Identifying Vegetation and Barren Land in Raichur (2019–2023)

Project Report

Course Information

- **Course Title:** Geospatial Data Analytics
- **Course Code:**CS321
- **Instructor:** Dubacharla Gyaneshwar

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This report provides a detailed overview of the project undertaken as part of the Geospatial Data Analytics course, focusing on vegetation and barren land analysis for Raichur and Nallamala Forest using multispectral imagery and NDVI.

Abstract

The project utilizes satellite-based multispectral imagery to study vegetation and barren land changes in Raichur, Karnataka, over five years (2019–2023). Using NDVI (Normalized Difference Vegetation Index) values, this work identifies regions covered by vegetation and barren land. It also quantifies year-to-year percentage changes in these classifications. The outcomes provide insights for agricultural planning, urban expansion monitoring, and environmental conservation.

Objectives

- **Classify Land Cover:** Identify vegetation and barren land using NDVI thresholds.
- **Quantify Changes:** Calculate the percentage increase or decrease in vegetation and barren land.
- **Visualize Results:** Generate output images and side-by-side visual comparisons.
- **Contribute Insights:** Provide data-driven recommendations for land-use management.

Introduction

With increasing human activities and climate variations, monitoring land cover dynamics is essential. **NDVI** is widely used to evaluate vegetation health by analyzing the reflectance of red and near-infrared (NIR) light.

- **Vegetation:** Healthy plants reflect more NIR and absorb red light, leading to high NDVI values.
- **Barren Land:** Displays low NDVI values due to minimal reflectance in NIR.

Raichur, known for its agriculture, is a relevant study area for assessing land-use changes, ensuring sustainable practices, and aiding local development efforts.

Study Area

Raichur

Location:

- Raichur district, Karnataka, India
- Lies between 15.37°N and 16.34°N latitude and 76.14°E and 77.36°E longitude.

Geographical Importance:

- Dominantly agricultural with dry climatic conditions.
- Presence of irrigation projects like the Tungabhadra Dam.
- Semi-arid region with significant dependency on seasonal rainfall.

Nallamala Forest

Location:

- Spanning across Andhra Pradesh and Telangana, India.
- Lies approximately between 15°N to 16°N latitude and 78°E to 80°E longitude.

Geographical Importance:

- A part of the Eastern Ghats, the Nallamala Forest is one of the largest dense forests in South India.
- Known for rich biodiversity, including teak forests, wildlife, and medicinal plants.
- Essential for maintaining regional ecological balance and providing habitat for endangered species like the Indian pangolin and sloth bear.

By integrating these two study areas, the project captures diverse landscapes ranging from semi-arid agricultural zones to dense forests, offering a unique opportunity to analyze NDVI patterns across varying ecosystems.

Data Source and Tools

Data Source

1. **Satellite Imagery:** Sentinel-2 satellite through Google Earth Engine (GEE).
2. **Image Format:** Multispectral `.tif` images containing NDVI values.
3. **Resolution:** 10m spatial resolution for accurate land classification.

Tools and Technologies

1. **Software:**
    - **Google Earth Engine:** Dataset collection.
    - **Visual Studio Code:** Code implementation and debugging.
2. **Programming Language:** Python
3. **Libraries:**
    - `rasterio`: For reading `.tif` files and image processing.
    - `numpy`: For matrix operations and threshold-based classification.

- `matplotlib`: For visualizing input and output images.

Methodology

Data Collection

NDVI images for the years 2019 to 2023 were downloaded from GEE using Sentinel-2 datasets. The images were clipped to Raichur's geographical boundaries and preprocessed for further analysis.

NDVI Thresholding

- **Vegetation Classification:** NDVI > 0.2
- **Barren Land Classification:** 0 ≤ NDVI ≤ 0.2

Image Processing Steps

1. **Load Image:** Each `.tif` file was read using `rasterio`.
2. **Classification:** Based on NDVI values:
   - **Vegetation pixels** were assigned a green color `[0, 255, 0]`.
   - **Barren pixels** were assigned a grey color `[128, 128, 128]`.
3. **Visualization:** Both the original NDVI and classified images were displayed side-by-side.
4. **Change Analysis:** Pixel counts for vegetation and barren land were compared year-to-year to calculate percentage changes.

Code Workflow

Step 1: Load the NDVI image.

python

```
import rasterio

with rasterio.open("NDVI_2019.tif") as src:

    ndvi = src.read(1)
```

Step 2: Classify the image.

python

```
vegetation = ndvi > 0.2

barren_land = (ndvi >= 0) & (ndvi <= 0.2)
```

Step 3: Create color-coded output.

python

```
output_image[vegetation] = [0, 255, 0]

output_image[barren_land] = [128, 128, 128]
```

Step 4: Save and display results.

