EcoSentinel

A Multi-Spectral Satellite Pipeline for Automated EUDR Compliance Auditing

Python Streamlit Sentinel-2

An automated satellite auditing pipeline that tasks Sentinel-2 imagery to generate real-time, multi-spectral deforestation risk assessments for EUDR compliance.

Verifying Supply Chain Compliance with the European Union Deforestation Regulation (EUDR).

Key Capabilities

Autonomous Tasking | Parallel Processing | Smart Masking: NDVI & NDWI | Compliance Reports

Three Modes of Operation

1. Preset Agricultural Hubs

Select key regions

Mode 1 Presets
Download Detailed Analysis Report (PDF)

2. Global Geocoding Search

Search any location.

Mode 2 Search
Download Detailed Analysis Report (PDF)

3. Interactive Area Drawing

Draw custom plots.

Mode 3 Drawing
Download Detailed Analysis Report (PDF)

ANYWHERE SEARCH:
GLOBAL EUDR MONITORING

Rapid, Automated Auditing via Natural Language

- Type any location (e.g., Kainuu, Finland),.
- System geocodes, tasks satellites, & delivers a report.
- Instant verification for any region on Earth.

Step 1: The Architecture.

An overview of the end-to-end Python pipeline:

From Sentinel-2 Tasking to Automated Risk Auditing.

[Keyword Search for any Region]

EcoSentinel

Select Region & Date

Targeting Mode

- ○ Use Presets
- ◉ Search Anywhere
- ○ Draw Area

Enter Location

Kainuu, Finland

System will analyze a 10km radius.

✅ Coordinates Found

Search Window

2024/06/01 – 2024/08/31

🚀 Run Analysis

🌍 EUDR Multi-Spectral Deforestation Engine

ℹ️ About the Platform & Methodology

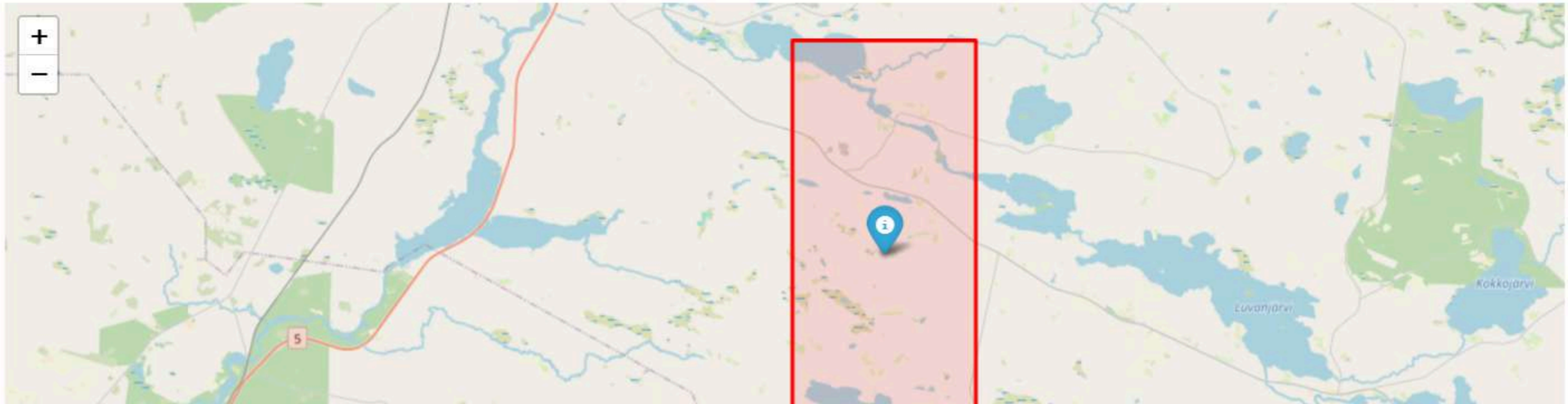
Objective: This platform provides real-time, satellite-based auditing for the **EU Deforestation Regulation (EUDR)**. It enables supply chain managers and financial auditors to verify if a sourcing region complies with environmental standards.

How it works:

1. **Ingestion:** Tasks the **Sentinel-2 constellation** (via Microsoft Planetary Computer) to retrieve multi-spectral imagery.
2. **Processing:** Applies a parallelized Python pipeline to calculate **NDVI** (Vegetation Health) and **NDWI** (Water Content).
3. **Smart Masking:** Uses a Multi-Index Decision Tree to filter out urban noise and water bodies.
4. **Audit:** Generates a precise "Risk Score" based on vegetation stress levels.

Target: Kainuu, Manner-Suomi, Suomi / Finland

Location & Targeting | Multi-Spectral Detection | Compliance Audit



localhost:8501

Relaunch to update

All Bookmarks

Step 2: Spectral Analysis.

Visualizing the raw NDVI/NDWI layers to establish a baseline for agricultural health before applying compliance thresholds.

Deploy

EcoSentinel

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

Enter Location

Kainuu, Finland

System will analyze a 10km radius.

