Geospatial Data Analysis (CS321)

Forest Cut Temporal Detection

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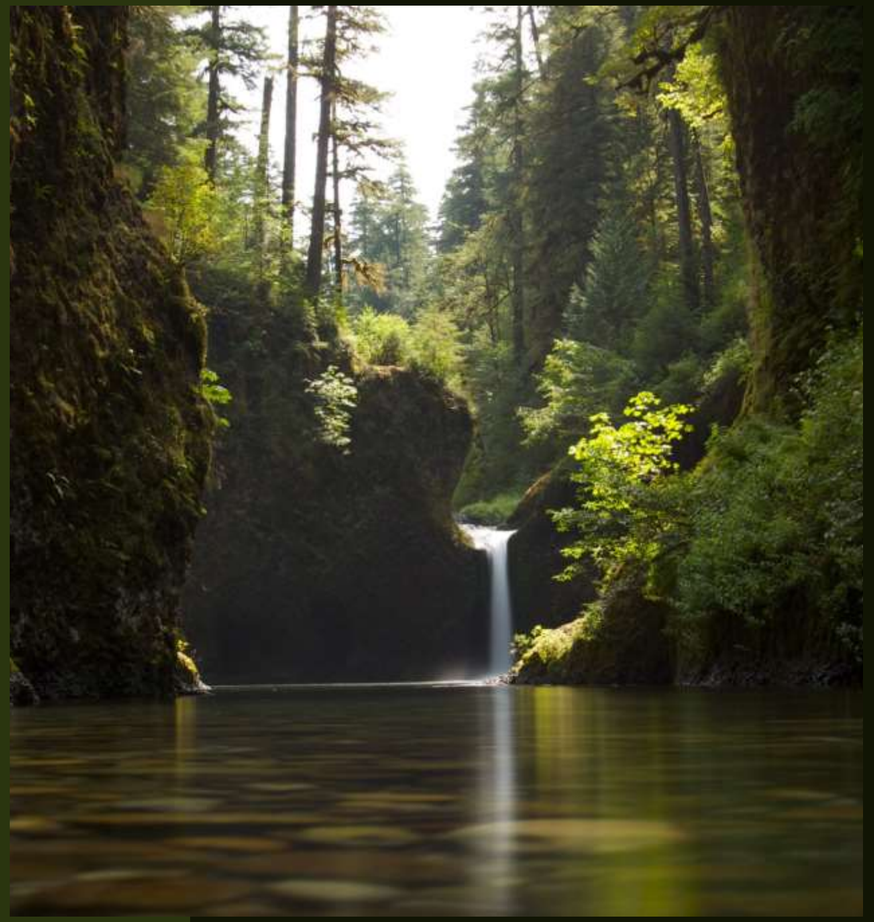
Deforestation

Deforestation is The large-scale clearing or thinning of forests, mainly due to human activities like logging, agriculture, and urbanization.

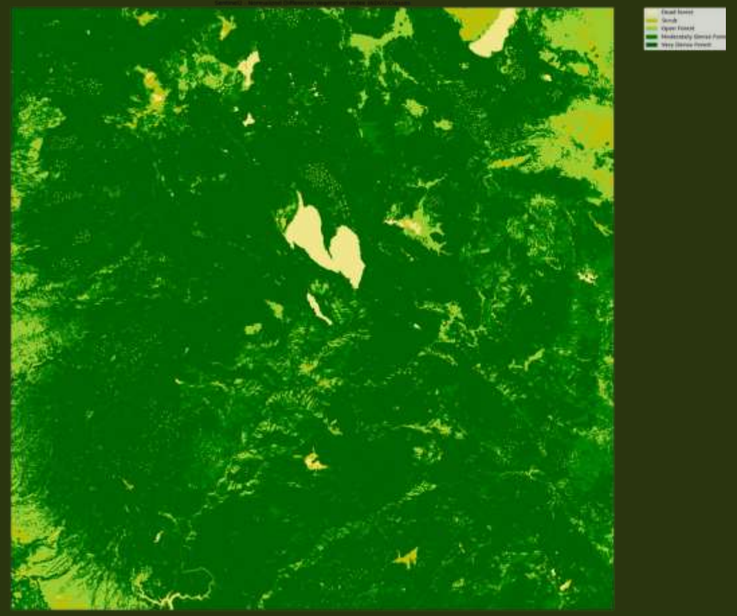
It leads to loss of biodiversity, disrupts ecosystems, contributes to climate change, and increases risks of natural disasters like floods and soil erosion.

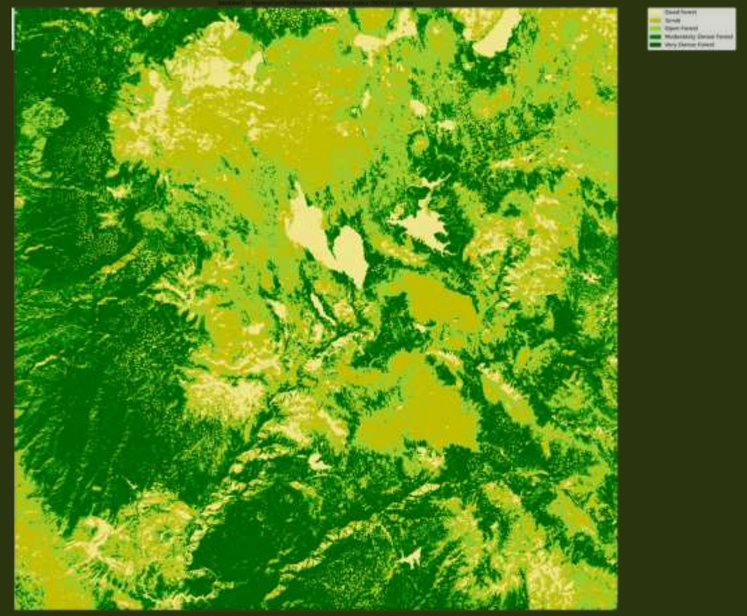
Introduction



- Deforestation, driven by human activities and natural events, devastates ecosystems, impacts climate patterns, and accelerates global warming and biodiversity loss.
- Rising deforestation rates threaten environmental sustainability, with forest fires and logging disrupting landscapes.
- Detecting and monitoring forest cover changes over time can aid conservation efforts, helping identify affected regions and implement timely interventions.
- Using satellite imagery, this project analyzes temporal forest cover changes, revealing deforestation patterns across landscapes.

Objective





Develop a method to accurately identify and visualize deforested areas over time using satellite imagery to assess forest loss.

Calculate and analyze the rate of forest cover change across time intervals to understand deforestation trends and patterns.

Appraoch

Setting Up the Environment

- Setting up the environment in SageMaker Studio Lab, selecting or uploading a YAML configuration file.
- Once configured, either install packages manually or import them to manage and analyze geospatial data effectively.

