DEVELOPMENT OF DIGITAL PREPROCESSING METHODS AND GEOPORTAL-BASED INTEGRATION FOR INTELLIGENT ANALYSIS OF GREEN ZONES FROM REMOTE SENSING IMAGES

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KEYWORDS

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ABSTRACT

The monitoring and analysis of green zones are important tasks for sustainable urban planning, environmental management, and ecological decision-making. Remote sensing images provide an effective source of spatial data for identifying vegetation areas and assessing their condition. However, raw remote sensing images often contain noise, illumination differences, spectral inconsistencies, and geometric distortions, which may reduce the accuracy of further analysis. Therefore, digital preprocessing plays a key role in preparing image data for reliable green zone detection. This paper presents a compact approach for the intelligent analysis of green zones based on remote sensing images. The proposed model includes image preprocessing, vegetation index calculation, segmentation of green areas, and integration of the obtained results into a geoportal environment. Vegetation indices such as NDVI and ExG are used to distinguish vegetation from non-vegetation objects. The processed results are transformed into geospatial layers and visualized through a geoportal for practical interpretation. The proposed approach can support environmental monitoring, urban green infrastructure assessment, and spatial decision-making.

1. Introduction

Green zones are an essential component of urban and ecological environments. They improve air quality, reduce land surface temperature, support biodiversity, and contribute to the overall environmental stability of residential and public areas. In modern cities, the condition and distribution of green zones are becoming increasingly important due to rapid urbanization, climate change, land degradation, and increasing anthropogenic pressure. For this reason, the development of effective methods for monitoring and analyzing green areas is one of the relevant tasks in environmental informatics and geospatial analysis.

Traditional field-based monitoring methods provide accurate local information, but they are usually time-consuming, labor-intensive, and limited in spatial coverage. In contrast, remote sensing technologies make it possible to obtain image data over large areas in a relatively short time. Satellite images and unmanned aerial vehicle images can be used to detect vegetation cover, identify changes in green areas, and evaluate the spatial distribution of ecological objects. These advantages make remote sensing an effective tool for the analysis of green zones in urban and agricultural environments.

Despite these advantages, remote sensing images cannot always be used directly for analysis. Raw images may include noise, shadows, illumination differences, atmospheric effects, and geometric distortions. These factors may negatively affect the accuracy of vegetation detection and classification. Therefore, digital preprocessing is considered an important stage in remote sensing image analysis. Preprocessing methods such as noise reduction, image normalization, contrast enhancement, geometric

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correction, and spectral transformation improve the quality of input data and increase the reliability of further analysis.

Vegetation indices are widely used to identify and assess green areas from remote sensing images. The Normalized Difference Vegetation Index is one of the most common indicators for detecting vegetation activity using near-infrared and red spectral bands. In cases where only RGB images are available, color-based indices such as the Excess Green Index can also be used to separate vegetation areas from other land cover objects. These indices help generate vegetation masks and provide a basis for further segmentation and spatial analysis.

Another important aspect of green zone monitoring is the visualization and practical use of obtained results. Processed images, vegetation masks, and analytical layers should be presented in a convenient geospatial form. Geoportal technologies provide an effective environment for storing, displaying, and analyzing spatial data. By integrating processed remote sensing results into a geoportal, users can visually observe green zone boundaries, assess vegetation condition, and make decisions based on spatial information.

The main objective of this paper is to develop a digital preprocessing and geoportal integration approach for the intelligent analysis of green zones based on remote sensing images. The proposed approach focuses on preparing remote sensing images, extracting vegetation-related information, segmenting green areas, and visualizing the results through a geoportal environment. The scope of the study is limited to preprocessing, vegetation index calculation, green zone segmentation, and geospatial visualization, without considering complex deep learning architectures or large-scale prediction models.

The main contribution of this paper is the development of a simplified but practical workflow that connects remote sensing image preprocessing with geoportal-based visualization. The proposed workflow can be used as a basis for further development of intelligent monitoring systems for green zones. In future studies, the approach can be extended using machine learning models, temporal image analysis, and automated decision-support modules.

2. Materials and Methods

The proposed approach is aimed at preparing remote sensing images for green zone analysis and presenting the obtained results in a geoportal environment. The general workflow consists of three main stages: digital preprocessing of the input image, vegetation index calculation, and integration of the processed result into a geospatial visualization system.

The overall structure of the proposed approach is represented as follows:

1. Remote sensing Image
2. Preprocessing
3. Vegetattion index
4. Geen Zone Mask
5. Geoportal

2.1. Digital Preprocessing of Remote Sensing Images

Remote sensing images usually contain noise, illumination differences, shadows, and geometric inconsistencies. These factors may reduce the accuracy of green zone detection. Therefore, digital preprocessing is applied before analytical processing.