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Search Window

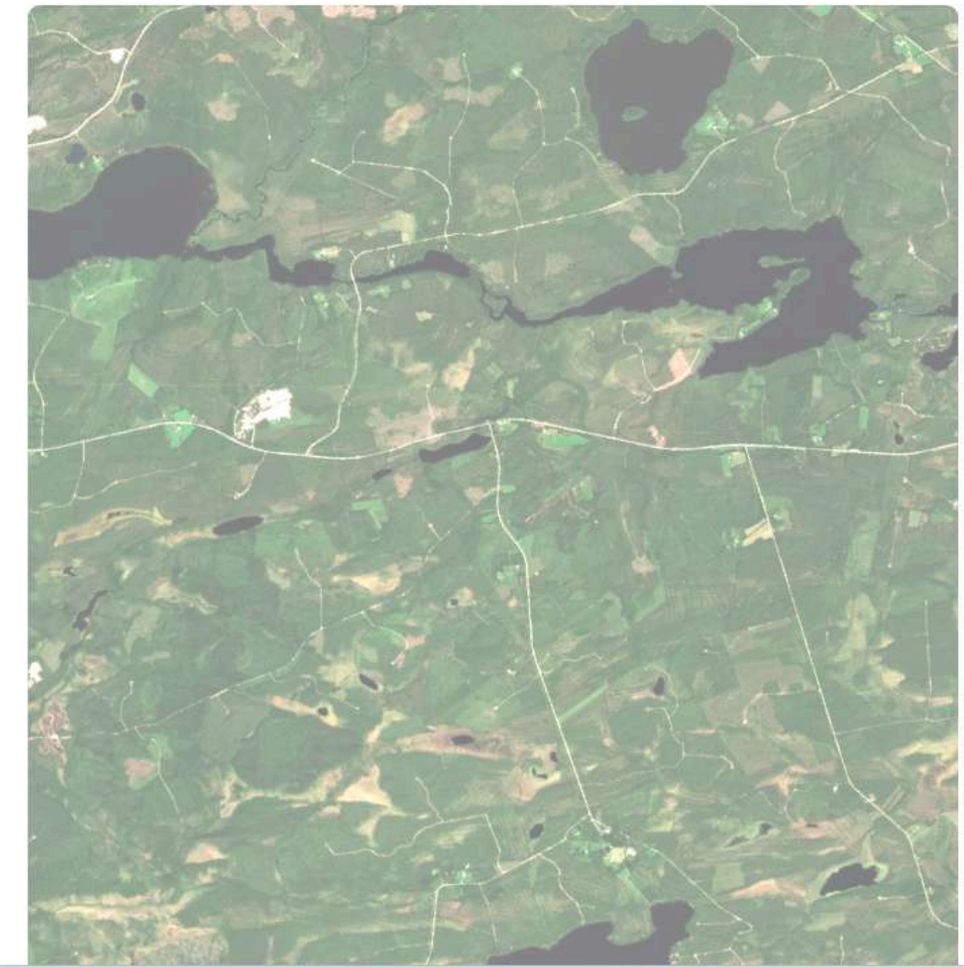
2024/06/01 – 2024/08/31

Run Analysis

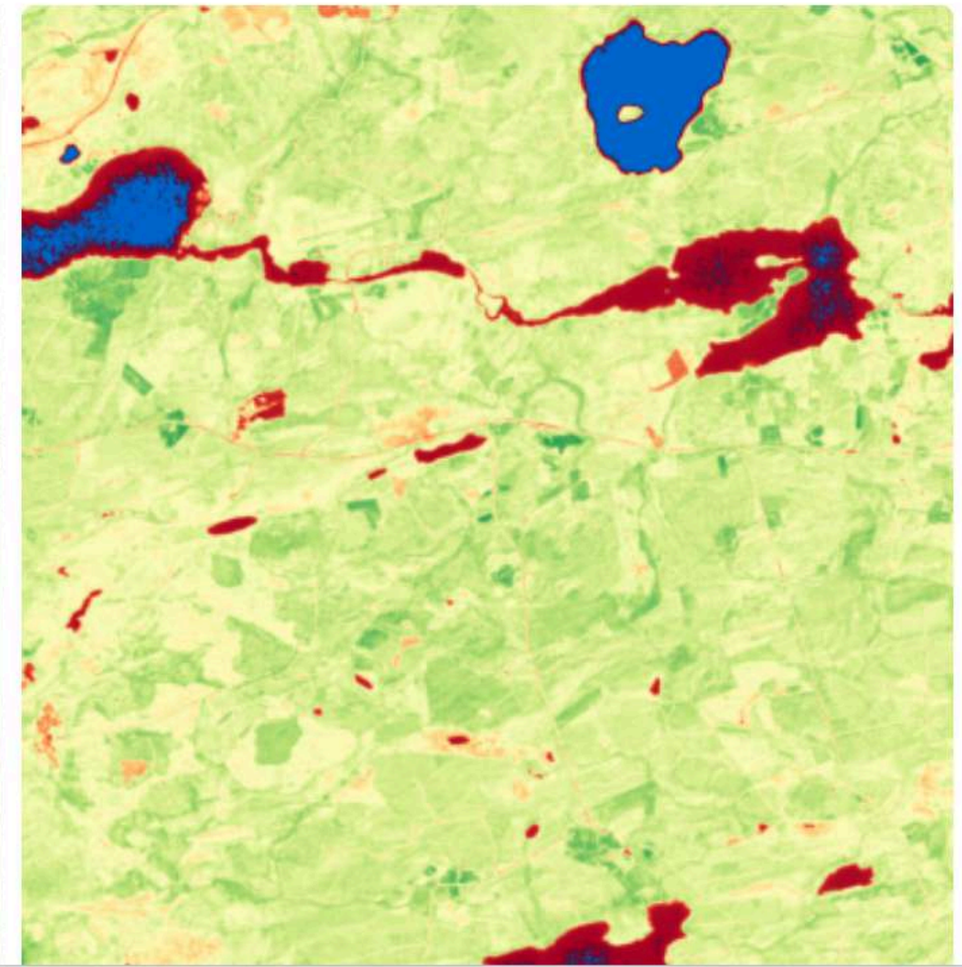
Target: Kainuu, Manner-Suomi, Suomi / Finland

Location & Targeting | Multi-Spectral Detection | Compliance Audit

Optical Reality



Multi-Spectral Deforestation Detection



Step 3: Multi-Class Smart Masking.

Applying the Decision Tree: Blue (Water), Grey (Urban), Red (Risk), and White (Safe) for pixel-perfect accuracy.

EcoSentinel

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

Enter Location

Kainuu, Finland

System will analyze a 10km radius.