Data Retrieval and Preparation

- Sentinel-2 geospatial data is accessed from the AWS registry to analyze deforestation using temporal detection.
- Define search coordinates, choose cloud-free tiles, and set a time window, optimizing for minimal cloud cover to ensure accurate data analysis.

Spectral Analysis with Sentinel-2

- Download specific spectral bands, like visible, NIR, and SWIR, to calculate indices such as NDVI.
- Use these indices to distinguish between healthy and damaged vegetation, providing insights into changes across the observed area.

Visualizing Vegetation Indices

- Utilize earthpy to plot NDVI indices, classifying the spectral data into bins.
- Through visualization, identify vegetation conditions over time, distinguishing areas with significant deforestation.

References we are going through..

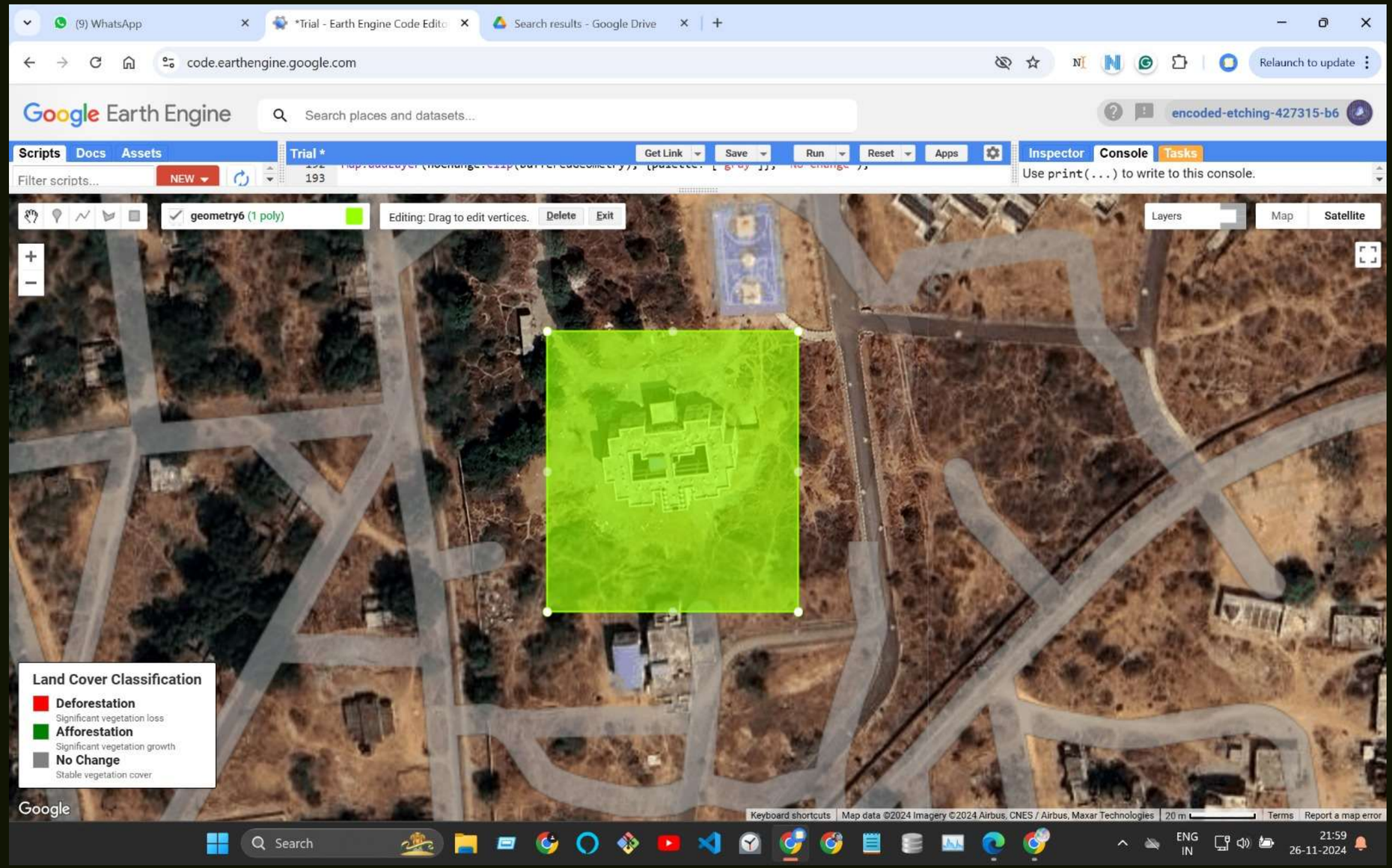
How people are approaching in literature on all kinds of dataset

How to use AWS SageMaker to retrieve data from Sentinel Hub and build proof of concepts for detailed analysis of any location.

