



2025

SATELLITE MONITORING REPORT

LT-007-SPA-072023 CÁCERES, SPAIN
Ecological restoration in Alia, Cáceres, Spain
Life Terra

April, 2025





I. GENERAL INFORMATION

Project name	Ecological Restoration in Alia, Caceres (Spain)
aOCP Registered Project ID	LT-007-SPA-072023 CACERES, SPAIN
Name of the Project Proponent	Life Terra
Name of authorized representative of the Project Proponent	Sven Kallen
Project start date	May 2023
Project end date	May 2062
aOCP Scopes in which the project participates	<input checked="" type="checkbox"/> Greenhouse gases <input checked="" type="checkbox"/> Biodiversity <input checked="" type="checkbox"/> Water <input type="checkbox"/> United Nations Sustainable Development Goals

II. MONITORING INFORMATION

Start of monitoring period	December 2024
End of monitoring period	March 2025
Duration of monitoring period (months)	4
Number of monitoring period (consecutive). Considers both onsite and remote monitoring campaigns.	1
Objective of this monitoring campaign	Generate the project baseline
Monitoring approach	<input type="checkbox"/> On-site (yearly) <input checked="" type="checkbox"/> Remote sensing (satellite images, acoustic sensors, etc) (quarterly)



III. METHODOLOGY

The quarterly remote sensing procedure forms a critical component of the monitoring framework for restoration and reforestation projects. This procedure aims to systematically evaluate changes in vegetation health and coverage over time, providing insights into the effectiveness of project interventions.

To establish baseline conditions, satellite imagery spanning six months prior to the project's implementation is acquired. These pre-project images are analyzed to calculate vegetation indices, which serve as reference points for assessing changes in vegetation cover and condition during subsequent monitoring phases.

After project implementation, satellite images are obtained quarterly to track and evaluate the progress of restoration or reforestation activities. This involves Randomly generated sampling points selected within the project area. The number of points is determined proportionally to the size of the project area to ensure representative coverage during assessments.

Sentinel-2 multi-spectral images, with a spatial resolution of 10 meters, are utilized due to their high-quality data, frequent revisit times, and suitability for vegetation analysis. Only images with cloud cover below 30% are selected to ensure accurate and reliable results.

The vegetation indices implemented for the purpose of this assessment are the Normalized Difference vegetation Index (NDVI) and the Green Normalized Difference Vegetation Index (GNDVI).

III.1. NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI).

The Normalized Difference Vegetation Index (NDVI) is a widely used indicator for assessing vegetation health, density, and photosynthetic activity. It is calculated using the formula:

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$

where NIR is the near-infrared reflectance (band 8 in Sentinel-2 imagery), and RED is the red-light reflectance (band 4 in Sentinel-2 imagery).

NDVI leverages the contrast between strong near-infrared reflection (high in healthy vegetation) and low red-light reflectance (absorbed by chlorophyll during photosynthesis). Higher NDVI values indicate dense, healthy vegetation, while lower values suggest sparse or stressed vegetation. This index is instrumental in monitoring vegetation phenology, tracking land use and cover changes, and detecting natural events such as droughts. By analyzing NDVI time series, we can gain insights into long-term trends and seasonal variations in vegetation, making it an essential tool for restoration monitoring.



III.2. GREEN NORMALIZED DIFFERENCE VEGETATION INDEX (GNDVI).

The Green Normalized Difference Vegetation Index (GNDVI) complements NDVI by providing enhanced sensitivity to chlorophyll levels in vegetation. It is calculated using the formula:

$$GNDVI = \frac{(NIR - GREEN)}{(NIR + GREEN)}$$

where NIR is the near-infrared reflectance (band 8 in Sentinel-2 imagery), and GREEN is the green-light reflectance (band 3 in Sentinel-2 imagery).

GNDVI measures "greenness" or the photosynthetic activity of vegetation. It is particularly useful for assessing nitrogen uptake and water content in the plant canopy, making it a valuable indicator for evaluating plant health and crop productivity. By combining GNDVI with NDVI, we gain a more comprehensive understanding of vegetation conditions, enabling more nuanced monitoring of restoration progress and ecosystem recovery.