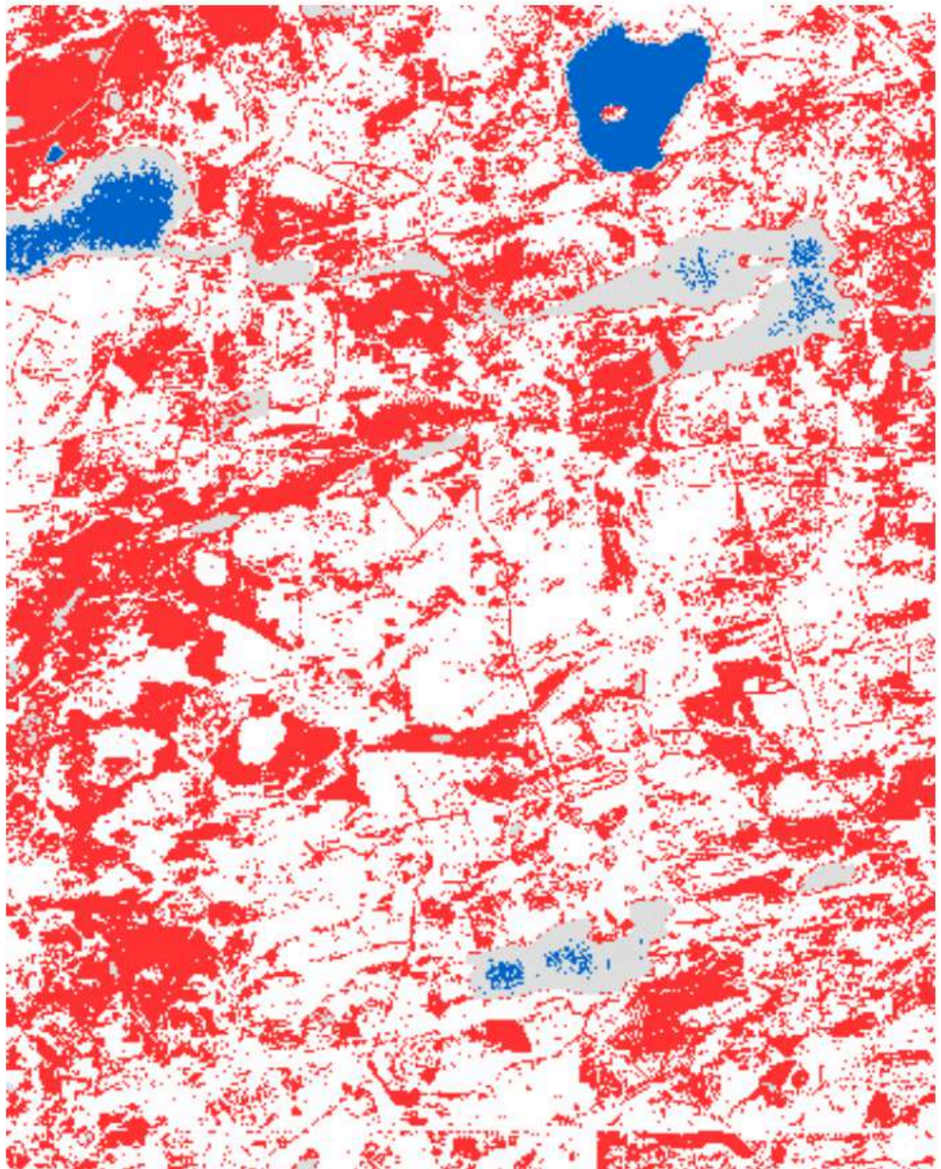
Coordinates Found

Search Window

2024/06/01 – 2024/08/31

Run Analysis

Multi-Class Masking & Compliance Map



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Step 4: Due Diligence Summary.

A generated risk assessment explaining the why and how of the result, ready for banking or supply chain audits.

coSentinel

Select Region & Date

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Use Presets

Search Anywhere

Draw Area

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Kainuu, Finland

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Coordinates Found

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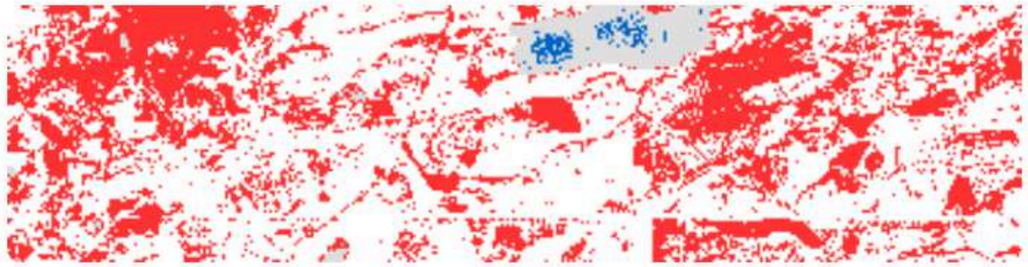
2024/06/01 – 2024/08/31

Run Analysis



EUDR Classification Layer

Executive Summary: 39.02% Risk (Compliant)

Risk Assessment:

The algorithm has identified that **39.02%** of the agricultural vegetation in this sector is exhibiting **moderate spectral variation** (typical for this biome). Vegetation gaps are within standard agricultural or forestry tolerance (thinning/spacing).

Algorithmic Methodology (Multi-Index Decision Tree):

- **BLUE (Water):** Masked via NDWI > 0 (Surface water bodies).
- **GREY (Urban/Barren):** Excluded where NDVI < 0.25 (Non-organic surfaces).
- **RED (Risk):** Vegetation with NDVI 0.25–0.45 (Sparse/Stressed signal).
- **WHITE (Safe):** Vegetation with NDVI > 0.45 (Dense chlorophyll signal).

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*Data Validity Check: This analysis detected active vegetation cover of **92.72%**. (Areas with < 10% cover may indicate invalid seasonal windows or desert terrain).*

Step 5: Metadata Verification.

Ensuring data integrity by exposing the exact Sentinel-2 scene ID, cloud cover percentage, and acquisition timestamp.

EcoSentinel

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

Enter Location

Kainuu, Finland

System will analyze a 10km radius.