Working and Demonstration

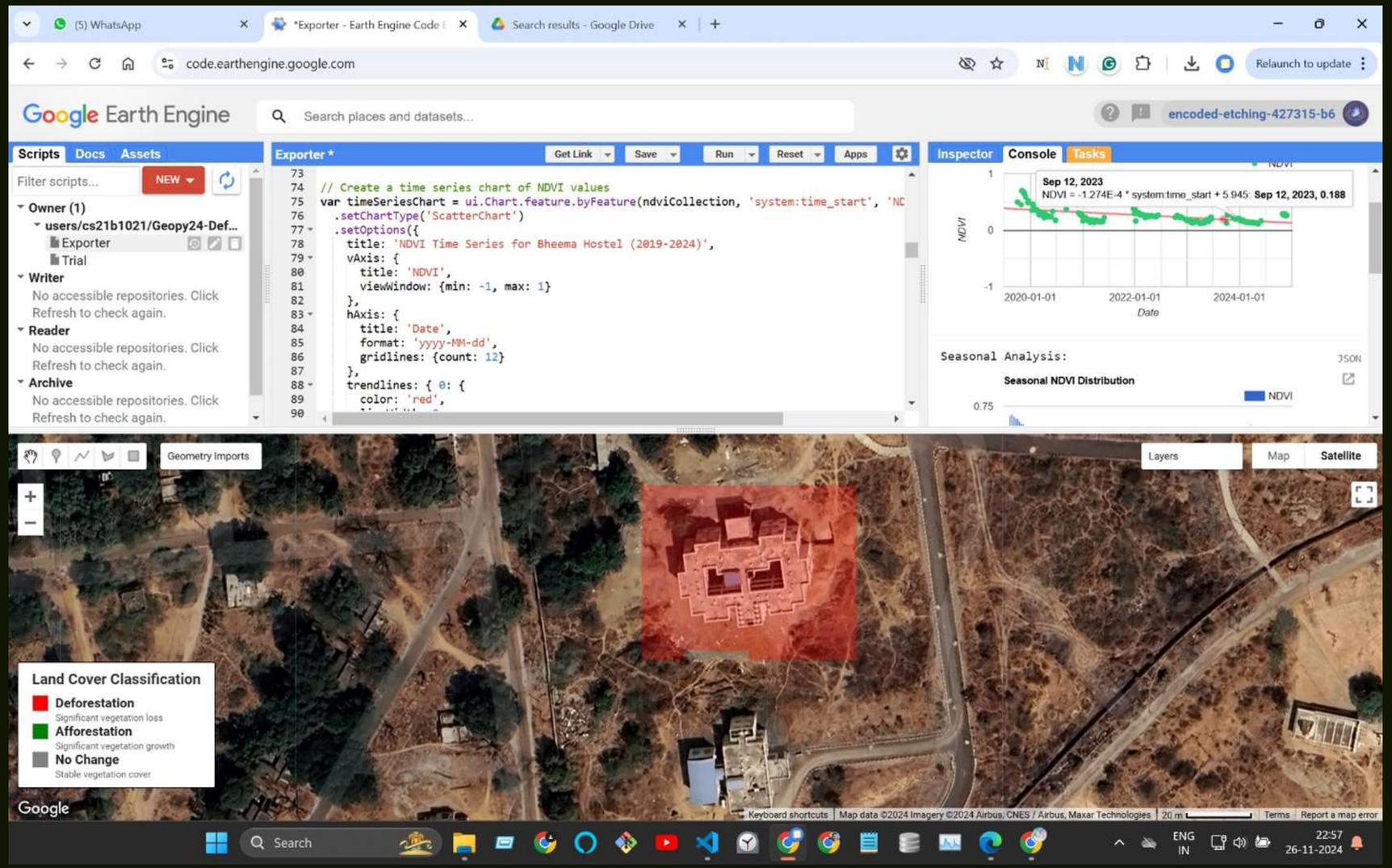
Step-1

Defining the study area



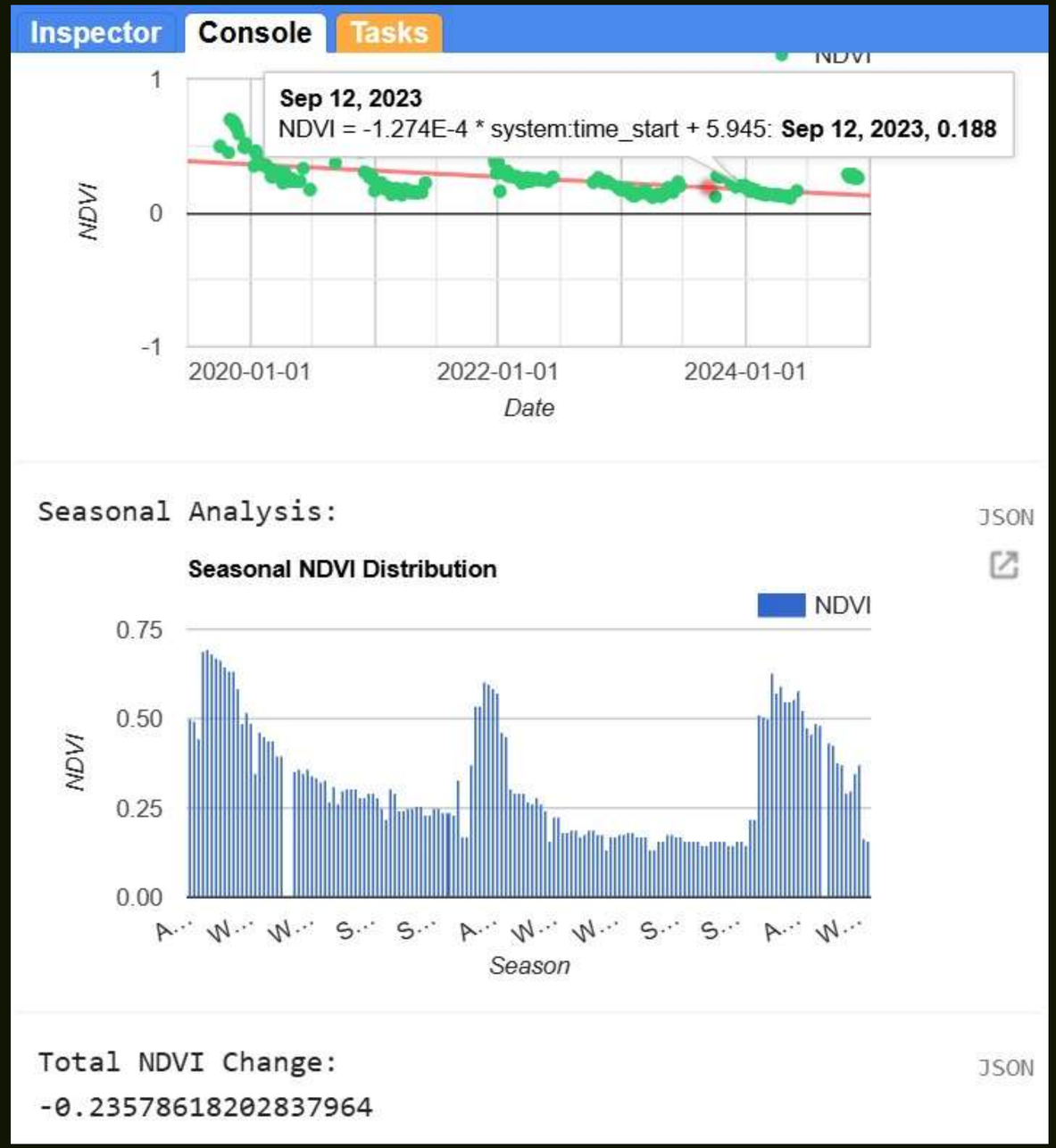
Step-2

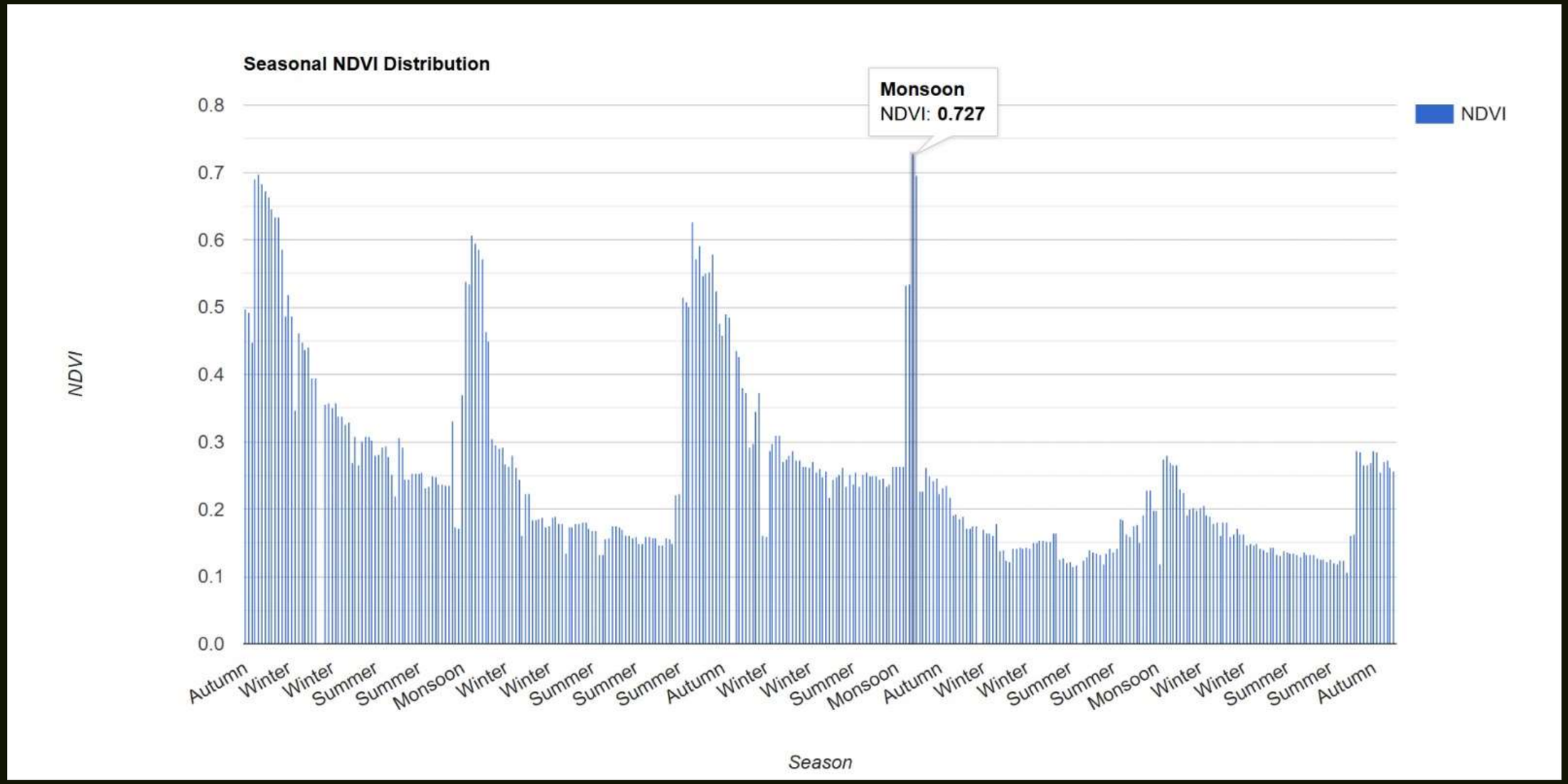
A visualization showing areas categorized into