Figure 1 illustrates the project area and the corresponding sampling points utilized for the current analysis. These points, along with the processed satellite imagery, facilitate an in-depth evaluation of vegetation dynamics, enabling the identification of progress and areas requiring further intervention.

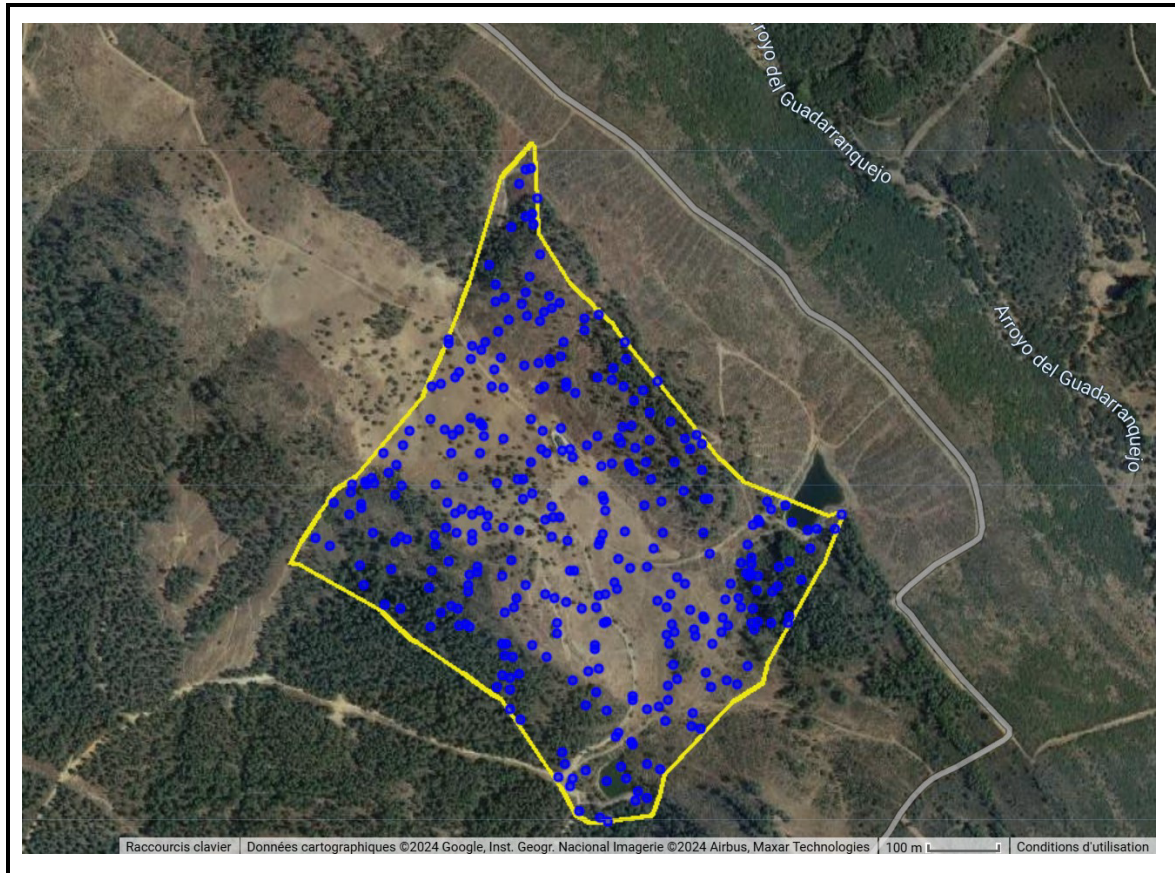
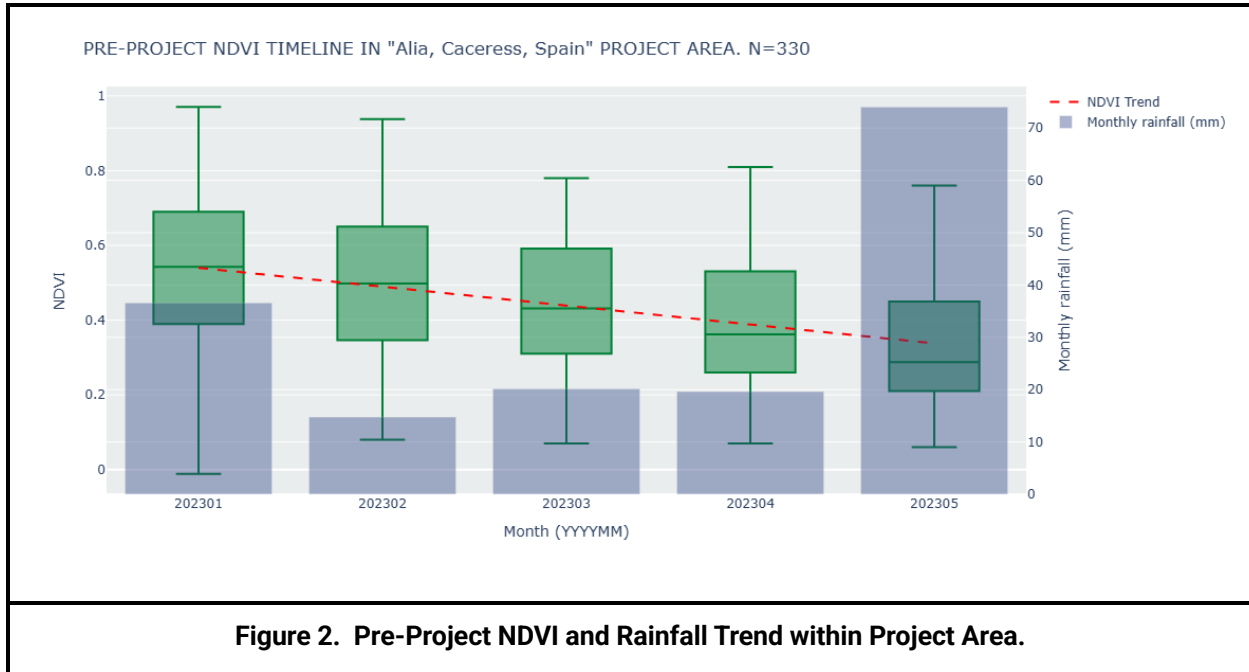