Coordinates Found

Search Window

2024/06/01 – 2024/08/31

Run Analysis

EUDR Multi-Spectral Deforestation Engine

About the Platform & Methodology

Target: Kainuu, Manner-Suomi, Suomi / Finland

Location & Targeting | Multi-Spectral Detection | Compliance Audit

Stress Area	Compliance	Cloud Cover
39.02%	COMPLIANT	0.0%


```
{
  "region_name" : "Kainuu, Manner-Suomi, Suomi / Finland"
  "scene_id" : "Mosaic_Composite"
  "acquisition_date" : "2024-08-07T09:55:49.024000+00:00"
  "cloud_cover_avg" : 0
  "platform" : "Sentinel-2B"
  "bbox" : [
    0 : 28.631052399999998
    1 : 64.5446354
    2 : 28.7310524
    3 : 64.6446354
  ]
}
```

PRECISION TARGETING:
PARCEL-LEVEL EUDR AUDITING

Traceable, User-Defined Boundary Analysis

- Draw exact boundaries on a map (e.g., Greater London)
- Pixel-perfect analysis of specific plots
- Ensures accuracy for compliance verification.

Step 1: The Architecture.

An overview of the end-to-end Python pipeline:

From Sentinel-2 Tasking to Automated Risk Auditing.

Draw Area on Map

EcoSentinel

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

Use the drawing tools on the 'Location' map.

Search Window

2025/03/01 – 2025/03/31

Run Analysis

Deploy

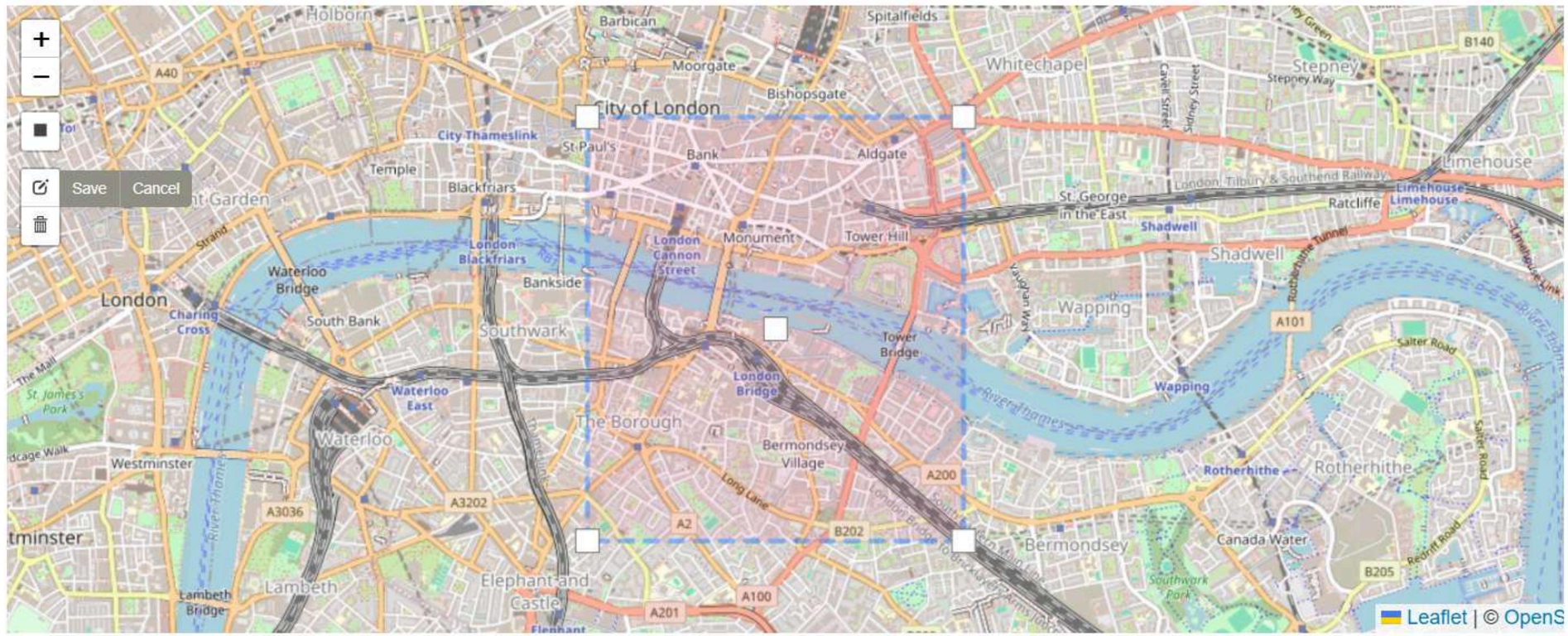
EUDR Multi-Spectral Deforestation Engine

About the Platform & Methodology

Target: Custom User Selection

Location & Targeting | Multi-Spectral Detection | Compliance Audit

Interactive Targeting Map



Step 2: Spectral Analysis.

Visualizing the raw NDVI/NDWI layers to establish a baseline for agricultural health before applying compliance thresholds.

Location & Targeting | Multi-Spectral Detection | Compliance Audit

EcoSentinel

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

Use the drawing tools on the 'Location' map.

