2025

SATELLITE MONITORING REPORT

Manejo forestal en el Ejido La Cañita y Anexos, Durango

BA-004-MEX-24042024 EJIDO LA CAÑITA Y ANEXOS, DURANGO, MÉXICO

November, 2025

I. GENERAL INFORMATION

Project name	Manejo forestal en el Ejido La Cañita y Anexos, Durango
aOCP Registered Project ID	BA-004-MEX-24042024 EJIDO LA CAÑITA Y ANEXOS, DURANGO, MÉXICO
Name of the Project Proponent	Benito Acevedo
Project start date	August 2024
Project end date	August 2062
aOCP Scopes in which the project participates	☐ Greenhouse gases ☒ Biodiversity ☐ Water ☐ Soil

II. MONITORING INFORMATION

Start of monitoring period	August 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	☐ On-site (yearly) ☒ 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 four to 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.

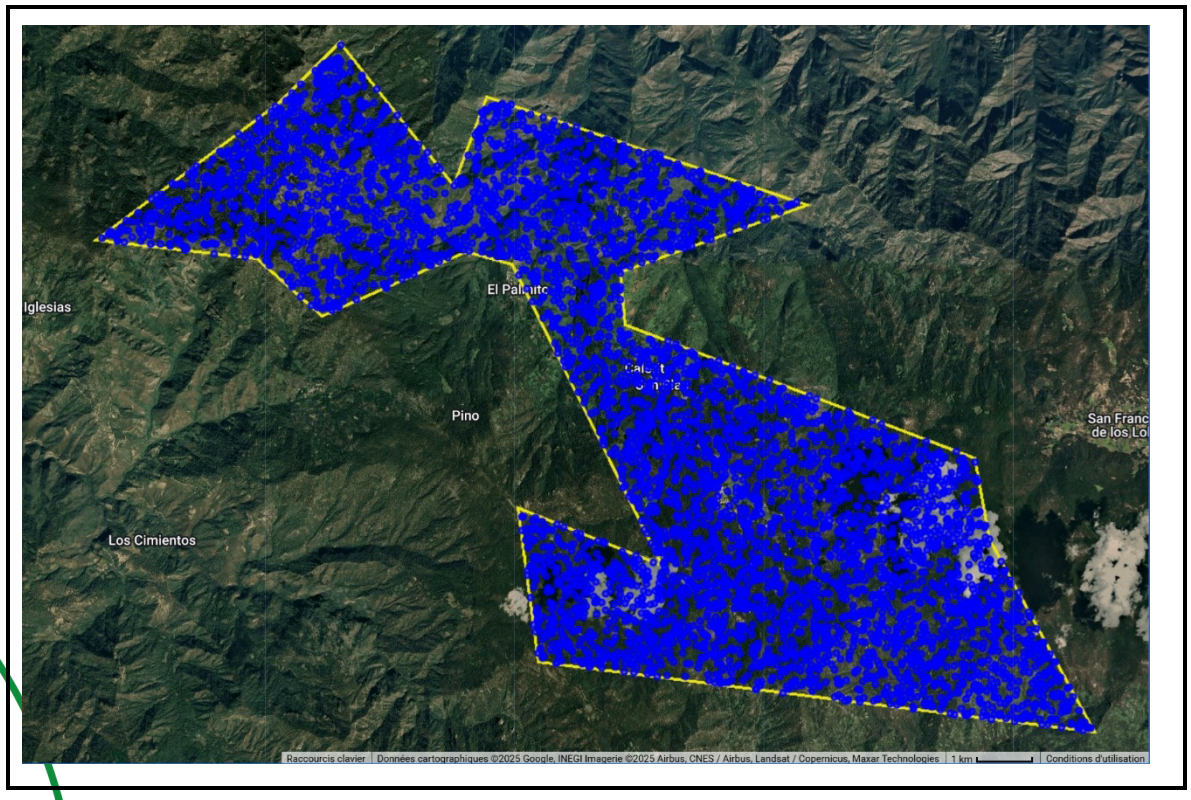


Figure 1. Project area and sampling points used for the NDVI analysis.

IV. BASELINE (2024 BEFORE PROJECT IMPLEMENTATION)

Baseline vegetation assessment conducted prior to the implementation of conservation measures (May–August 2024) indicates moderate vegetation cover and variable chlorophyll activity across the project area. The mean NDVI value of 0.57 reflects patchy and partly stressed vegetation conditions, while the mean GNDVI of 0.49 suggested relatively low photosynthetic activity and chlorophyll concentration. The month-to-month variability, with NDVI values ranging from 0.46 to 0.70, implies seasonal influence and uneven vegetation vigor across the landscape.

These baseline results provide an essential reference point against which subsequent improvements in vegetation health and cover observed during the 2025 monitoring periods could be evaluated.