Figure 1. Project area and sampling points used for the NDVI analysis.

IV. BASELINE (2023 BEFORE PROJECT IMPLEMENTATION)

During the baseline phase of 2023, the NDVI and GNDVI values indicate a gradual decline in vegetation health and density within the project area. Starting with relatively higher values in January (NDVI: 0.53, GNDVI: 0.55), there is a consistent decrease through the months, reaching the lowest levels in May (NDVI: 0.33). The GNDVI shows a similar trend. The overall mean NDVI of 0.44 and GNDVI of 0.50 reflect moderate vegetation activity typical of the area but reveal a need for intervention to maintain or improve plant health.



2023	January	February	March	April	May	Mean
NDVI	0.53	0.50	0.45	0.39	0.33	0.44
GNDVI	0.55	0.50	0.49	0.45	-	0.50

V. THIRD-QUARTER MONITORING (2024)

The third quarter shows a gradual recovery in vegetation health within the project area, as evidenced by increasing NDVI and GNDVI values. NDVI rises from 0.32 in August to 0.51 in November, indicating a revival of plant cover and density. GNDVI also exhibits an upward trend, improving from 0.39 in August to 0.49 in October. These increases coincide with potential seasonal improvements such as the onset of rains supporting vegetation growth. The absence of data for November and December limits a complete understanding of the year-end conditions, but the mean NDVI of 0.41 and GNDVI of 0.43 for the period suggest a return to healthier vegetation activity compared to the mid-year decline.