Search Window

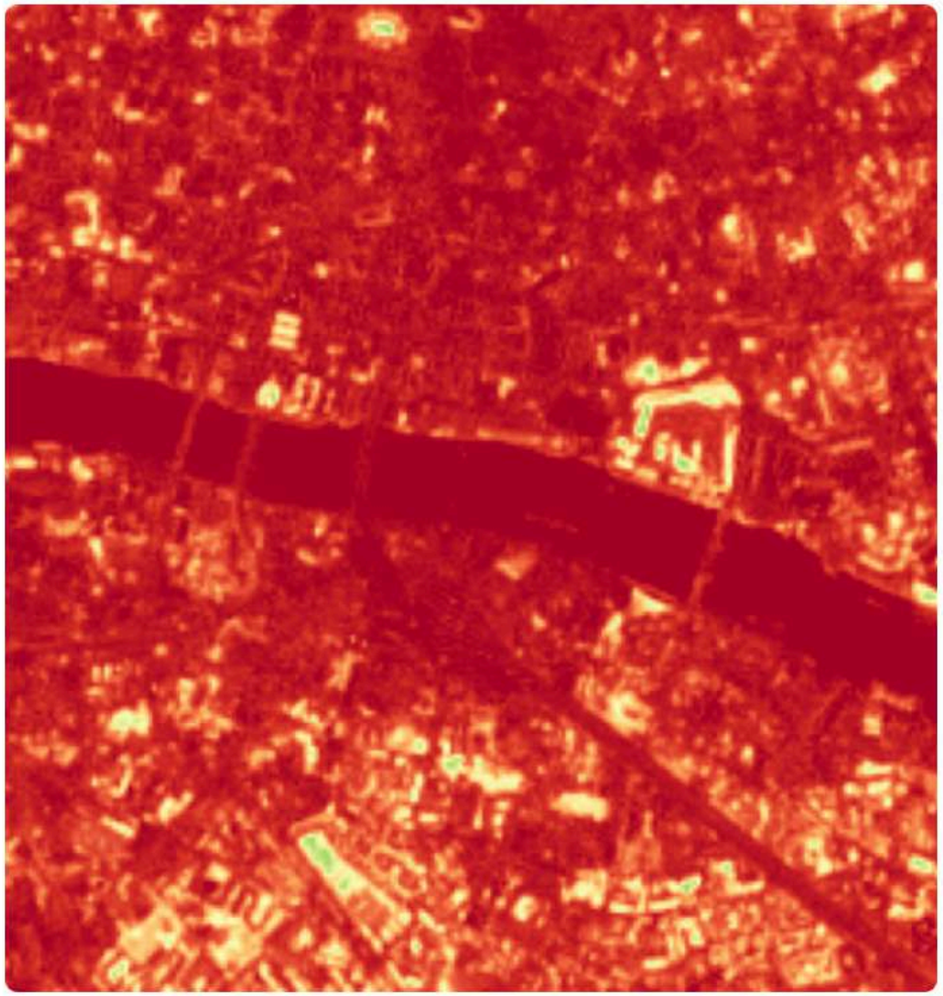
2025/03/01 – 2025/03/31

Run Analysis

Optical Reality

Sentinel-2 Composite (Visible Light)

Multi-Spectral Deforestation Detection



Hybrid Spectral Analysis (NDVI + NDWI)

Step 3: Multi-Class Smart Masking.
Applying the Decision Tree: Blue (Water), Grey (Urban), Red (Risk), and White (Safe) for pixel-perfect accuracy.

EcoSentinel

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

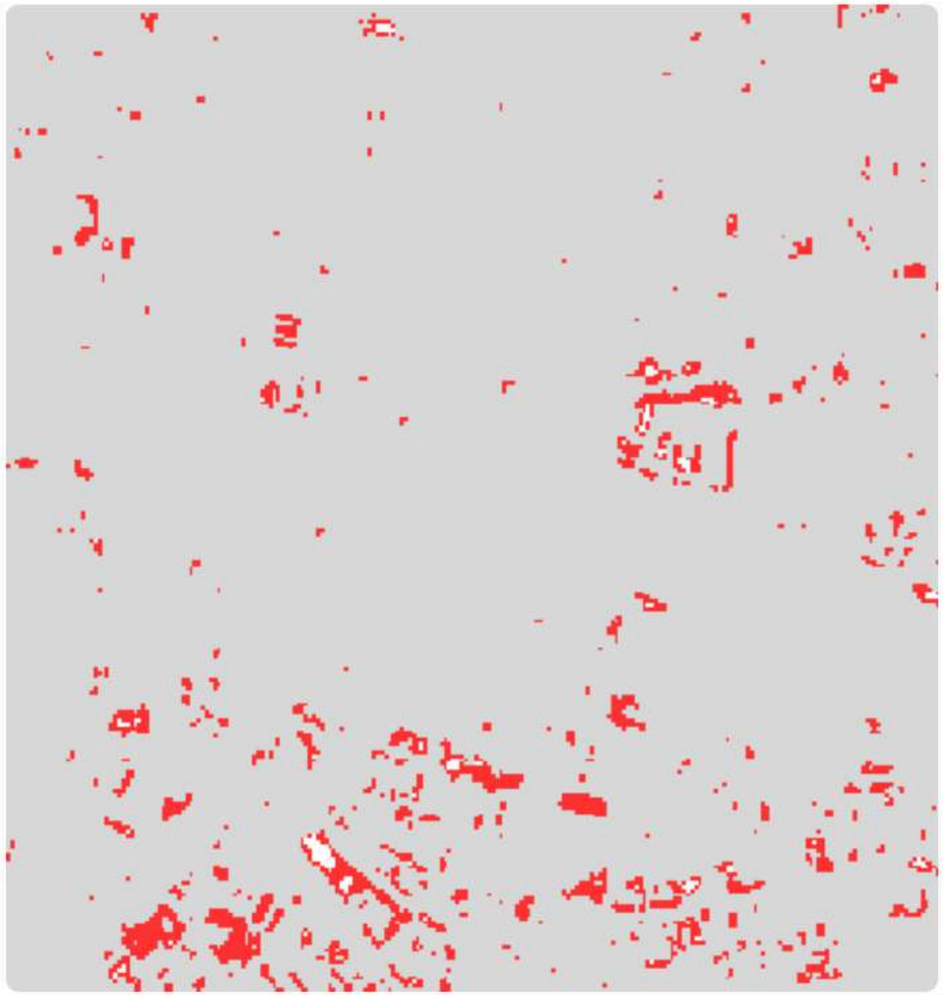
Use the drawing tools on the 'Location' map.

Search Window

2025/03/01 – 2025/03/31

Run Analysis

Multi-Class Masking & Compliance Map



EUDR Classification Layer

Step 4: Due Diligence Summary.