deforestation, afforestation, and stable zones based on NDVI change analysis.



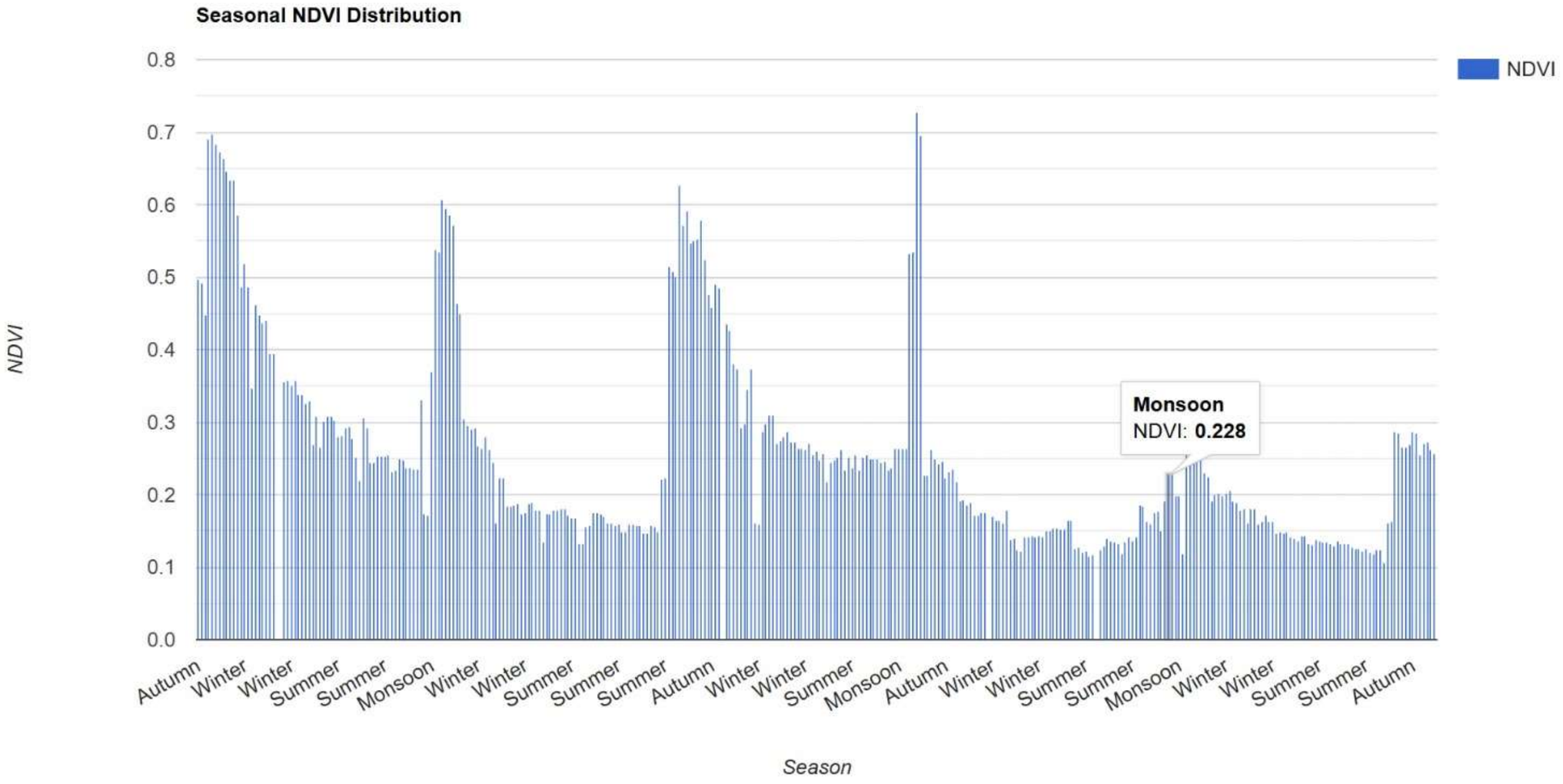
Step-3

These visualizations provide insights into NDVI distribution and trends, enhancing the understanding of vegetation health changes.

