Satellite-Based Vegetation Change Detection Report
Thane Range, Maharashtra

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Abstract

This report presents the findings of a satellite-based vegetation change detection analysis conducted on the Thane Range forest area in Maharashtra, India. Using Sentinel-2 imagery and NDVI (Normalized Difference Vegetation Index) analysis, we compared vegetation conditions between December 2023 and November-December 2024 to identify potential deforestation or land-use changes. The analysis revealed approximately 177 hectares of significant vegetation loss, warranting field verification.

1 Introduction

Deforestation and illegal land-use changes pose significant threats to forest ecosystems in India. The Thane Range, located near Mumbai in Maharashtra, is part of the ecologically sensitive Western Ghats region and requires continuous monitoring to detect and prevent unauthorized activities.

This analysis employs remote sensing techniques using freely available Sentinel-2 satellite imagery accessed through Google Earth Engine. The NDVI metric provides a reliable indicator of vegetation health, with significant decreases potentially indicating deforestation, fire damage, or land clearing.

2 Study Area

Parameter	Value
Location	Thane Range, Maharashtra
Region	Western Ghats / Sanjay Gandhi National Park vicinity
Bounding Box	73.0034°E, 19.0777°N to 73.0545°E, 19.2060°N
Total Area	Approximately 81 sq km

Table 1: Study Area Parameters

3 Methodology

3.1 Data Source

Sentinel-2 Surface Reflectance (SR) imagery from the Copernicus program was used for this analysis. Images with cloud cover less than 30% were selected and cloud-masked using the QA60 band.

3.2   Time Periods

- **Baseline Period:** December 1-31, 2023 (4 images)

- **Current Period:** November 1 - December 15, 2024 (9 images)

3.3   NDVI Calculation

NDVI was computed using the standard formula:

$$NDVI = \frac{NIR - Red}{NIR + Red} = \frac{B8 - B4}{B8 + B4}$$

Median composites were created for each period to reduce noise and cloud artifacts. Change was calculated as:

$$\Delta NDVI = NDVI_{current} - NDVI_{baseline}$$

3.4   Alert Thresholds

- **Significant Loss:** $\Delta NDVI < -0.15$

- **Moderate Loss:** $\Delta NDVI < -0.10$
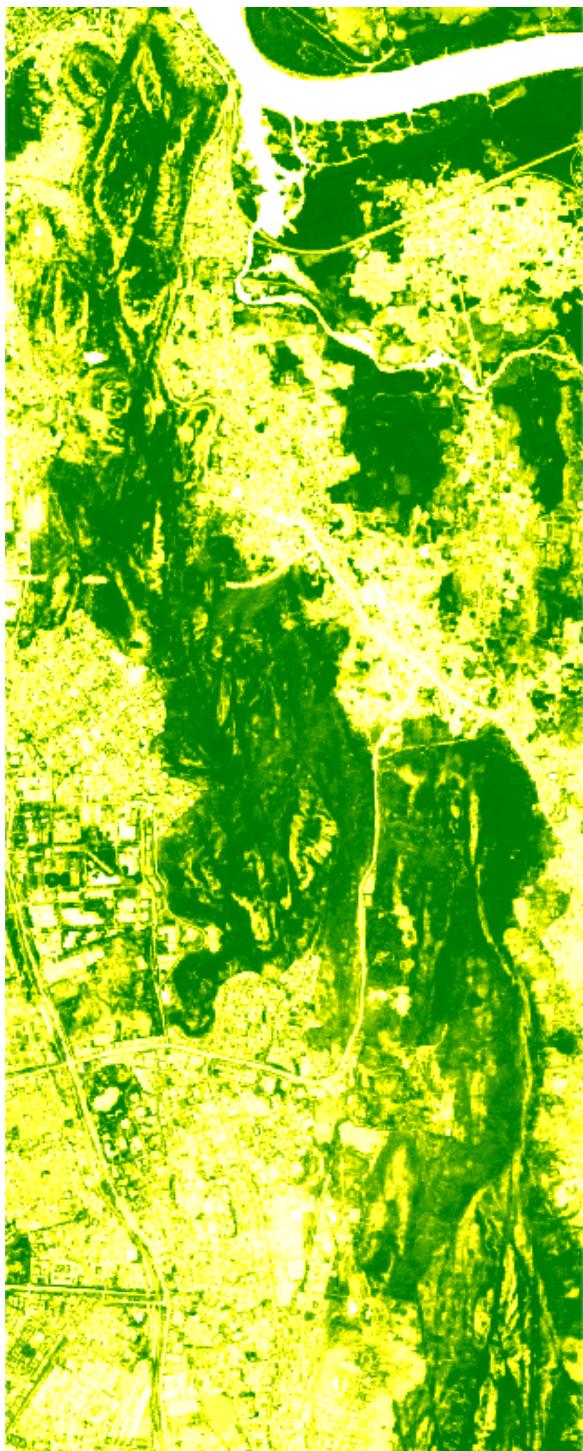
4   Results