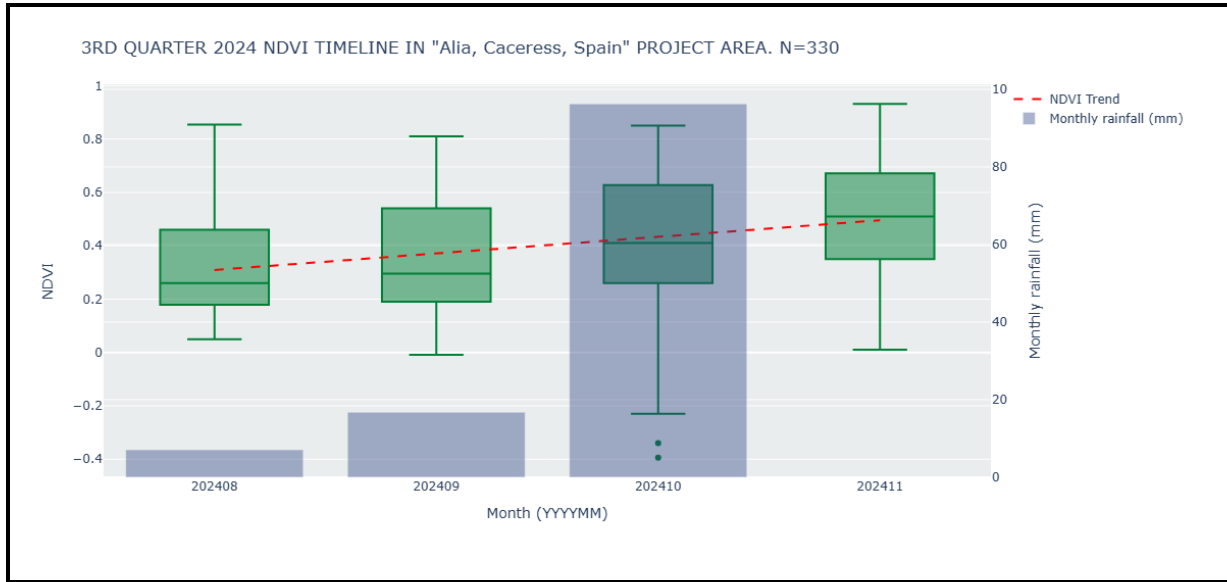


Figure 3. 2024 3rd Quarter NDVI and Rainfall Trend within Project Area.

2024	August	September	October	November	December	Mean
NDVI	0.32	0.36	0.43	0.51	-	0.41
GNDVI	0.39	0.42	0.49	-	-	0.43

VI. FIRST-QUARTER MONITORING (2025)

The first-quarter vegetation monitoring results for the 2024/2025 period reflect continued improvement in vegetative health and cover within the restoration project area, particularly when compared to both the 2023 baseline and the previous quarter (Q4 2024).

NDVI increased from a baseline mean of 0.44 (Jan–May 2023) to 0.57 (Dec–Mar 2024/2025). The GNDVI, while slightly variable, shows an overall comparable mean (0.50 in 2023 vs. 0.46 in current Q1), despite a dip in December and March.

Comparison with Previous Quarter (Q4 2024) shows NDVI rose from a Q4 mean of 0.41 to 0.57 in Q1 of 2025, indicating a significant increase in vegetative cover.