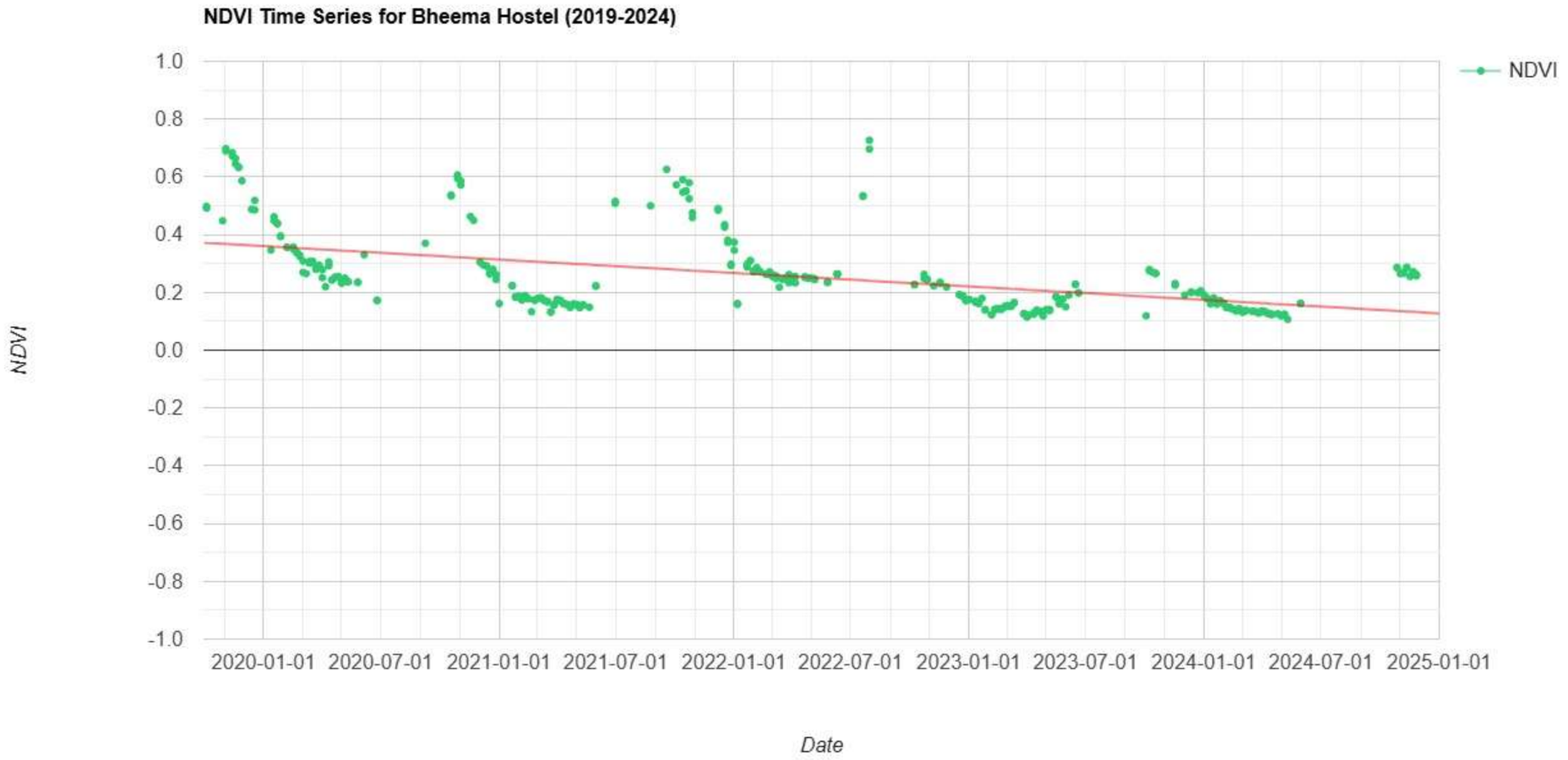




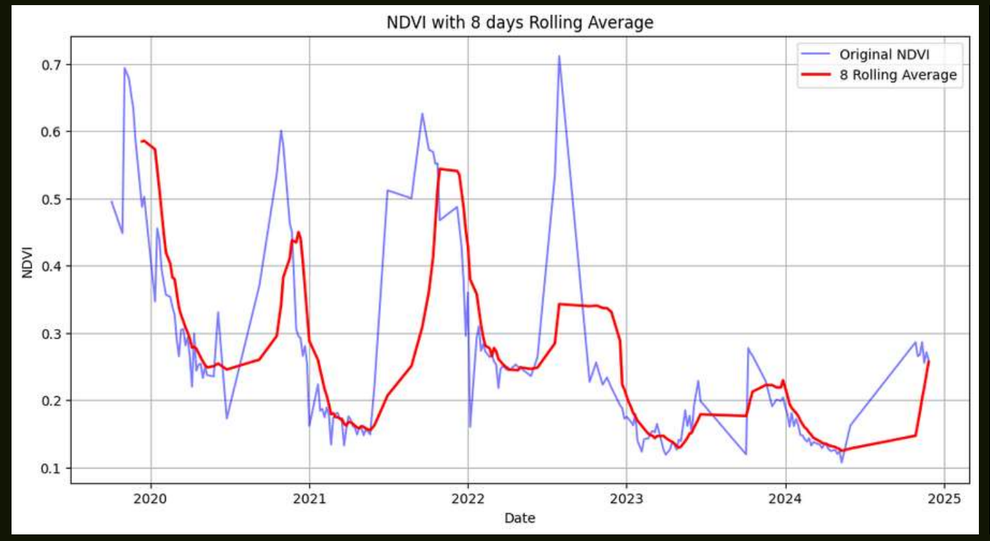
The peak NDVI before construction (July 30, 2022) was 0.726, indicating dense vegetation