A generated risk assessment explaining the why and how of the result, ready for banking or supply chain audits.

EcoSentinel

Select Region & Date

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- Use Presets
- Search Anywhere
- Draw Area

Use the drawing tools on the 'Location' map.

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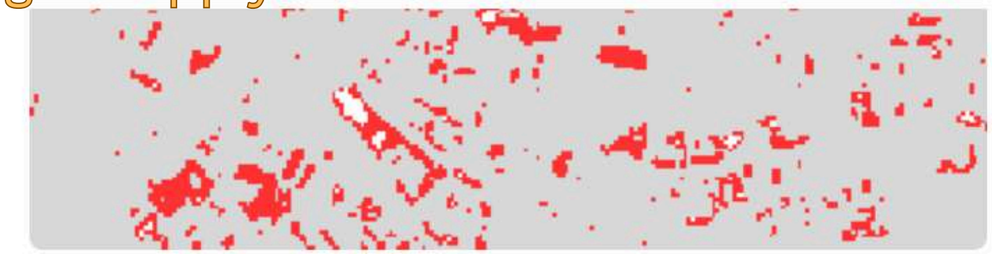
Run Analysis



EUDR Classification Layer

Executive Summary: 93.63% Risk (Critical Risk)

Risk Assessment:

The algorithm has identified that **93.63%** of the agricultural vegetation in this sector is exhibiting **critical spectral stress** (Red Zones). This indicates potential deforestation or severe drought. Immediate on-site audit recommended.

Algorithmic Methodology (Multi-Index Decision Tree):

- **BLUE (Water):** Masked via NDWI > 0 (Surface water bodies).
- **GREY (Urban/Barren):** Excluded where NDVI < 0.25 (Non-organic surfaces).
- **RED (Risk):** Vegetation with NDVI 0.25–0.45 (Sparse/Stressed signal).
- **WHITE (Safe):** Vegetation with NDVI > 0.45 (Dense chlorophyll signal).

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*Data Validity Check: This analysis detected active vegetation cover of **4.64%**. (Areas with < 10% cover may indicate invalid seasonal windows or desert terrain).*

HOTSPOT ANALYSIS:
PRESET BIOME MONITORING

Instant Assessment of High-Risk Zones

- One-click selection of critical regions (e.g, Amazon).
- Tests the algorithm's sensitivity to land clearing.
- Immediate insights for environmental risk assessment.

Step 1: The Architecture.

An overview of the end-to-end Python pipeline:

From Sentinel-2 Tasking to Automated Risk Auditing.

Presets Values

EcoSentinel

Select Region & Date

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Use Presets

Search Anywhere

Draw Area

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Amazon Rainforest (Defor…

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2025/03/01 – 2025/03/31

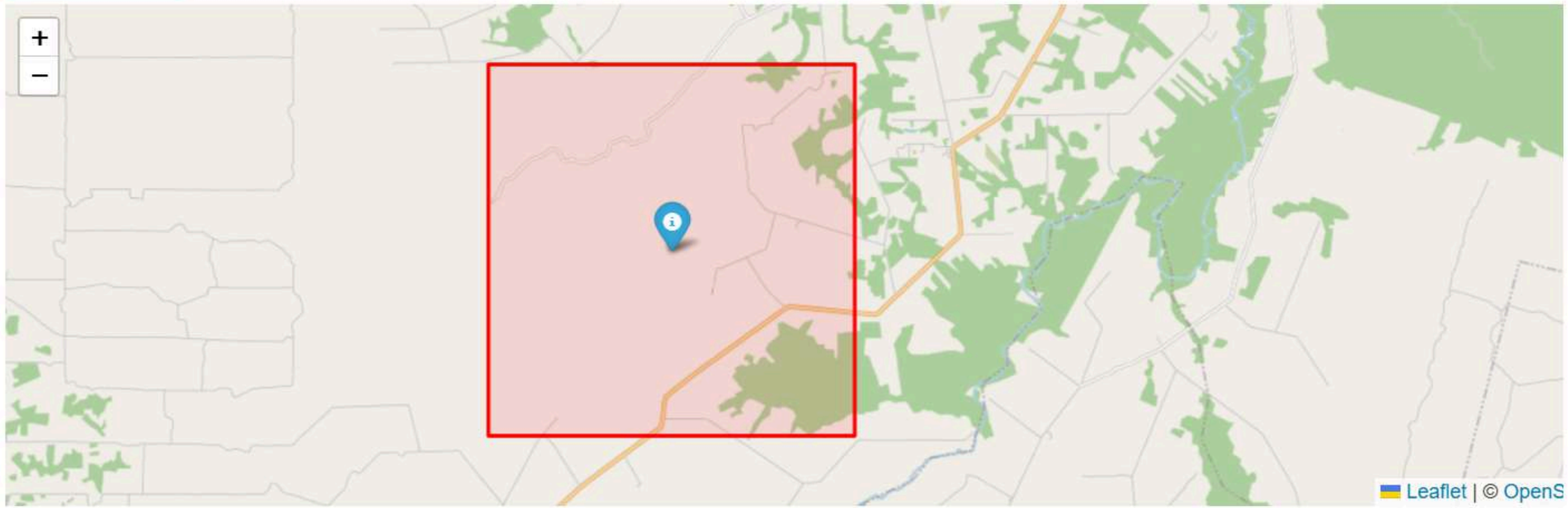
Run Analysis

EUDR Multi-Spectral Deforestation Engine

About the Platform & Methodology

Target: Amazon Rainforest (Deforestation)

Location & Targeting | Multi-Spectral Detection | Compliance Audit



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Relaunch to update

All Bookmarks

Step 2: Spectral Analysis.

Visualizing the raw NDVI/NDWI layers to establish a baseline for agricultural health before applying compliance thresholds.