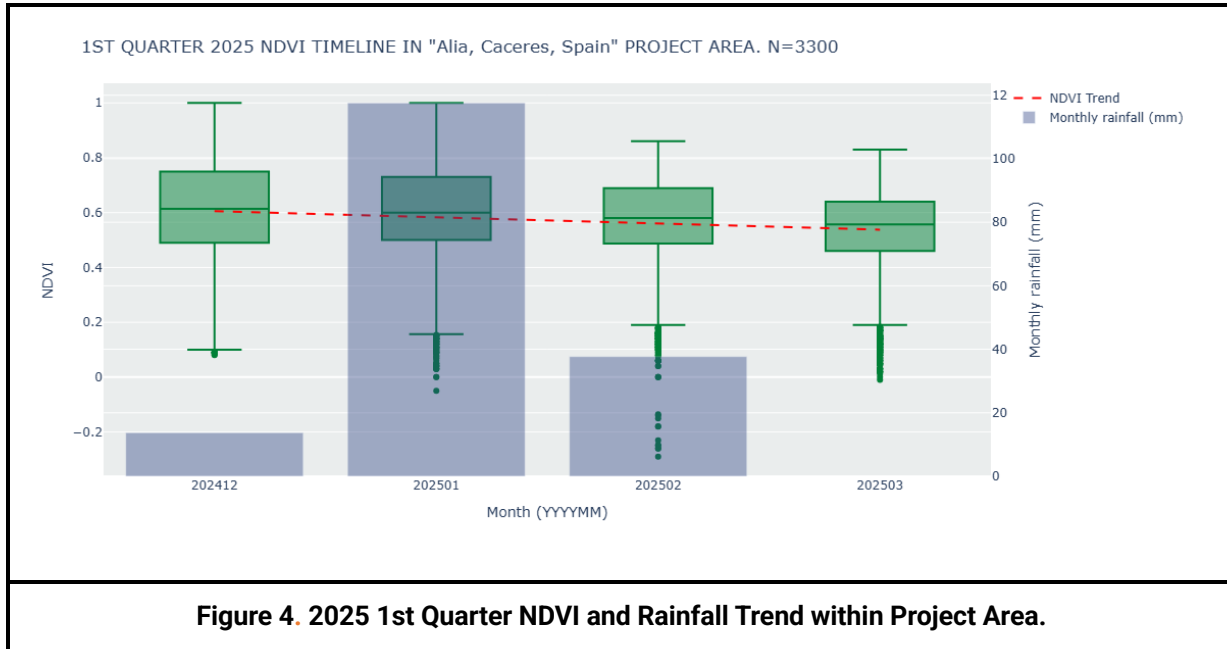
GNDVI also improved slightly, from 0.43 to 0.46, suggesting sustained or increasing photosynthetic activity despite seasonal limitations.





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The increase in NDVI from both the pre-restoration baseline and preceding quarter signals that the project is progressing steadily toward its restoration goals. The GNDVI values show more fluctuation, potentially due to seasonal stress or species composition, but remain within healthy ranges overall.



2024/2025	December	January	February	March	Mean
NDVI	0.60	0.59	0.56	0.53	0.57
GNDVI	0.38	0.60	0.57	0.28	0.46

VII. GLOBAL VARIATION

To accurately evaluate the evolution of NDVI within the project area, it is crucial to establish control areas in the vicinity. These control areas are selected within a defined buffer zone surrounding the project site, ensuring their environmental and ecological conditions are comparable to those of the project area. The selection of suitable control areas allows for a robust comparative analysis, distinguishing the effects of project interventions from natural or external factors influencing vegetation trends. This method ensures that observed changes in NDVI and



vegetation health can be confidently attributed to the project activities rather than broader regional variations or unrelated environmental factors.

Figure 5 illustrates the control areas and sampling points strategically identified for this assessment. These sampling points within the control areas provide a representative dataset for tracking vegetation dynamics over time.