In this study, preprocessing includes three main operations: noise reduction, image normalization, and geometric alignment. Noise reduction is used to remove small random distortions from the image. For this purpose, Gaussian or median filtering can be applied. Image normalization reduces the influence of different illumination conditions and transforms pixel values into a common range:

$$I_{norm} = \frac{I - I_{min}}{I_{max} - I_{min}}$$

where $I$is the original pixel value, while $I_{min}$and I_{max}represent the minimum and maximum values of the image. After normalization, the image becomes more suitable for vegetation index calculation and segmentation.

Geometric alignment is applied when the processed image must be connected with a geographic coordinate system. This step is important for further visualization of green zones in a geoportal environment.

2.2. Vegetation Index Calculation and Green Zone Extraction

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Vegetation indices are used to separate green vegetation from other land cover objects. If multispectral images are available, the Normalized Difference Vegetation Index is calculated:

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

where $NIR$is the near-infrared band and $Red$is the red spectral band. NDVI values close to positive high values usually indicate vegetation areas, while low or negative values correspond to non-vegetation objects such as roads, buildings, soil, or water.

If only RGB images are available, the Excess Green Index can be used:

$$ExG = 2G - R - B$$

where R, G, and $B$are the red, green, and blue channels of the image. This index emphasizes the green component and helps to detect vegetation areas in ordinary RGB images.

After calculating the vegetation index, a thresholding operation is applied to generate a binary green zone mask:

$$M(x,y) = \begin{cases} 1, & VI(x,y) \geq T \\ 0, & VI(x,y) < T \end{cases}$$

where $VI(x,y)$is the vegetation index value and $T$is the selected threshold. Pixels with values greater than or equal to the threshold are considered green zone pixels.

2.3. Geoportal Integration

The obtained green zone mask is prepared as a geospatial layer for further visualization. At this stage, the processed raster result can be converted into vector polygons or stored as a thematic raster layer. Each layer may contain basic attributes such as green zone boundary, area, and vegetation index value.

The geoportal integration stage allows users to view the original image, vegetation index map, and extracted green zone layer on an interactive map. This makes the result more understandable and useful for ecological monitoring, urban planning, and decision-making.

The simplified geoportal integration model includes the following sequence:

1. Green zone mask
2. Geospatial layer
3. Web map
4. User visualization

Thus, the proposed method connects digital preprocessing of remote sensing images with practical spatial visualization. The approach is simple, computationally efficient, and suitable for small and medium-scale green zone monitoring tasks.

3. Results and Discussion

The proposed approach provides a simple workflow for extracting green zones from remote sensing images and preparing the obtained results for geoportal-based visualization. The main result of the processing stage is a vegetation mask that separates green areas from other land cover objects such as buildings, roads, bare soil, and water surfaces.

After digital preprocessing, the quality of the input image becomes more suitable for vegetation analysis. Noise reduction decreases small random distortions, while normalization reduces the influence of illumination differences. As a result, vegetation index calculation becomes more stable, especially in images containing shadows or brightness variations.

The vegetation index stage allows the identification of pixels related to green vegetation. In multispectral images, NDVI provides more reliable results because it uses the difference between near-infrared and red bands. In RGB images, the ExG index can be used as an alternative solution. Although ExG is simpler than NDVI, it can still be useful for detecting visible green areas when multispectral data are not available.

The generated green zone mask is the main analytical output of the proposed method. This mask can be used to calculate the approximate area of vegetation objects and to prepare thematic layers for spatial analysis. The simplified result structure is shown in Table 1.

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Table 1.

Main outputs of the proposed processing workflow

Processing stage	*Output result*	*Practical meaning*
Digital preprocessing	Improved image	Reduced noise and illumination influence
Vegetation index calculation	NDVI or ExG map	Detection of vegetation-related pixels
Thresholding	Green zone mask	Separation of vegetation and non-vegetation areas
Geoportal integration	Spatial layer	Interactive visualization on a web map

The integration of the processed result into a geoportal environment improves the practical value of image analysis. Instead of presenting only raster images, the extracted green zones can be displayed as geospatial layers on an interactive map. This allows users to visually inspect green zone boundaries, compare vegetation distribution, and use the results for ecological monitoring or urban planning.

A simplified visualization structure of the proposed system is given below:

1. Orginal image
2. Vegetation index map
3. Green zone mask
4. Geoportal layer

The proposed approach is not intended to replace complex machine learning or deep learning models. Its main advantage is simplicity and practical applicability. Since the workflow is based on preprocessing, vegetation index calculation, and threshold-based extraction, it can be implemented with relatively low computational cost. This makes the method suitable for small and medium-scale monitoring tasks.

At the same time, the accuracy of the result depends on several factors, including image resolution, lighting conditions, seasonal changes, and the selected threshold value. For example, shadows and dry vegetation may reduce the reliability of green zone extraction in RGB images. Multispectral images usually provide more stable results because NDVI can better distinguish vegetation from non-vegetation objects.