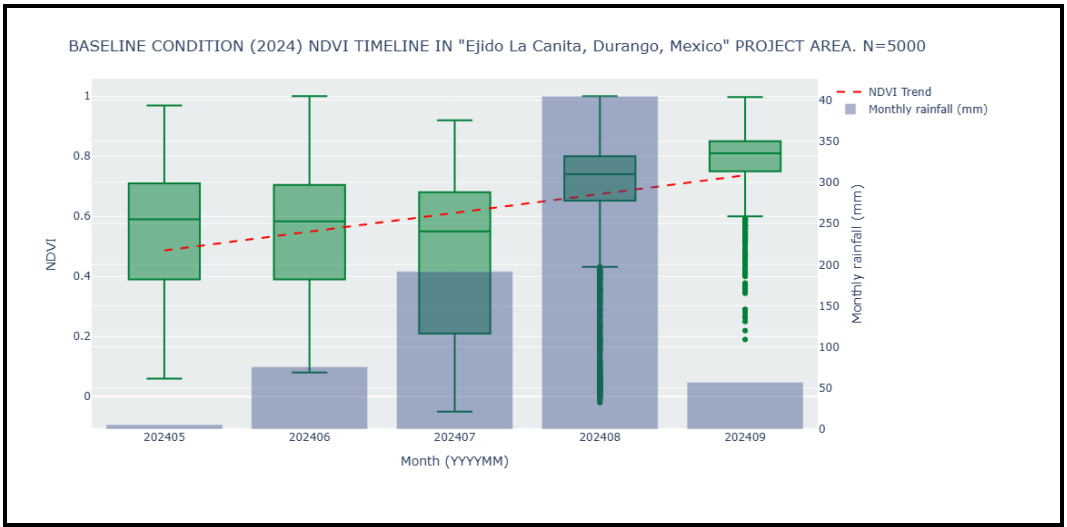


Figure 2. Pre-Project NDVI and Rainfall Trend within Project Area.

2024	May	June	July	August	Mean
NDVI	0.55	0.55	0.46	0.70	**0.57**
GNDVI	0.59	0.56	0.31	0.50	**0.49**

V. FOURTH-QUARTER MONITORING (2024)

The fourth quarter of 2024 maintains the high vegetation performance observed in the previous quarter, with mean NDVI and GNDVI values of 0.79 and 0.67, respectively. NDVI values remain stable, fluctuating minimally between 0.77 and 0.83, indicating a well-established and thriving vegetation cover. Similarly, GNDVI values remain high, peaking at 0.72 in November, which highlights ongoing photosynthetic activity and vegetation health.

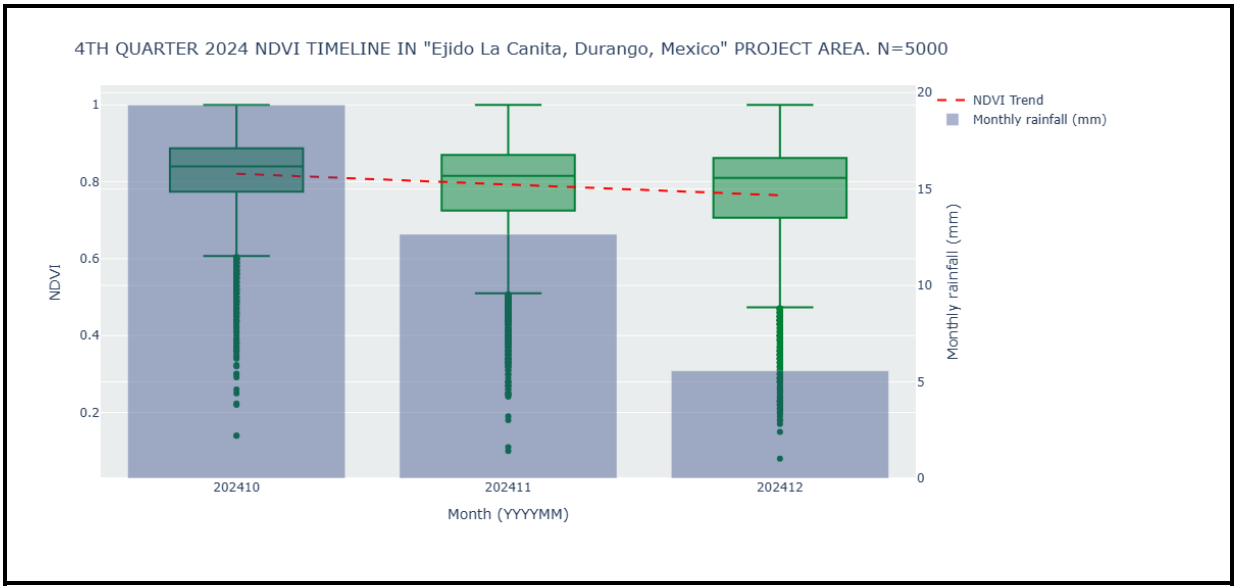


Figure 3. 2024 4th Quarter NDVI and Rainfall Trend within Project Area.