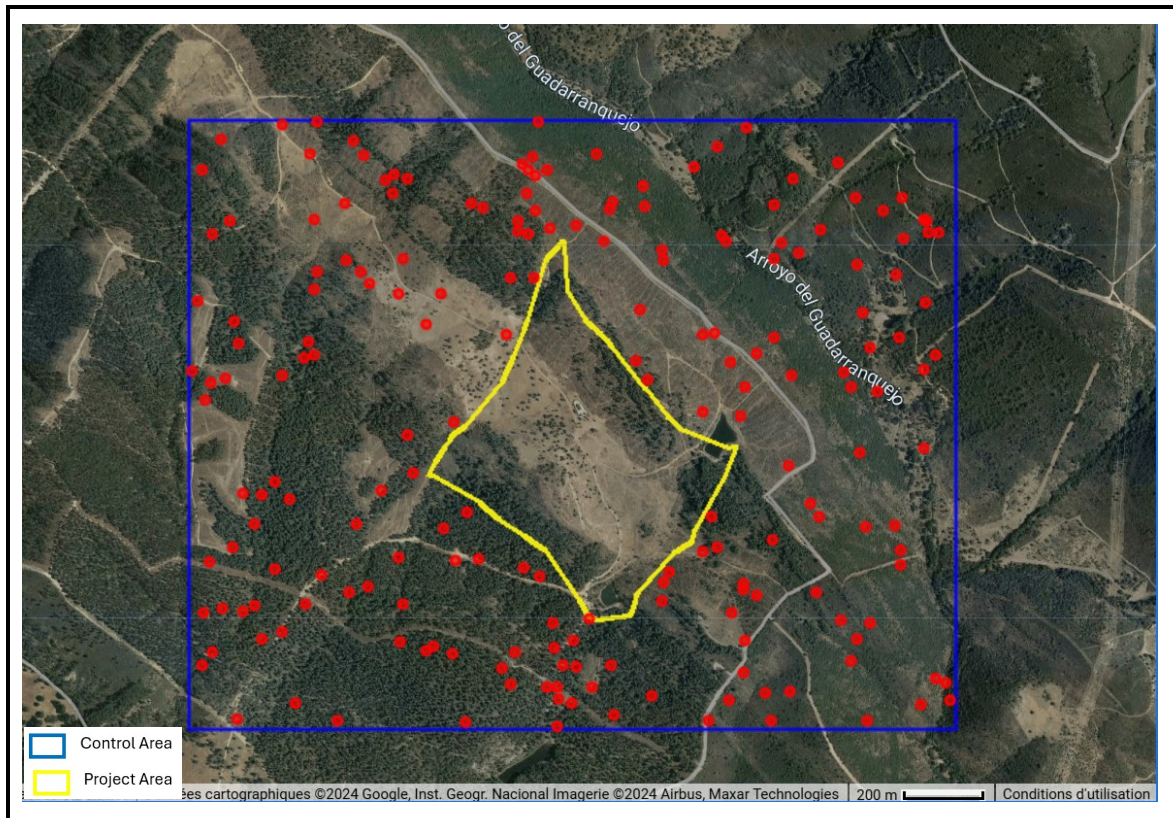


Figure 5. Selected Control Area and Sampling Points

Figure 6 presents the spatial distribution of NDVI values for two key monitoring periods: the pre-project baseline and the first quarter of 2025. During the baseline phase, the project area exhibited significantly lower NDVI values compared to the surrounding landscape, highlighting the limited vegetative cover relative to the more established vegetation in adjacent control zones. By the first quarter of 2025, approximately 21 months after project implementation the NDVI distribution shows emerging signs of vegetative recovery within the project area. While this greening trend is modest, it suggests the early stages of ecosystem response to restoration interventions. The subdued improvement may reflect seasonal variability or external stressors influencing vegetation performance during this period.



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To further validate these spatial patterns and assess project effectiveness, a more granular evaluation using targeted sampling points within the project area and adjacent control sites is required.

To enable a more detailed assessment and comparison of vegetation dynamics between the project and control areas, sampling points within both areas were analyzed. These comparisons provide a quantitative basis for understanding changes in vegetation cover over time.

