

NDVI, Copernicus & Satellite Verification

NDVI (Normalized Difference Vegetation Index) is a numerical indicator derived from satellite imagery that estimates **vegetation “greenness” and vigor**.

Formula

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

- **Red band:** vegetation absorbs this for photosynthesis
- **Near-Infrared (NIR):** vegetation reflects this strongly if healthy

Value range

NDVI value	Interpretation
-1 to 0	Water, snow, clouds
0-0.2	Bare soil, rocks
0.2-0.4	Sparse vegetation, grass
0.4-0.6	Healthy vegetation
0.6-0.9	Dense forest canopy

Key point: NDVI does **not** detect “trees” directly — it detects **photosynthetically active biomass**.

Copernicus & Sentinel-2: what data you actually get

Sentinel-2 key specs

- **Spatial resolution:**
 - 10 m (Red, NIR) → NDVI is **10×10 m per pixel**
- **Temporal resolution:**
 - Every **5 days** globally
- **Cost:** Free, open data (huge win for DAOs)
- **Bands:** 13 spectral bands (visible + infrared)

This means:

- One pixel \approx **100 m²**
- You cannot see individual saplings
- You can see **land cover trends over time**

What NDVI can verify

Strong, defensible claims

These are **blockchain-safe claims** you can attach to smart contracts:

1. Vegetation increase over time

“NDVI increased from 0.21 → 0.47 over 18 months in polygon X”

This is **robust**, auditable, and repeatable.

2. No-regression guarantees

“NDVI did not fall below baseline for 12 months”

Useful for:

- Anti-deforestation clauses
- Delayed DAO payouts

3. Seasonal survival trends

By comparing **same season year-over-year**, you can show:

- Whether vegetation persists
- Whether the area is stable or degrading

4. Area-based verification

You can verify:

- **Hectares showing sustained vegetation**
- **Continuity of canopy cover**, not just spot planting

Canopy cover analysis (beyond basic NDVI)

https://eros.usgs.gov/doi-remote-sensing-activities/sites/default/files/PIRO_PotentialForestCanopyGa
https://data.fs.usda.gov/geodata/rastergateway/treemap/resources/TreeMap_GIF_v2.gif
https://cdn.prod.website-files.com/61436206a95bd10922bde560/668d4fb3db7057926babe9ea_Fore
NDVI alone is **not enough** for forest-quality claims. Typically you combine:

Techniques used in practice

1. **NDVI thresholding**
 - e.g. $NDVI > 0.5$ = likely canopy
2. **Time-series smoothing**
 - filters out noise & weather artifacts
3. **Change detection**
 - $\Delta NDVI$ between years
4. **Masking**
 - exclude water, agriculture, urban areas

What canopy analysis can say

- “This area transitioned from low biomass to sustained canopy”
- “Vegetation density increased and stabilized”

What it cannot say

- Tree species
- Forest age
- Biodiversity quality
- Native vs invasive plants

Limitations you **MUST** be explicit about (to avoid greenwashing)

https://today.uconn.edu/wp-content/uploads/2023/02/Mid-Atlantic_states_-_satellite_image_-_Blizzar
https://blogs.fu-berlin.de/reseda/files/2019/07/Quality_scene_1_KF.png
<https://miro.medium.com/v2/da%3Atrue/resize%3Afit%3A1200/0%2AtcXAB9T9bZ-SZwEe>

1. Cloud cover

- Optical satellites **cannot see through clouds**

- Tropical regions can lose **30-60% of observations**
- Mitigation:
 - Cloud masking
 - Multi-month aggregation
 - DAO rules that accept “data gaps”

On-chain implication:

Smart contracts must tolerate missing data windows.

2. Resolution constraints (10 m)

- Young trees <2-3 years may be invisible
- Agroforestry can look like forest
- Shrubs can inflate NDVI

You cannot claim:

“10,000 trees planted”

3. Species identification is impossible

NDVI:

- Does not know *what* is growing
- Does not know *why* it's growing

A monoculture plantation can score higher NDVI than a biodiverse forest.

Mitigation strategies

- Combine with:
 - Field audits
 - Community attestations
 - NGO validation NFTs
 - Use NDVI as **one oracle**, not the only one
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4. Cause vs correlation

NDVI increase \neq successful reforestation

It could be:

- Natural regrowth

- Agricultural cycles
- Irrigation changes

Honest framing:

“This project contributed to vegetation recovery as verified by satellite indices”

Not:

“This project restored a forest ecosystem”

6. What claims are DAO-safe vs DAO-dangerous

Safe, verifiable, professional claims

- “Vegetation cover increased”
- “NDVI stabilized above baseline”
- “No major deforestation detected”
- “Land cover change confirmed by Copernicus”

Dangerous claims (avoid on-chain)

- Exact tree counts
- Species restoration
- Biodiversity recovery
- Carbon sequestration without models + field data

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