2024	October	November	December	Mean
NDVI	0.83	0.78	0.77	**0.79**
GNDVI	0.69	0.72	0.61	**0.67**

VI. FIRST-QUARTER MONITORING (2025)

The first-quarter monitoring of 2025 shows a seasonal decline in vegetation indices compared to the consistently high values observed in the fourth quarter of 2024. Mean NDVI decreased from 0.79 (Q4 2024) to 0.71, with values ranging from 0.67 in March to 0.74 in January.

Mean GNDVI also declined from 0.67 (Q4 2024) to 0.65. This fluctuation is likely attributable to seasonal climatic variations, such as lower temperatures, reduced sunlight, and potential

dormancy of some plant species during winter months. Despite the temporary decline, the indices remain within healthy ranges.

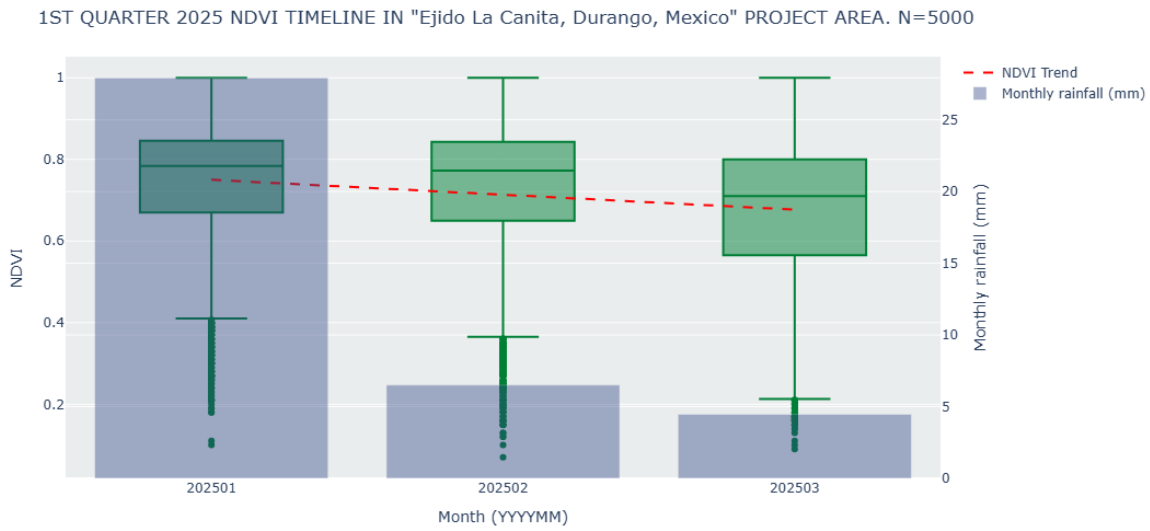


Figure 4. 2025 1st Quarter NDVI and Rainfall Trend within Project Area.

2025	January	February	March	Mean
NDVI	0.74	0.73	0.67	**0.71**
GNDVI	0.62	0.70	0.63	**0.65**

VII. SECOND-QUARTER MONITORING (2025)

The mean NDVI decreased from 0.71 in Q1 to 0.57 in Q2. Monthly values reveal a dip in May and June (0.55–0.59).

Also, the mean GNDVI decreased from 0.65 in Q1 to 0.53 in Q2, implying a reduction in chlorophyll concentration and photosynthetic activity during the mid-year period. Overall, these trends suggest that while vegetation cover remained relatively stable, slight stress or senescence occurred during early Q2, with recovery observed toward the quarter's end.