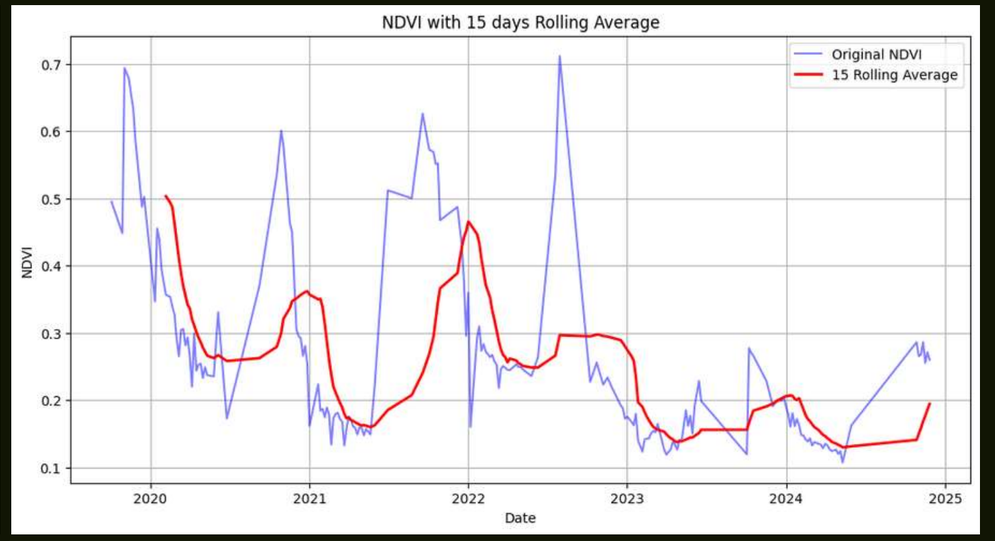


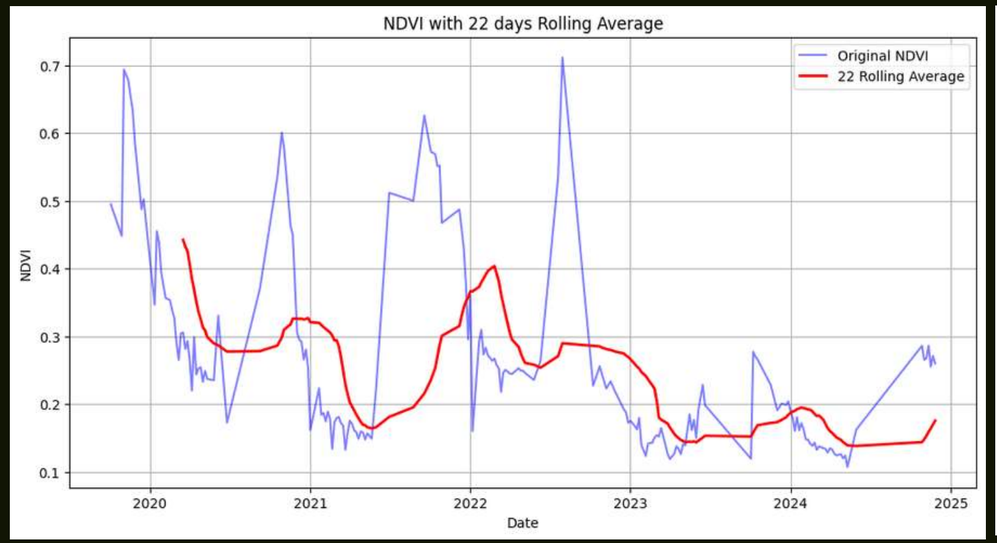
After construction (July 15, 2023), it dropped significantly to 0.288 due to vegetation clearance for development.

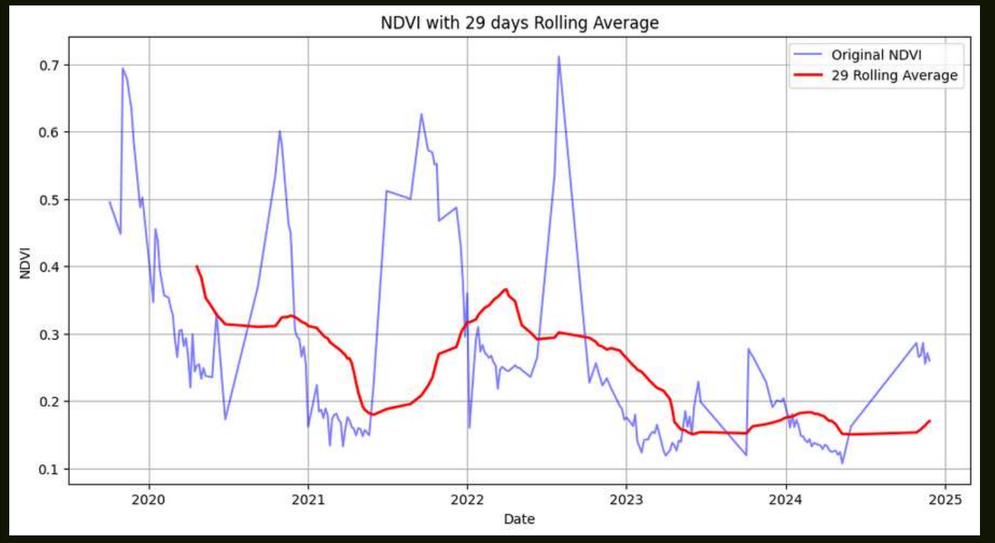


This chart depicts vegetation health trends over the study period, highlighting seasonal variations and long-term changes.