Deploy

Target: Amazon Rainforest (Deforestation)

EcoSentinel

Location & Targeting | Multi-Spectral Detection | Compliance Audit

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

Choose Region

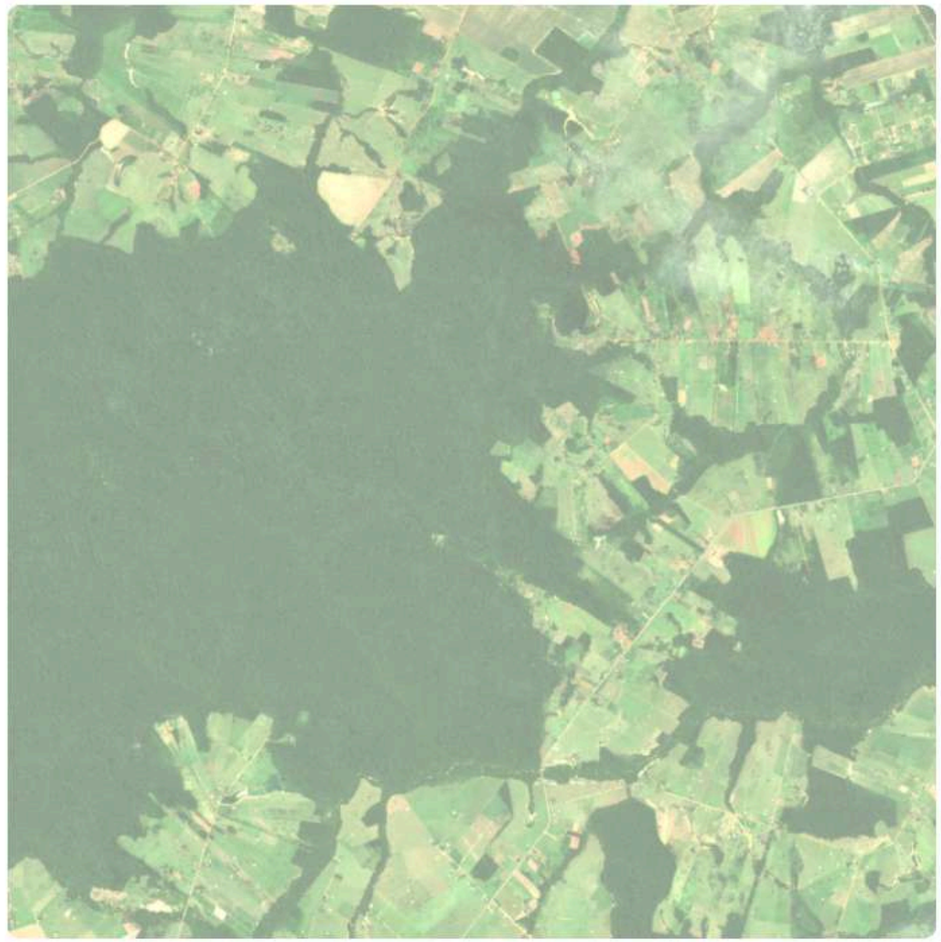
Amazon Rainforest (Defor…

Search Window

2025/03/01 – 2025/03/31

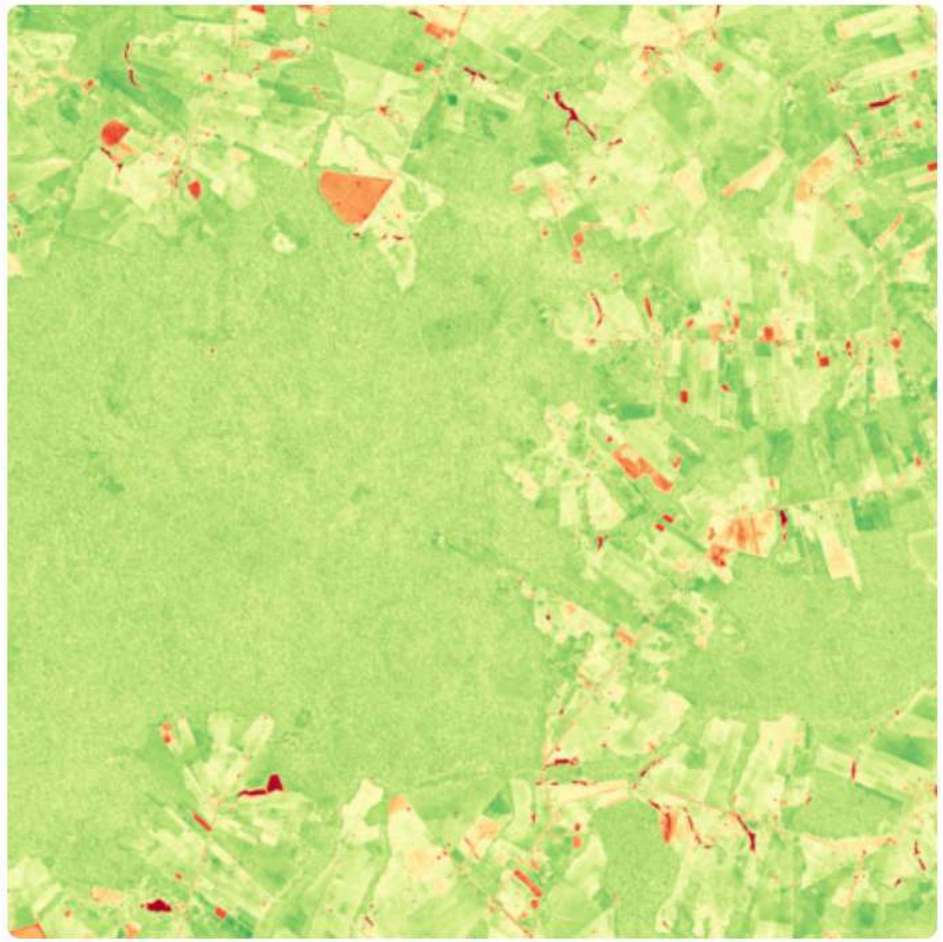
Run Analysis

Optical Reality



Sentinel-2 Composite (Visible Light)

Multi-Spectral Deforestation Detection



Hybrid Spectral Analysis (NDVI + NDWI)

Step 3: Multi-Class Smart Masking.