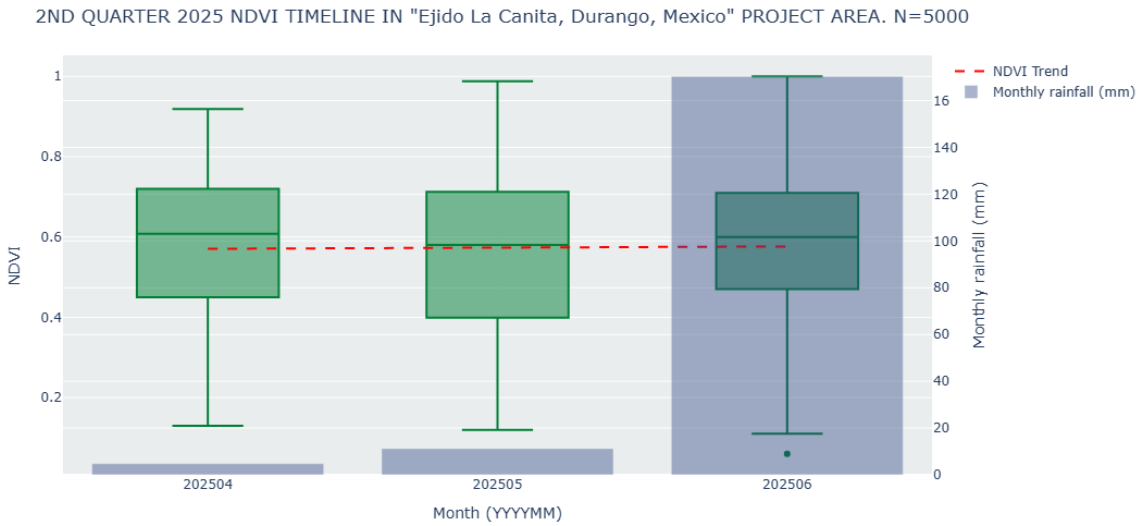


Figure 5. 2025 2nd Quarter NDVI and Rainfall Trend within Project Area.

2025	April	May	June	Mean
NDVI	0.58	0.55	0.59	**0.57**
GNDVI	0.57	0.56	0.47	**0.53**

VIII. THIRD-QUARTER MONITORING (2025)

The vegetation indices for the third quarter of 2025 demonstrate a notable improvement in overall vegetation vigor compared to the second quarter. The mean NDVI increased from 0.57 in Q2 to 0.73 in Q3, indicating enhanced vegetation density and greenness across the landscape. This upward trend, with values peaking at 0.75 in August, suggests a strong recovery and active growth phase, likely associated with favorable climatic or moisture conditions during this period.

Mean GNDVI of 0.53 was maintained compared to the previous quarter, reflecting stability in chlorophyll content and photosynthetic activity. The consistently high NDVI values through August and September further support the presence of sustained vegetation health and productivity during the late-year months. Overall, these results highlight a positive vegetation response following mid-year fluctuations, indicating improved ecosystem condition and resilience in the third quarter of 2025.

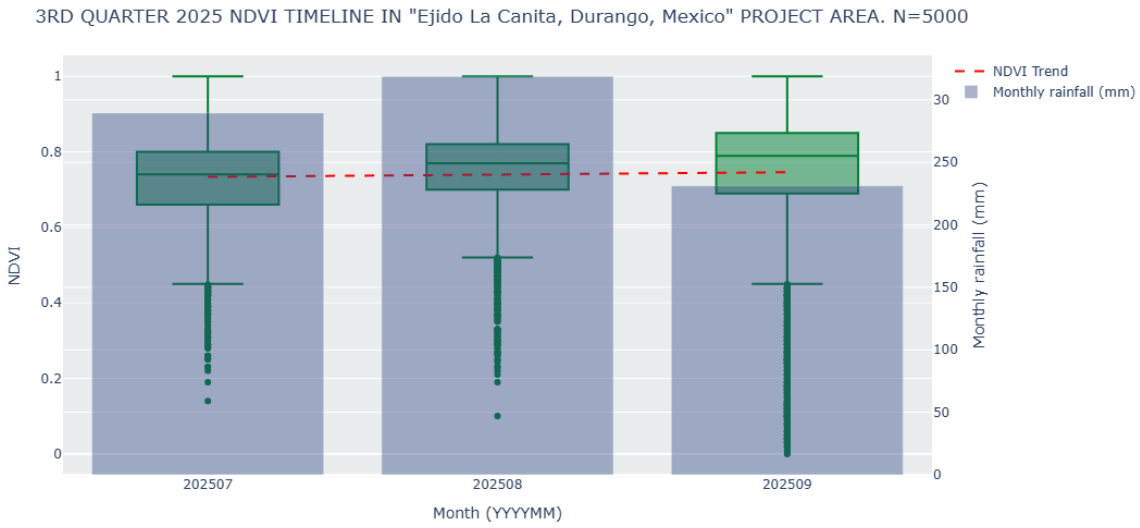


Figure 6. 2025 3rd Quarter NDVI and Rainfall Trend within Project Area.