4.1   Change Statistics
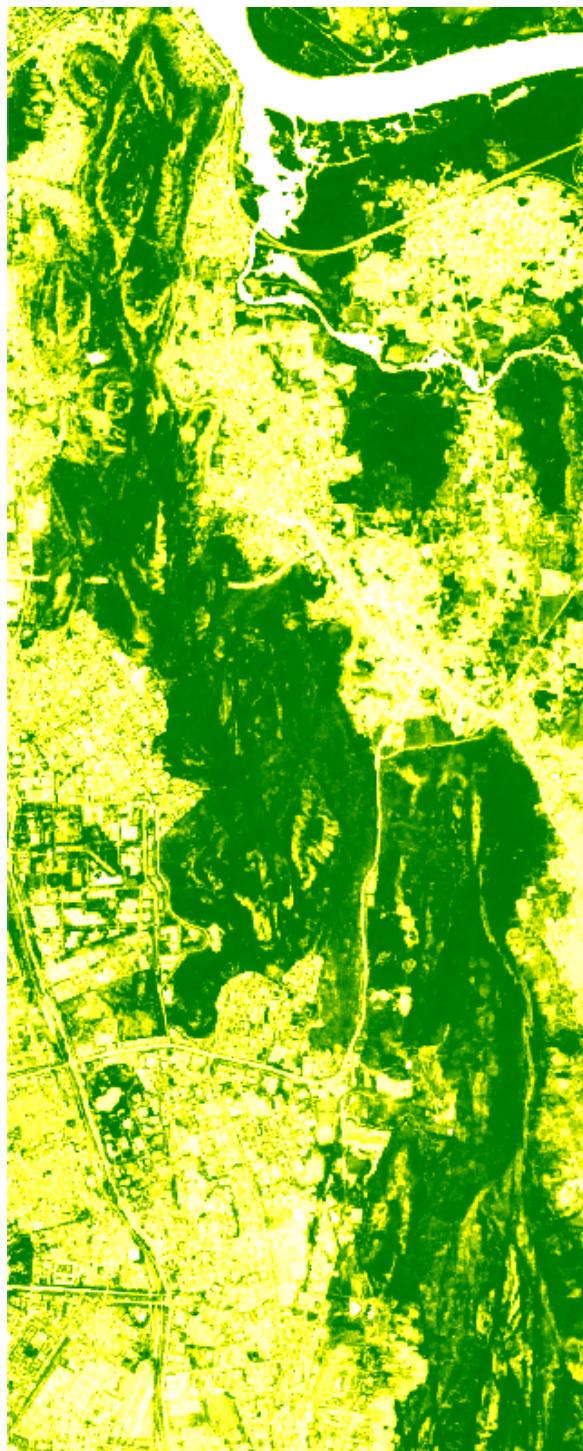
Metric	Value	Interpretation
Mean NDVI Change	+0.0196	Slight overall vegetation gain
Standard Deviation	0.0759	Moderate variability
Minimum Change	-0.7234	Severe localized loss
Maximum Change	+0.6287	Significant localized gain
Significant Loss Area	**176.67 ha**	NDVI drop > 0.15
Moderate Loss Area	322.67 ha	NDVI drop > 0.10
Alert Level	**HIGH**	