The obtained results show that the proposed approach can serve as a basic model for green zone monitoring based on remote sensing images. The geoportal integration stage makes the results more understandable for users and supports spatial decision-making. In future research, the proposed workflow can be extended with machine learning classification, temporal change analysis, and automated vegetation condition assessment.

4. Conclusion

This paper presented a compact approach for the intelligent analysis of green zones based on remote sensing images. The proposed workflow combines digital preprocessing, vegetation index calculation, green zone extraction, and geoportal-based visualization. The main purpose of the approach is to prepare remote sensing images for practical environmental analysis and to present the obtained results in a convenient geospatial form.

Digital preprocessing is an important stage because raw remote sensing images may contain noise, shadows, illumination differences, and geometric inconsistencies. Filtering, normalization, and alignment operations improve the quality of the input image and make it more suitable for vegetation analysis. After preprocessing, vegetation indices such as NDVI and ExG can be used to identify green areas from multispectral or RGB images.

The generated green zone mask represents the main analytical result of the proposed method. This mask can be used to estimate vegetation areas, separate green and non-green objects, and prepare thematic geospatial layers. The integration of these results into a geoportal environment increases the practical value of the analysis by allowing users to view, compare, and interpret green zone information on an interactive map.

The proposed approach is simple, computationally efficient, and suitable for small and medium-scale monitoring tasks. It can be applied in urban planning, ecological monitoring,

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and green infrastructure management. At the same time, the accuracy of the method depends on image quality, spatial resolution, lighting conditions, seasonal changes, and the selected threshold values.

In future research, the proposed workflow can be improved by using machine learning algorithms, temporal image analysis, and automated vegetation condition assessment. These extensions may increase the accuracy of green zone detection and support more advanced decision-making systems for environmental monitoring.

References

1. J. R. Jensen, *Remote Sensing of the Environment: An Earth Resource Perspective*. Pearson, 2015.
2. T. Lillesand, R. W. Kiefer, and J. Chipman, *Remote Sensing and Image Interpretation*. Wiley, 2015.
3. N. Horning, J. A. Robinson, E. J. Sterling, W. Turner, and S. Spector, *Remote Sensing for Ecology and Conservation*. Oxford University Press, 2010.
4. J. W. Rouse, R. H. Haas, J. A. Schell, and D. W. Deering, "Monitoring vegetation systems in the Great Plains with ERTS," *NASA Special Publication*, vol. 351, pp. 309–317, 1974.
5. A. Huete, "A soil-adjusted vegetation index," *Remote Sensing of Environment*, vol. 25, no. 3, pp. 295–309, 1988.
6. A. A. Gitelson, Y. J. Kaufman, and M. N. Merzlyak, "Use of a green channel in remote sensing of global vegetation from EOS-MODIS," *Remote Sensing of Environment*, vol. 58, no. 3, pp. 289–298, 1996.
7. D. Lu and Q. Weng, "A survey of image classification methods and techniques for improving classification performance," *International Journal of Remote Sensing*, vol. 28, no. 5, pp. 823–870, 2007.
8. M. Sonka, V. Hlavac, and R. Boyle, *Image Processing, Analysis, and Machine Vision*. Cengage Learning, 2014.
9. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*. Pearson, 2018.
10. M. Neteler and H. Mitasova, *Open Source GIS: A GRASS GIS Approach*. Springer, 2008.
11. P. A. Longley, M. F. Goodchild, D. J. Maguire, and D. W. Rhind, *Geographic Information Systems and Science*. Wiley, 2015.
12. A. K. Skidmore, *Environmental Modelling with GIS and Remote Sensing*. CRC Press, 2002.
13. Shirinboyev R. GRAF ASOSIDA TIMSOLLARNI ANIQLASH UCHUN VIDEO TASVIRLARDA ANOMALIYANI MODELLASHTIRISH: FAZOVIY-VAQTINCHALIK YONDASHUV //Scientific practical conference. – 2025. – T. 1. – №. 1. – C. 33-38.
14. Shirinboyev R., Akhralov S., Ulashev A. Intelligent Analysis of Urban Green Zones Based on Unmanned Aerial Vehicle Data //2026 International Russian Smart Industry Conference (SmartIndustryCon). – IEEE, 2026. – C. 263-268.
15. Ruzikulovich T. M. Neyron tarmoq algoritmlari yordamida murakkab fondagi belgilarni aniqlash algoritmlari //International Journal of Contemporary Scientific and Technical Research. – 2022. – C. 238-241.
16. Axatov A. R., Tojiyev M. R., Shirinboyev R. S. Konvolyutsion neyron tarmog 'i asosida video tasvirdan yong 'inni erta aniqlash //International Journal of Contemporary Scientific and Technical Research. – 2022. – T. 1. – №. 1. – C. 128-132.

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