2025	July	August	September	Mean
NDVI	0.73	0.75	0.75	0.73
GNDVI	0.57	0.57	0.44	0.53

IX. 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.

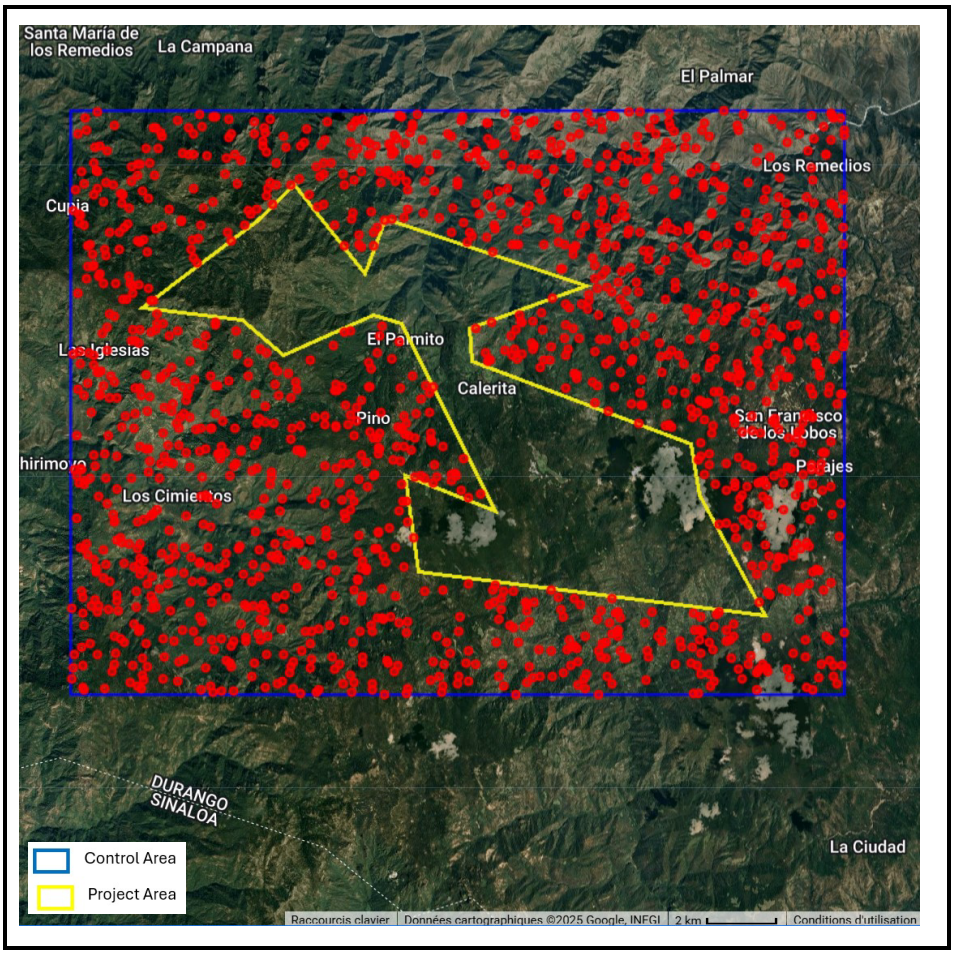


Figure 7. Selected Control Area and Sampling Points

Figure 8 presents the spatial distribution of NDVI across four key assessment periods: the pre-project phase and the first, second and third quarters of 2025.

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.