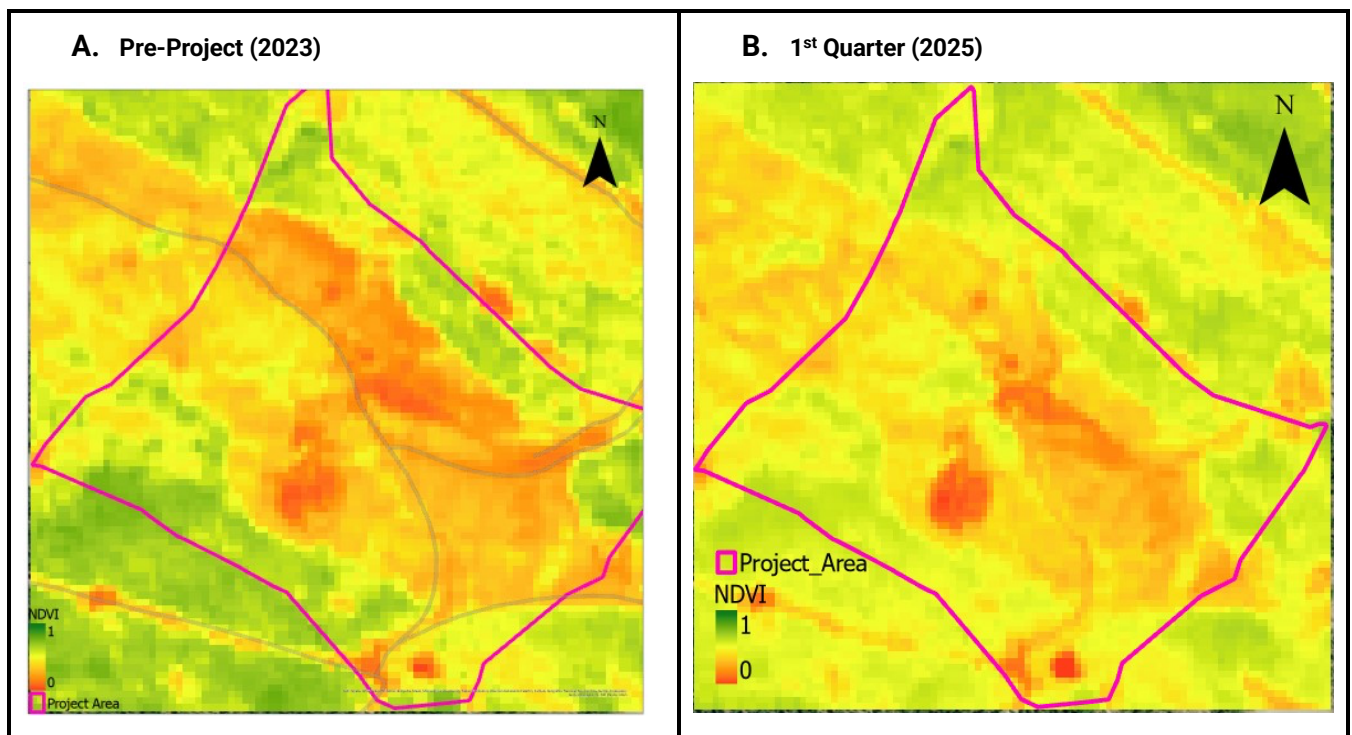


Figure 6. Spatial Evolution of NDVI Within Project area.

Vegetation indices for the project and control areas between December 2024 and March 2025 indicate a continued improvement in the project area, though some seasonal variation is observed (Figure 7). NDVI and GNDVI values in the project area remain consistently lower than those of the control area, which is expected given the more mature vegetative cover present in the latter. However, the gap between project and control values narrows during peak months (January and February), where project NDVI values reach 0.58 and 0.54, respectively compared to 0.69 and 0.64 in the control area.

The lower values observed in March (NDVI = 0.28) likely reflect seasonal environmental stress, such as reduced moisture or temperature fluctuations affecting photosynthetic activity. These results suggest that while the project area has not yet reached the vegetative density of the





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control site, positive trends in greening and vegetation establishment are evident, particularly during more favorable months.

