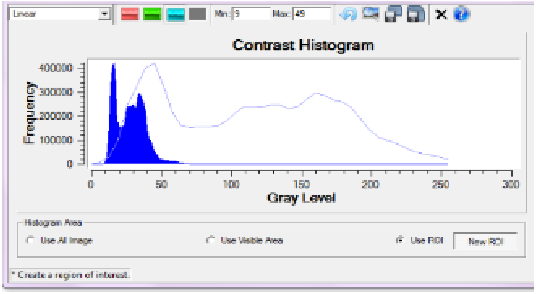

Fig 1. Highlight

Georeferencing

For the georeferencing it was necessary to use the enhanced Landsat-5 images and as a reference the Landsat-8 Satellite images of the orbits/point 225/66 and 226/66 previously downloaded together with the Landsat-5 images. For georeferencing, the monitor recommended adopting at least 20 control points with homogeneous distribution in the scene, considering a maximum error of 1.5 pixels per point. We also performed lat/long reprojection on the SIRGAS 2000 Datum, Decimal degrees. This transformation eliminates existing distortions in the image, caused in the image formation process, by the sensor system and by inaccuracy of the platform positioning data.

With the database activated, we add the composition of the Landsat-5 scene and the Landsat-8 image by opening the plugins in PDI and selecting the Register option within the Image Processing toolbar. When the window with the image opened, we went to the Input tab, and clicked on draw because that was how the images appeared, with the raw image on the left, and the image already georeferenced on the right (Landsat-8) . In the Output tab we typed the name for the new image, in the Properties tab we selected the geometric transformation and interpolation, since the georeferencing was manual. In Options we save the new control points. Then we close the display and export the image generated in Export Theme.

Georeferencing is used in many areas, including cartography, urban planning, natural resource management, agriculture, environmental monitoring, climate studies, and more. Allows geographic information to be integrated into other analyzes and models, improving the accuracy and usefulness of the information. It also helps to ensure that the information is georeferenced in a consistent and standardized way, allowing the comparison and sharing of data between different users and organizations (PIROLI et al, 1999; QUEIROZ, 2002).

Mosaic and clipping of landsat-5 scenes

We performed the mosaic of adjacent scenes after the process of georeferencing the Landsat-5 scenes and also a free format clipping covering parts of the two images and with about 400 km2.

Furthermore, the quality of a mosaic is directly associated with the accuracy of recording the images when in different projects, for the mosaic we will use two landsat images. We loaded the database of the two landsat images, in the menu bar we clicked on Plugin and then on Terra Imagem. Select Image Processing and Mosaic from the main menu.

Cropping allows you to delimit any image, defining a specific area to use in a project. To start clipping, we define the boundary to be clipped. This limit can be defined in three ways: vector, block and ROI. In the PDI plugin we select Image processing, Function and then Raster Cut. We selected the theme of the image that was cropped, choosing the option Regions and clicking on Acquire. Finally, after having configured the output location.

Linear Spectral Mixing Model Method (MLME) and NDVI Processing

For MLME processing we access Image Processing and Mixture Model in the toolbar. For its application, it was to identify a sample of each component, soil, water, shade and vegetation. The Normalized Difference Vegetation Index, on the other hand, increases the contrast between soil and vegetation, using the ratio between bands referring to red and near infrared, constituting vegetation indices. Serving to analyze the condition of the natural or agricultural vegetation in the images generated by remote sensors.

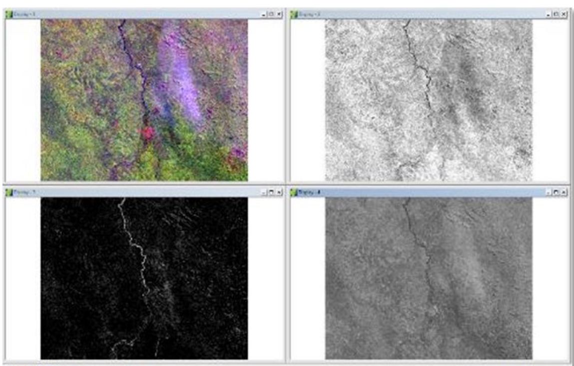

Fig 2. MLME e NDVI

Cropped image rating

The classes of water use and cover, dense forest, secondary forest, pasture, agriculture, exposed soil and urban area were identified. Classification is the process of extracting information from images to recognize patterns and homogeneous objects.

Classification methods are used to map areas of the Earth's surface that have the same meaning in digital images. The spectral information of a scene can be represented by a spectral image, where each "pixel" has the spatial coordinates x, y and the spectral coordinate L, which represents the radiation of a target in the wavelength range of a spectral band. Each "pixel" in a band has a spatial correspondence with another "pixel" in all other bands.

It shows what was soil, water, secondary vegetation, dense vegetation and among others. After the process, the vectorization was performed, accessing Image processing right after Raster to vector, and selecting the option Create Layer from Theme and Export Theme.

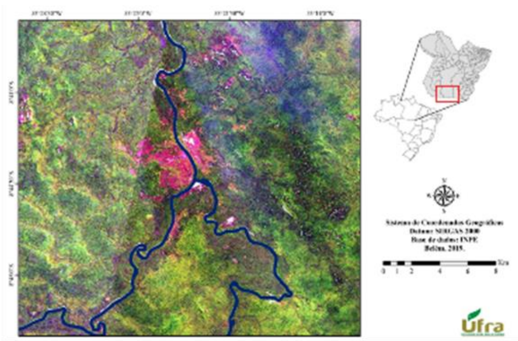

Fig 3. Scene location map

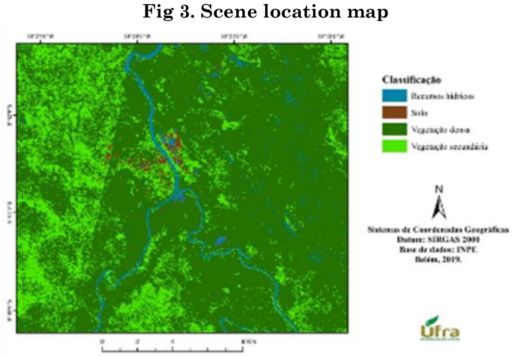

Fig 4. Land use and land cover map

4. CONCLUSION

The studied scenes have good environmental conservation, with few anthropized areas and exposed soil. Furthermore, the conservation of reserve areas can bring economic and environmental benefits to the property, such as improving soil quality, conservation of water resources, protection against natural disasters and property valuation.

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