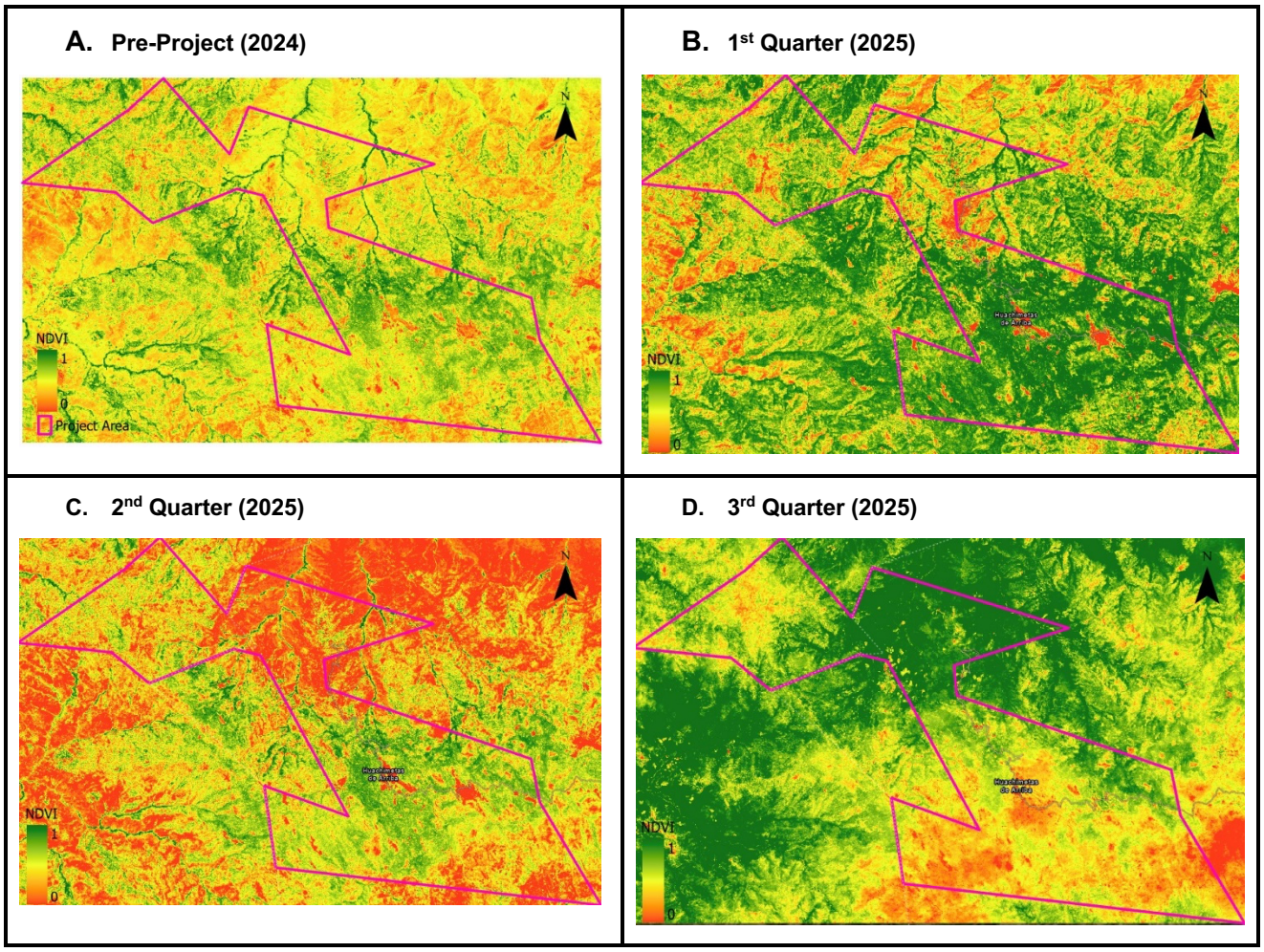


Figure 8. Spatial Evolution of NDVI Within Project area.

Comparative analysis of vegetation trends between the conserved project area and adjacent control areas from August 2024 to October 2025 indicates generally higher and more stable vegetation performance within the project site. Throughout most of the monitoring period, NDVI and GNDVI values in the project area were consistently comparable to or slightly higher than those in the control, with noticeable divergence during early 2025 when the project site exhibited higher NDVI (0.63 vs. 0.55–0.57) and GNDVI (0.57–0.62 vs. 0.46–0.53).

Both areas showed seasonal fluctuations, with dips around April–June corresponding to drier conditions, followed by recovery from July onward. By late 2025 (October), both zones displayed high NDVI values (>0.76), but the project area maintained slightly superior greenness levels (0.768 vs. 0.763).

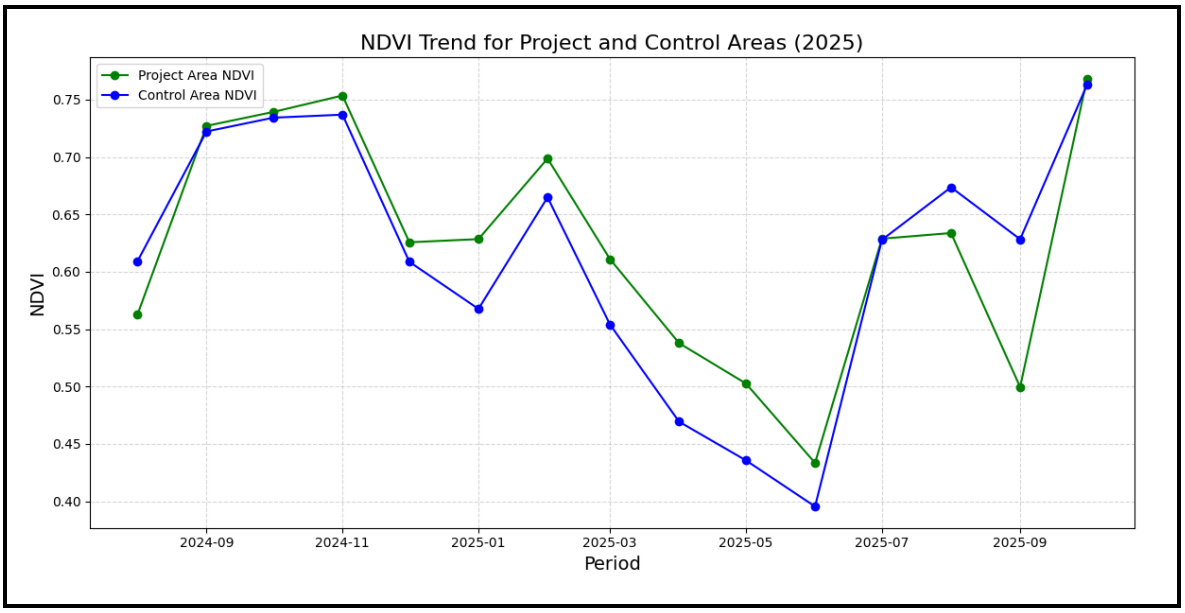


Figure 9. Comparison of NDVI trends between the project and control areas.