python

```
plt.imsave("NDVI_processed.png", output_image)
```

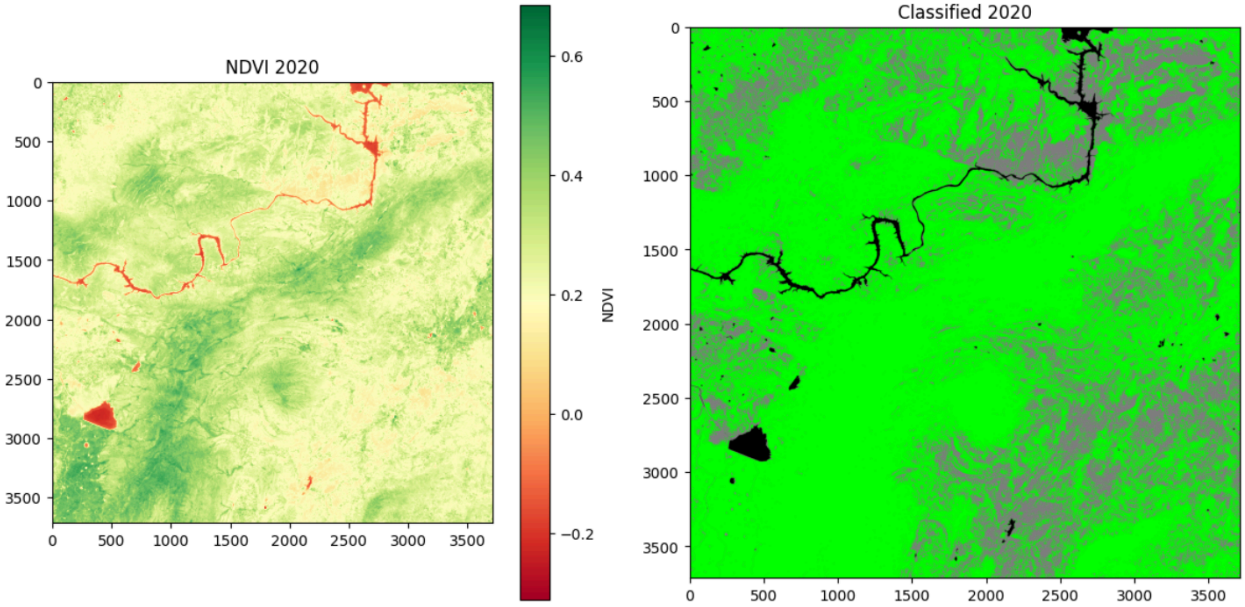
Change Calculation Formula

Percentage Change = ((Count in Year2) - (Count in Year1)) / Total Pixels * 100

Implementation

Sample Input and Output

- **Input Image:** Raw NDVI data for Raichur and Nallamala Forest (2019-2023).
- **Output Images:**
    - NDVI Map: Visual representation of NDVI values.
    - Classified Map: Color-coded map (green for vegetation, grey for barren land).



INPUT AND OUTPUT

Results

Classified Images

Classified images for each year show vegetation and barren land distinctly:

- Vegetation: **Green**
- Barren Land: **Gray**

Percentage Change Summary

RAICHUR

- Observed fluctuations in vegetation due to agricultural patterns.
- Increase in vegetation in later years due to improved irrigation.

Year	Vegetation Change (%)	Barren Land Change (%)
2019-2020	+22.21%	-22.56%
2020-2021	+8.98%	-8.81%

2021–2022	-50.91%	+50.52%
2022–2023	+6.33%	-6.20%

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NALLAMALA

- Stable vegetation coverage with minimal year-on-year variation.
- Localized barren patches identified near human settlements.

Year	Vegetation Change (%)	Barren Land Change (%)
2019–2020	+33.39%	-33.71%
2020–2021	+9.03%	-9.14%
2021–2022	-57.85%	+57.96%
2022–2023	+19.38%	-19.22%

Discussion

Observations

- Vegetation increased in years with favorable monsoon conditions.
- Barren land declined in regions adopting irrigation practices or afforestation.

Challenges

- Processing high-resolution `.tif` files required significant computational resources.
- Determining optimal NDVI thresholds involves domain knowledge.

Applications

- **Policy-Making:** Support for agricultural and environmental policies.
- **Urban Planning:** Identifying areas for sustainable development.

Future Scope

1. **Deforestation Alerts:**
   Develop an automated system to detect deforestation in real time.
2. **Urban Expansion Impact:**
   Analyze the effect of urbanization on vegetation in nearby areas.
3. **Higher-Resolution Analysis:**
   Use finer-resolution imagery for more accurate classifications.
4. **Carbon Stock Estimation:**
   Extend the study to calculate carbon sequestration trends.
5. **Climate Correlation:**
   Study NDVI trends in relation to rainfall, temperature, and human activities.

Conclusion

This project successfully classified vegetation and barren land in Raichur and quantified land-cover changes over five years. The results contribute valuable insights for sustainable land use, ensuring better agricultural and environmental planning.

References

1. **Sentinel-2 Satellite Documentation:** European Space Agency (ESA).
2. **Google Earth Engine Documentation:** GEE datasets and processing.
3. Python libraries: `rasterio`, `numpy`, and `matplotlib`.

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CS22B1020