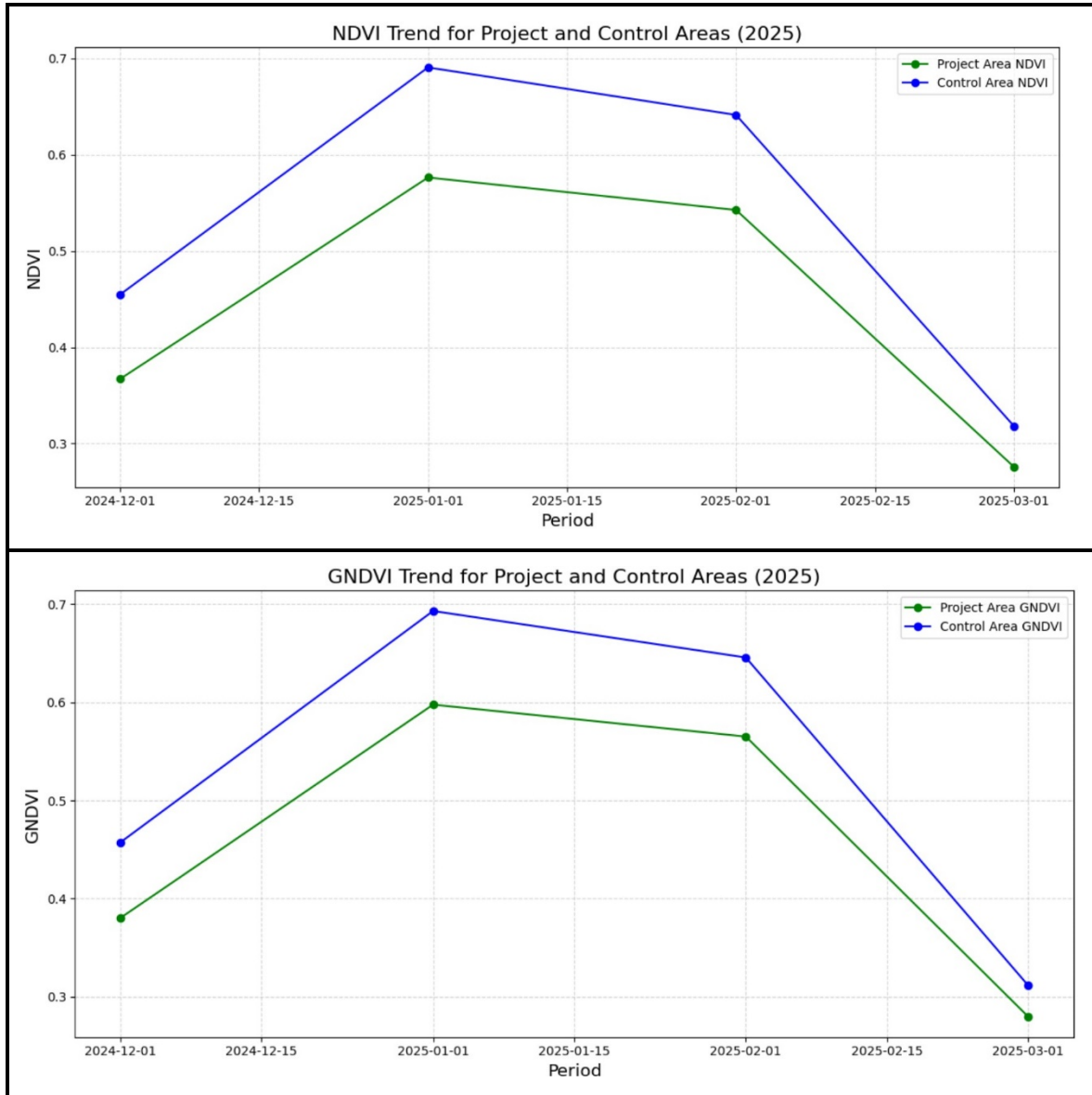


Figure 7. Comparison of NDVI and GNDVI trends between the project and control areas.





VIII. OBSERVATIONS AND COMMENTS

Date	Comments and observations
Pre-project (2023)	The values of NDVI and GNDVI in the year 2023 were relatively low, reflecting the sparse vegetation in the project area. The average NDVI was 0.44, and GNDVI was 0.50, consistent with baseline conditions before project implementation. These values indicate limited vegetative cover, underscoring the need for intervention.
March 2025	The first-quarter results demonstrate notable ecological gains within the restoration area. Vegetation indices indicate that the restored landscape is now outperforming its pre-project state, with improving trends in both vegetation density and photosynthetic activity.

IX. CONCLUSIONS

The upward trajectory in both NDVI and GNDVI values demonstrates the effectiveness of the restoration interventions. Continued monitoring will be essential to ensure sustained progress and to identify any seasonal or spatial variations requiring adaptive management. This positive trend reinforces the project's contribution to ecological recovery and carbon sequestration objectives.