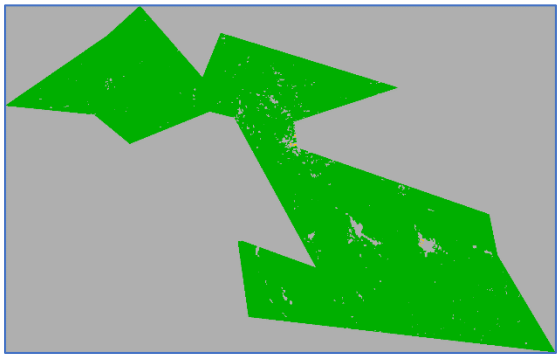
X. LANDSCAPE FRAGMENTATION ANALYSIS

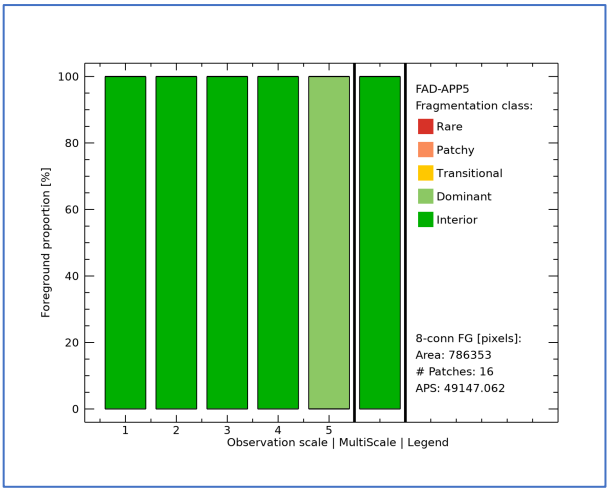
Landscape fragmentation refers to the process by which large, continuous habitats are divided into smaller and more isolated patches, often driven by anthropogenic pressures such as agricultural expansion, urbanization, and infrastructure development. Such fragmentation disrupts landscape connectivity, alters habitat composition, and can adversely impact biodiversity, ecological processes, and the delivery of ecosystem services.

In this report, fragmentation was assessed to evaluate whether the ecological connectivity within the project area remains intact or has been disrupted over time. The analysis compared fragmentation patterns between 2024 (baseline) and 2025 (monitoring year) to determine the extent of structural changes and the potential influence of conservation interventions on maintaining or improving landscape connectivity.

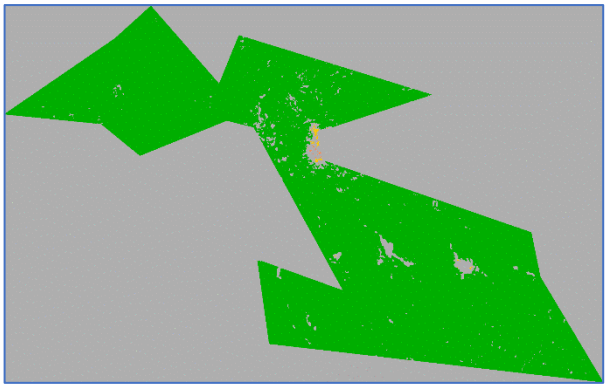
Using a binary (forested vs. non-forested) land cover map derived from Sentinel-2 imagery through supervised classification, the fragmentation analysis was conducted in GUIDOS Toolbox employing the Multiscale Analysis tool across five spatial scales (Vogt & Ritters, 2017), following the aOCP Methodology for the Evaluation of Biodiversity Credits for Conservation (Version 2.0). The analysis produced an aggregated multiscale fragmentation map and a corresponding bar graph illustrating the distribution of fragmentation classes and the number of forest patches (Figure 10). These outputs provide insight into spatial patterns of forest continuity and the degree to which conservation actions are contributing to the maintenance or restoration of landscape integrity within the project area.

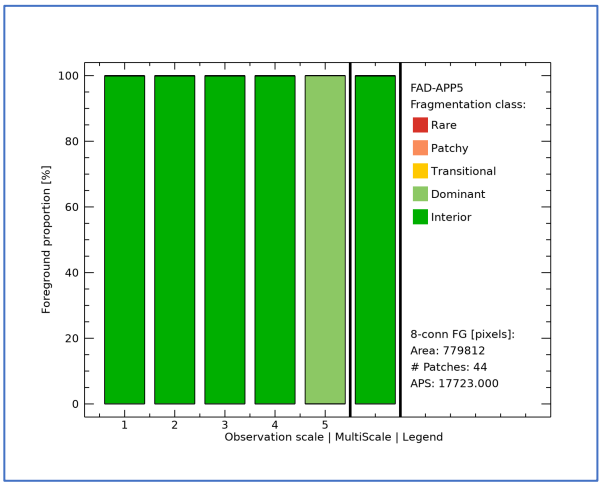
A. 2024 Fragmentation Analysis





B. 2025 Fragmentation Analysis





The results of the multiscale Forest Area Density (FAD) assessment are presented in Figure 10 and Figure 11. The analysis recorded an average FAD of 91.99% in 2024 and 91.94% in 2025 across the five observation scales, indicating a consistently high level of landscape connectivity within the project area. Based on the classification criteria outlined in Table 1, these values correspond to a very low level of fragmentation, signifying that extensive, continuous forest patches remain largely intact.

