Green space processing and analysis using ENVI based on GIS

Li Qiang[1,a], Lin Jianhang[1,b], Yang Jinyue[1,c]

[1]*Geophysical Institute, Chengdu University of Technology, Chengdu, China*
[a]*2813998748@qq.com,* [b]*2959085409@qq.com,* [c]*1575976460@qq.com*

Abstract: *This article adopts a spectral feature based extraction method. After atmospheric correction and radiation correction, the original remote sensing image calculates the NDVI value of each pixel through a band calculator, and then extracts the NDVI value of a specific band through a band calculator. Obtain the extracted image, and then vectorize the extracted green space image using geographic information processing software such as Qgis or Arcgis. Next, we calculate the scale between different points in vector data and obtain the distance between two points, which is then combined with Python to use polygon segmentation to obtain the area of irregular shapes. On the basis of this data, a series of operations such as element queries and corresponding mouse events can also be performed. By using overlay, we can establish green space data from different sources for differential or overlapping analysis, which can help us clean the data and analyze its specificity in time and space.*

Keywords: *Radiometric calibration, NDVI, Mask extraction, Visualization analysis of green spaces*

1. Introduction

In recent years, with the development of urbanization, the area of urban green space has gradually decreased, bringing many negative impacts to the urban environment and residents, such as climate change, water resource pollution, etc. Therefore, the protection of green space ecology is urgent. It is of great significance to jointly monitor and analyze the area of green space through satellites or other means for environmental protection.

2. Extraction and analysis of green spaces

2.1. Raw data processing

PDownload remote sensing images of the selected area from the Geospatial Data Cloud website. This article uses Landsat8 satellite remote sensing data from Wuhou District, Chengdu City as an example. To improve the accuracy of the extraction of green space, we selected images with cloud content of less than 15% and occurring between July and October, when plant growth trends are best.

Continue with image stitching. When the target area is composed of multiple scenes, it can only be used after remote sensing stitching. The concatenated remote sensing images can provide a larger range and higher resolution of surface information. The prerequisite for image concatenation is the remote sensing images from the same satellite at the same time.

Mask extraction. By utilizing remote sensing image data and image processing techniques, target areas or specific objects are extracted from remote sensing images to form masks for further analysis and application. Import vector surface data of Wuhou District into ENVI, and then use Subset Data from ROIs tool to extract remote sensing images of Wuhou District.The schematic diagram before and after mask extraction is as follows.The result is shown in Figure 1and 2.

Figure 1: Before Mask Extraction

Figure 2: After Mask Extraction

2.2. Radiometric calibration

Convert the digital quantization value (DN) in remote sensing images into radiance values, which reflect the reflectivity or brightness values of objects at different wavelengths, determine the accurate radiation value at the sensor entrance, and improve the accuracy and reliability of remote sensing images. Use the Radiometric Calibration[1] function in the tool to perform radiometric calibration on the image extracted by the mask.The results are shown in Figures 3.

Figure 3: After radiometric calibration

2.3. Extracting NDVI values

$$NDVI = (NIR - R)/(NIR + R) \tag{1}$$

(In the formula: is the near-infrared band, is the infrared band)

In the formula: is the near-infrared band, is the infrared band NDVI (Normalized Difference Vegetation Index) is a commonly used green space index. It uses the difference in reflectance between red and near-infrared light to extract vegetation coverage information. Using the Band Math tool, the NDVI calculation formula is added first, and the float is added to make the result a floating point number. At this time, b1 and b2 only represent variables, and then the assignment is calculated to obtain a grayscale image. Rapid statistical analysis of NDVI values[4] can observe a relatively uniform distribution

within the range of -1 to 1, and the extraction effect is relatively good.The results are shown in Figures 4.

Figure 4: NDVI value

Use the band calculator again to extract the green band (band<0.30) region and export it as a TIF file.Dot should be included after the number of headings.

2.4. Vectoring

Export the obtained tif file in Argis, and then perform mask extraction analysis on the shape file of Wuhou District to obtain the raster vegetation file of Wuhou District.[2] Continuing with vectorization will obtain the vectorized plant distribution file of Wuhou District.[3]The results are shown in Figures 5.
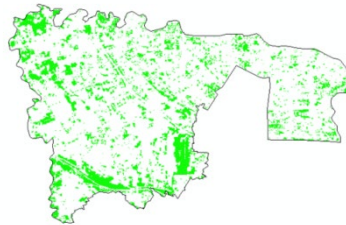