Applying the Decision Tree: Blue (Water), Grey (Urban), Red (Risk), and White (Safe) for pixel-perfect accuracy.

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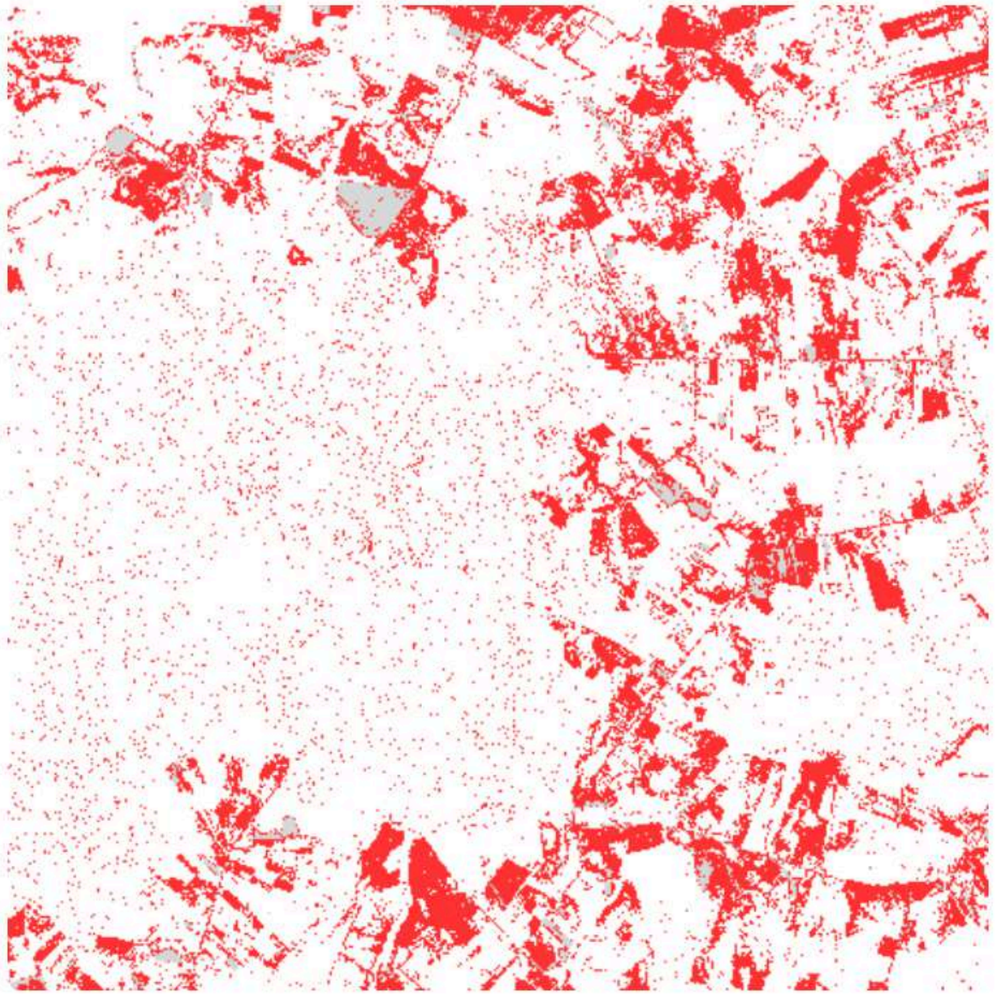
Run Analysis

Multi-Class Masking & Compliance Map



EUDR Classification Layer

Step 4: Due Diligence Summary.

A generated risk assessment explaining the why and how of the result, ready for banking or supply chain audits.

Deploy

EcoSentinel

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

Choose Region

Amazon Rainforest (Defor…

Search Window

2025/03/01 – 2025/03/31

Run Analysis

EUDR Classification Layer

Executive Summary: 18.15% Risk (Compliant)

Risk Assessment:

The algorithm has identified that **18.15%** of the agricultural vegetation in this sector is exhibiting **moderate spectral variation** (typical for this biome). Vegetation gaps are within standard agricultural or forestry tolerance (thinning/spacing).

Algorithmic Methodology (Multi-Index Decision Tree):

- **BLUE (Water):** Masked via NDWI > 0 (Surface water bodies).
- **GREY (Urban/Barren):** Excluded where NDVI < 0.25 (Non-organic surfaces).
- **RED (Risk):** Vegetation with NDVI 0.25–0.45 (Sparse/Stressed signal).
- **WHITE (Safe):** Vegetation with NDVI > 0.45 (Dense chlorophyll signal).

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*Data Validity Check: This analysis detected active vegetation cover of **98.37%**. (Areas with < 10% cover may indicate invalid seasonal windows or desert terrain).*

Step 5: Metadata Verification.

Ensuring data integrity by exposing the exact Sentinel-2 scene ID, cloud cover percentage, and acquisition timestamp.

localhost:8501

Relaunch to update

All Bookmarks

Deploy

EcoSentinel

Select Region & Date

Targeting Mode

- Use Presets
- Search Anywhere
- Draw Area

Choose Region

Amazon Rainforest (Defor…

Search Window

2025/03/01 – 2025/03/31

Run Analysis

EUDR Multi-Spectral Deforestation Engine

About the Platform & Methodology

Target: Amazon Rainforest (Deforestation)

Location & Targeting | Multi-Spectral Detection | Compliance Audit

Stress Area	Compliance	Cloud Cover
18.15%	COMPLIANT	2.3%


```
{
  "region_name" : "Amazon Rainforest (Deforestation)"
  "scene_id" : "Mosaic_Composite"
  "acquisition_date" : "2025-03-15T14:28:11.025000+00:00"
  "cloud_cover_avg" : 2.306674
  "platform" : "Sentinel-2C"
  "bbox" : [
    0 : -62.2
    1 : -9.6
    2 : -62.1
    3 : -9.5
  ]
}
```