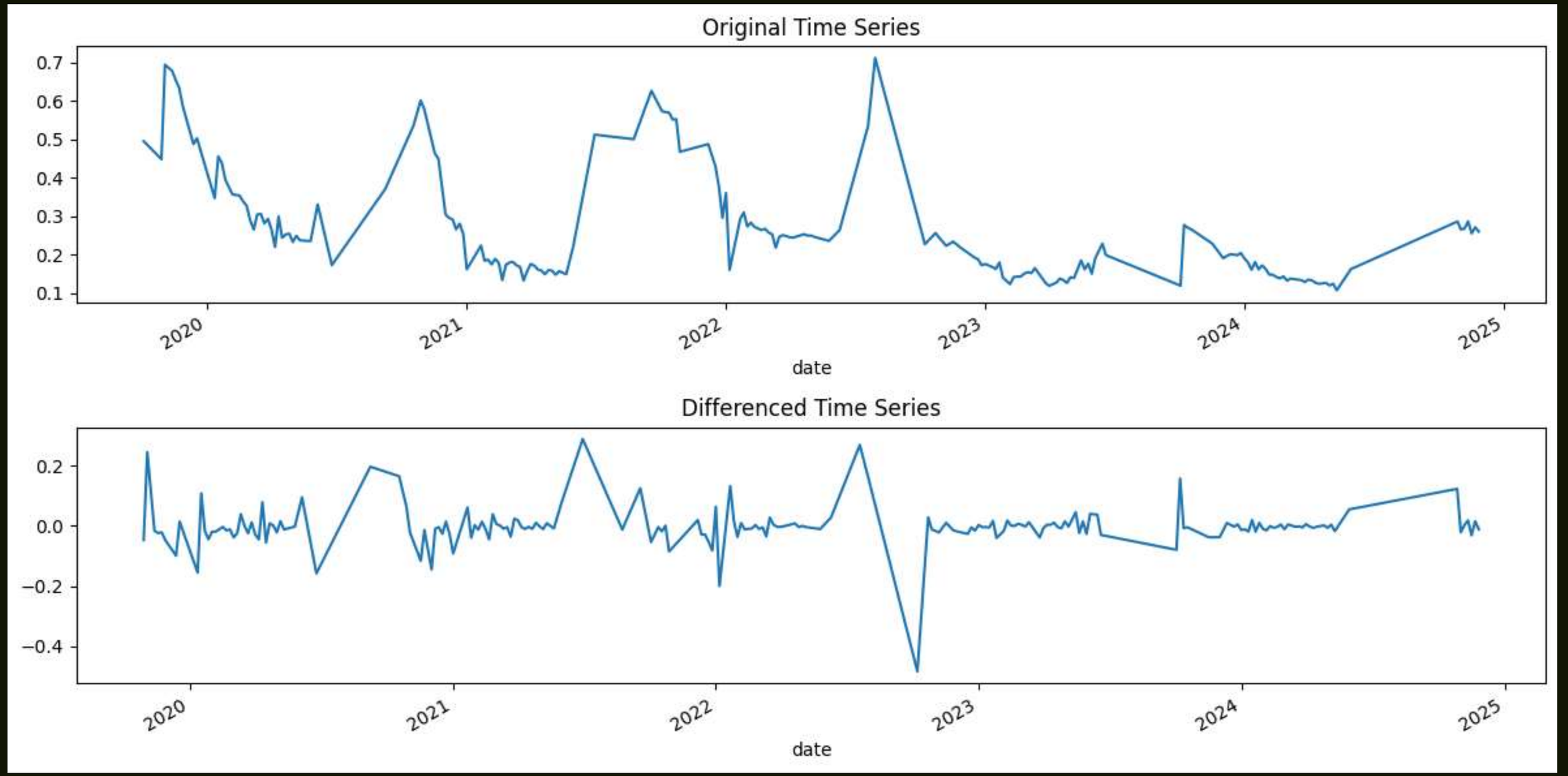




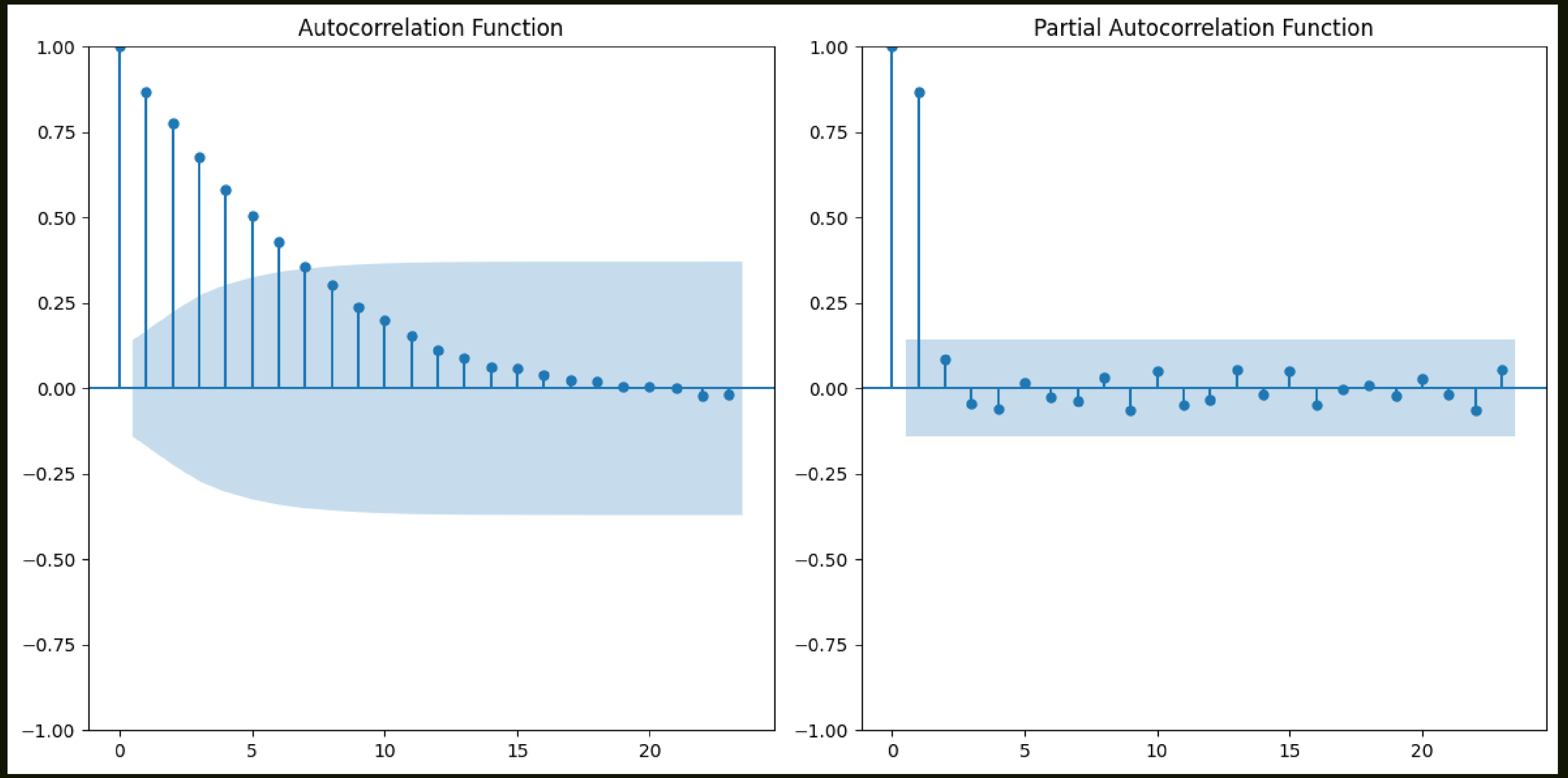




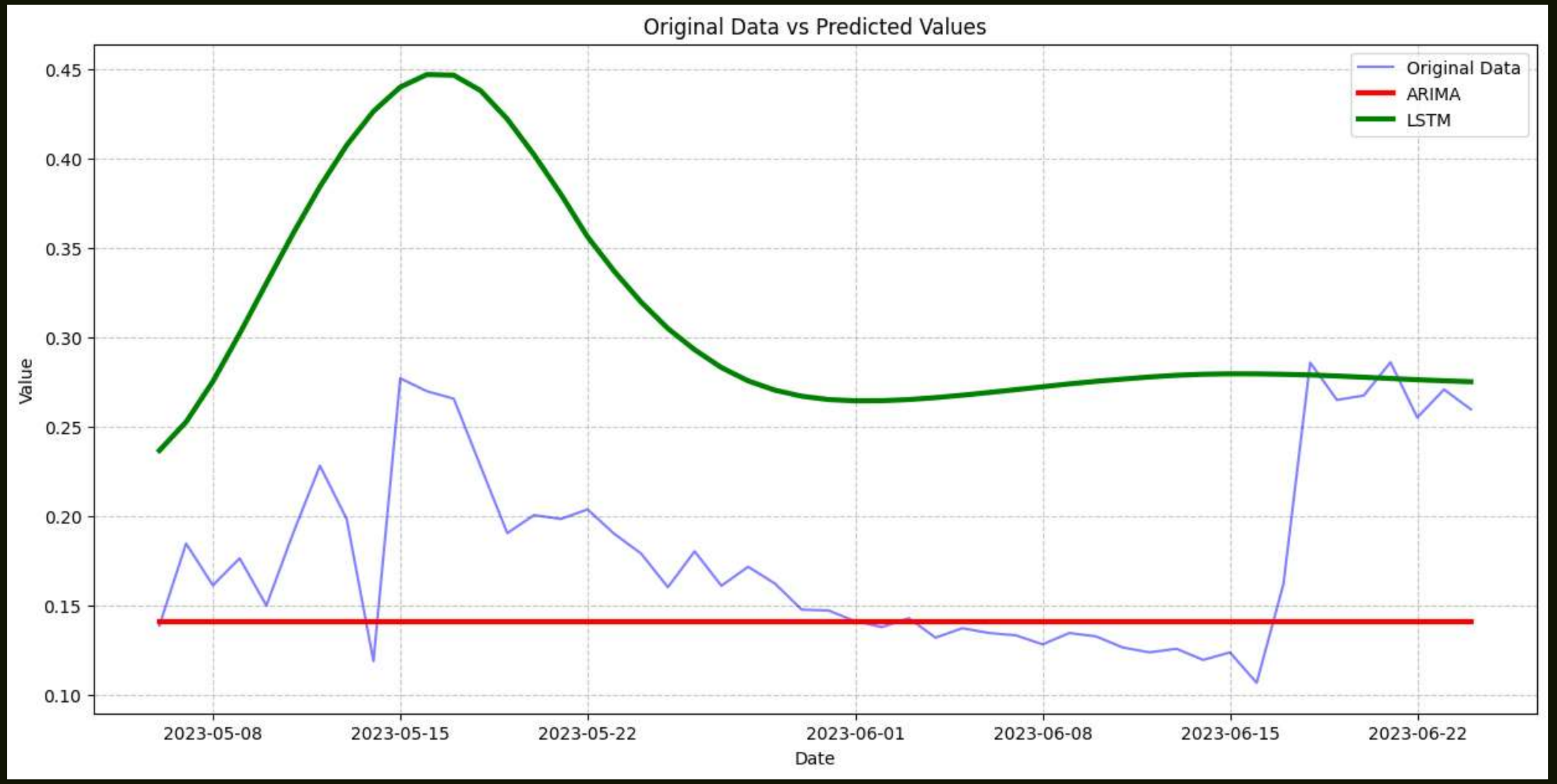
Comparison of rolling averages with window sizes of 8, 16, 22, and 29 days. Rolling averages help smooth noisy data, revealing clearer trends. Among these, the 8-day and 14-day rolling averages perform best, striking a balance between smoothness and fidelity to the data. Larger window sizes tend to over-smooth and obscure finer details in the dataset



Transformation of the dataset into a stationary time series through differencing: Stationarity ensures that statistical properties like mean, variance, and autocorrelation remain consistent over time, which is crucial for reliable modeling and forecasting in time series analysis



Autocorrelation helps identify the seasonality hyperparameter *m* for optimal results. A greater distance from the zero line indicates stronger correlation. Partial autocorrelation typically exhibits an exponential decay, with the highest correlations observed at lags 2 and 3 (it is always 1 at lag 0 by default)