Figure 5: Green space extraction vector map

3. System View and Visualization Construction and Data Analysis

For the obtained green space shp format data, we used the geopandas package in Python to visualize it, and some of the results are shown in the following figure (where the green part represents green space):The results are shown in Figures 6
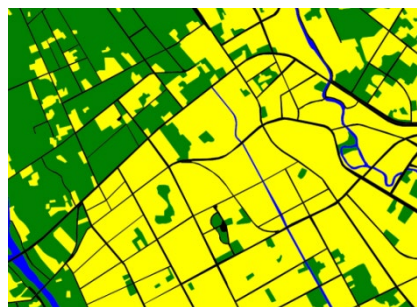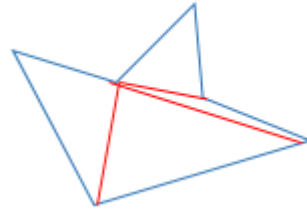

Figure 6: Green space visualization map

Next, we will study the method for calculating the area of irregular green spaces. This article divides irregular polygons into multiple triangles based on the positions of their endpoints, in order to calculate their area[5](Schematic diagram as shown in Figure 7):

Figure 7: Schematic diagram of polygon splitting

For each green polygon layer, with known endpoint data, we establish a plane Cartesian coordinate system based on WGS1984 and obtain the coordinates of each endpoint in the coordinate system, namely longitude and latitude. Due to the fact that the latitude and longitude data is obtained through Gaussian projection from three-dimensional spatial data, its scale will also change depending on the longitude and latitude differences of each point. Therefore, we obtain the scale between a certain two points based on the latitude and longitude difference table, and calculate the distance between the two points. After obtaining the distance between all adjacent points in each triangle, we can calculate the area of the triangle according to Helen's formula, and add it up to obtain the irregular green area.

The latitude and longitude differences are shown in Table 1 (can be extrapolated):

Table 1: Latitude and longitude difference table

Scale	1:100000	1:50000	1:25000
Longitude difference	30′	15′	7′30″
Latitude difference	20′	10′	5′

Let the scale between two points be K, and the formula for the distance between two points is:

$$d = \sqrt[2]{(x2 - x1)^2 + (y2 - y1)^2} \tag{2}$$

Helen's formula:

$$S = k\sqrt[2]{p(p - a)(p - b)(p - c)}, \ p = \frac{(a+b+c)}{2} \tag{3}$$

(Among them, a, b, and c are the lengths of the three sides of the triangle.)

The total area of irregular polygons can be expressed as:

$$S_{total} = \sum S \tag{4}$$

Based on this principle, the green area in the figure can be obtained.

In addition, trigger functions can also be assigned to mouse operation events based on mplcursors. We use this method to establish a "display name after clicking" operation for each green space layer, improving the interactivity performance of the user view. In addition, we can also query and highlight specific layers based on data characteristics. It is worth mentioning that this system can also perform differential or overlapping analysis on green space data from different sources through overlay operations, which helps us clean and analyze data specificity. When conducting data accuracy analysis, it can intuitively reflect the differences between data. Combining with actual situations, more accurate data can be obtained.

4. Conclusion

It can be seen from the above analysis that the effect is accurate when ENVI is used to extract green space and other ground objects from the area extracted by mask. Moreover, the visual analysis shows that the difference between the area size of the extracted green space and the real area size is less than 5%, and the overlap rate between the real green space is more than 95%, indicating that the extraction method is effective. Moreover, the spatial relations and differences of each map vector can be obtained through the difference analysis, which helps researchers to analyze the spatial information of green space.

References

[1] Gou Guanglei, Zhu Donghua, Li Xiaofei, etc Deep Mask Brownian Distance Covariance Small

Sample Classification Method [J/OL] Computer Application Research, 1-7 [2024-02-28] https://doi. org/10.19734/j.issn.1001-3695.2023.09.0514.

[2] Pei Jian. Research on Urban Green Space Extraction Method Based on Gaofen-2 [J]. Surveying and Spatial Geographic Information, 2024, 47 (01): 110-112+116

[3] Wu Kunze. Extraction of urban green space information changes based on multi temporal satellite images [J]. Surveying and Spatial Geographic Information, 2024, 47 (01): 145-147+151

[4] Chen Hao, Dong Tingxu, Ma Li, etc. Research on the spatiotemporal evolution characteristics of NDVI in Sichuan Province [J]. Journal of Mianyang Normal University, 2024, 43 (02): 106-112. DOI: 10.16276/j.cnki.cn51-1670/g/2024.02.015

[5] Lin Yueming, Gu Rihui, Leng Guoxing, etc. A study on the range of values and influencing factors of the area ratio for calculating surface subsidence [J]. Guangdong Civil Engineering and Architecture, 2024, 31 (01): 1-4. DOI: 10.19731/j.gdtmyjz.2024.01.001