However, the minor reduction in mean FAD between 2024 and 2025 suggests slight spatial discontinuities, likely associated with edge effects or small-scale disturbances at the forest margins. This level of FAD implies that the project area continues to maintain strong ecological

cohesion and structural integrity, providing suitable conditions for species movement, gene flow, and ecosystem functioning.

A. 2024 FAD Results

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FAD-APP: Foreground Area Density summary analysis for image:

================================================================================
8-conn FG: area, # patches, aps [pixels]: 786353, 16, 49147.062
Fragmentation class: foreground proportion at observation scale/area:
Observation scale:    1         2         3         4         5         mscale
Neighborhood area:   7x7      13x13     27x27     81x81    243x243
================================================================================
FAD-APP_5class:
        Rare:      0.0011    0.0006    0.0000    0.0000    0.0000    0.0000
      Patchy:      0.0128    0.0173    0.0080    0.0050    0.0000    0.0010
Transitional:      0.0047    0.0085    0.0179    0.0111    0.0000    0.0254
    Dominant:      0.0080    0.0003    0.0006    0.0106   99.9901    0.0003
    Interior:     99.9733   99.9733   99.9734   99.9734    0.0099   99.9733
FAD-APP_2class:
   Separated:      0.0140    0.0179    0.0080    0.0050    0.0000    0.0010
  Continuous:     99.9860   99.9821   99.9920   99.9950  100.0000   99.9990
================================================================================
      FAD_av:     98.5269   97.5933   95.9067   90.5213   77.0543   91.9884
```

B . 2025 FAD Results

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FAD-APP: Foreground Area Density summary analysis for image:

================================================================================
8-conn FG: area, # patches, aps [pixels]: 779812, 44, 17723.000
Fragmentation class: foreground proportion at observation scale/area:
Observation scale:    1         2         3         4         5         mscale
Neighborhood area:   7x7      13x13     27x27     81x81    243x243
================================================================================
FAD-APP_5class:
        Rare:      0.0014    0.0035    0.0010    0.0000    0.0000    0.0000
      Patchy:      0.0304    0.0664    0.1276    0.0528    0.0000    0.0299
Transitional:      0.0262    0.0662    0.0059    0.0653    0.0032    0.1046
    Dominant:      0.0781    0.0000    0.0015    0.0177   99.9847    0.0015
    Interior:     99.8639   99.8639   99.8639   99.8642    0.0121   99.8639
FAD-APP_2class:
   Separated:      0.0318    0.0699    0.1286    0.0528    0.0000    0.0299
  Continuous:     99.9682   99.9301   99.8714   99.9472  100.0000   99.9701
================================================================================
      FAD_av:     98.3340   97.3179   95.5622   90.1102   76.5421   91.9368
```

Table 1. Multiscale fragmentation levels FAD/FAD-APP

Cubierta en primer plano	Densidad del primer plano (FAD por sus siglas en inglés “Foreground Area Density”)	Grado de fragmentación
Raro	0% ≤ x <10%	Muy alta
Irregular	10% ≤ x < 40%	Alta

Cubierta en primer plano	Densidad del primer plano (FAD por sus siglas en inglés "Foreground Area Density")	Grado de fragmentación
Transición	40% ≤ x < 60%	Intermedia
Dominante	60% ≤ x < 90%	Baja
Intacto	90% ≤ x ≤100%	Muy baja

Source: Comisión Europea, 2024

XI. OBSERVATIONS AND COMMENTS

Date	Comments and observations
Pre-project (2024)	Baseline assessments indicated moderate vegetation cover (mean NDVI ≈ 0.57; GNDVI ≈ 0.49) with patchy distribution and signs of vegetation stress in some areas. Fragmentation analysis showed high overall connectivity (FAD ≈ 91.99%), but with localized edge effects and spatial discontinuities at forest margins. These conditions provided the reference for evaluating subsequent ecological improvements under the conservation initiative.
2025	Monitoring results demonstrated overall improvement in vegetation health and ecosystem stability. NDVI and GNDVI values increased across most quarters, indicating enhanced vegetation vigor and chlorophyll activity within the conserved area compared to the baseline and adjacent control zones. Landscape fragmentation remained low and stable (FAD ≈ 91.94%), confirming that ecological connectivity was largely maintained. Overall, the conservation measures appear effective in sustaining vegetation recovery, reducing fragmentation risk, and supporting long-term habitat integrity within the project area.