LSTM fits the data and its shape better tham ARIMA across same strech of testing data

Future Scope

Real-time Deforestation Alerts: Advanced technology will enable real-time alerts for immediate response to forest loss.

Support for Conservation Policies: Accurate data can inform policies, helping governments protect forests and reduce carbon emissions.

Thank You

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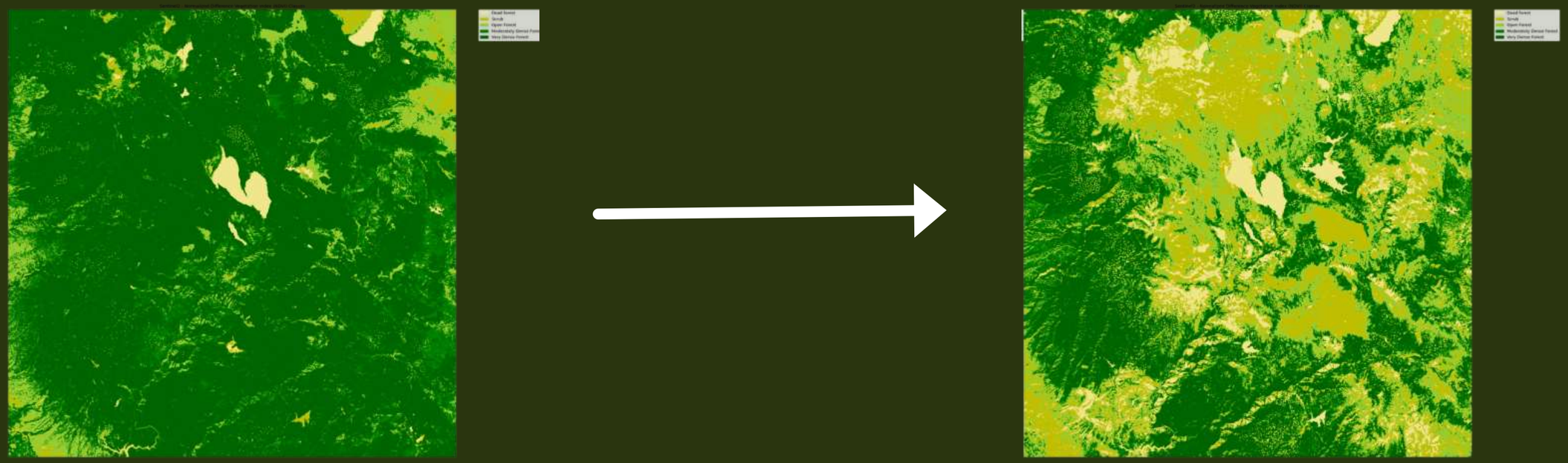
Forest Cut Temporal Detection

- **Objective**



Develop a method to accurately identify and visualize deforested areas over time using satellite imagery to assess forest loss accounting for existing vegetation spread.

→

Calculate and analyze the rate of forest cover change across time intervals to understand deforestation trends and patterns.