Table 2: Vegetation Change Detection Results

4.2   Visualization
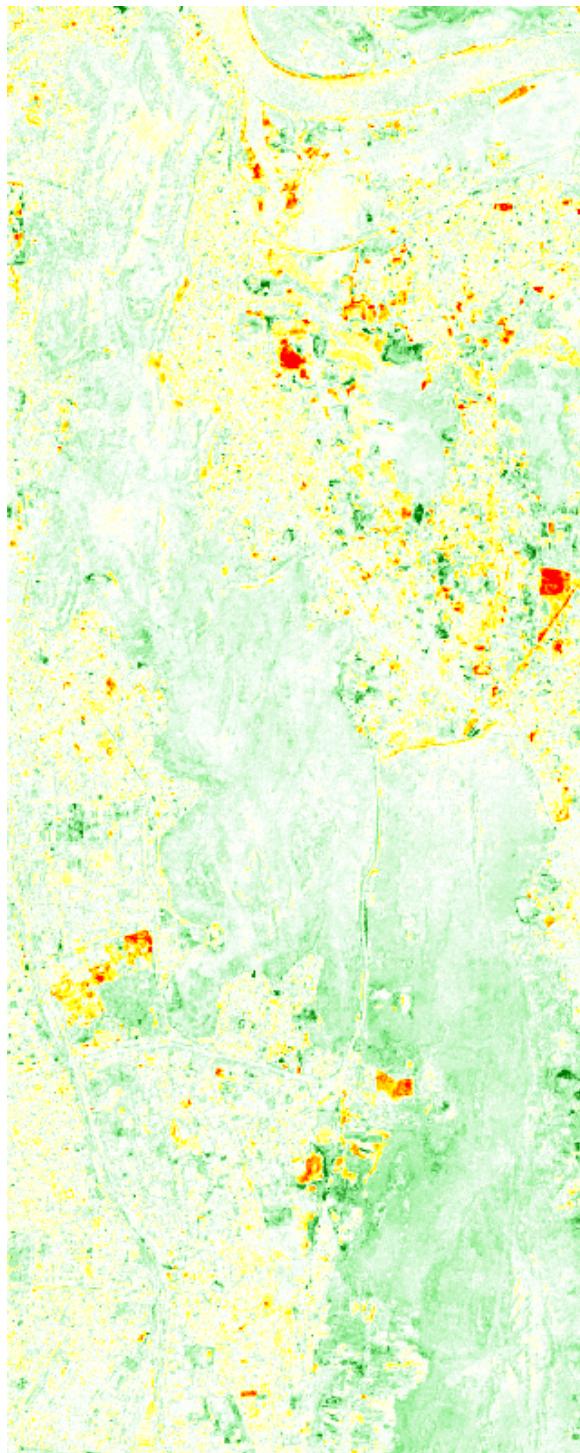
(a) Baseline NDVI (December 2023)   (b) Current NDVI (Nov-Dec 2024)
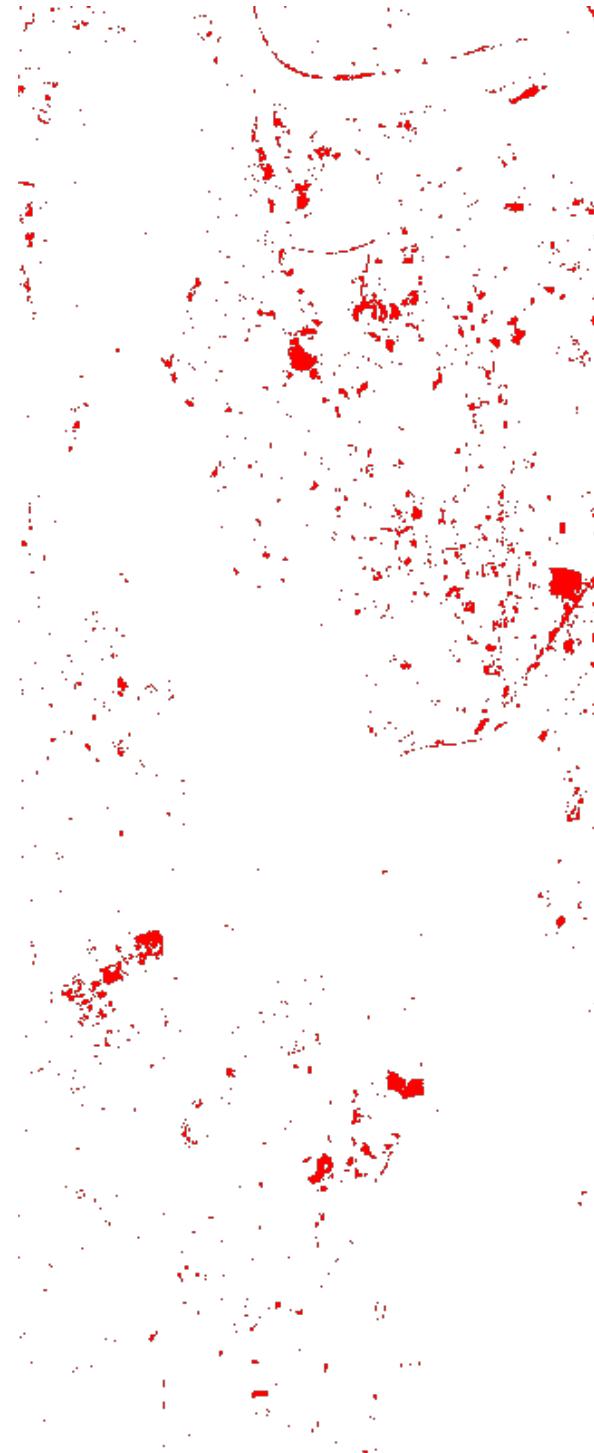
Figure 1: NDVI Composites: Baseline vs Current Period

(a) NDVI Change Map (Red=Loss, Green=Gain)   (b) Significant Loss Areas Only (Red)

Figure 2: Change Detection Results: Full change map and areas with significant vegetation loss highlighted.

5   Discussion

5.1   Key Findings

While the overall mean NDVI change is slightly positive (+0.0196), indicating general vegetation stability or growth across the study area, the analysis reveals **localized hotspots of significant**

vegetation loss totaling approximately 177 hectares.

The presence of extreme negative values (minimum change of -0.7234) indicates areas where vegetation has been almost completely removed, which is characteristic of:

- Clear-cutting or deforestation

- Construction and development activities

- Fire damage

- Quarrying or mining operations

- Landslides (given the hilly terrain)

5.2 Spatial Distribution

The loss areas appear to be distributed across specific locations rather than uniformly spread, suggesting targeted anthropogenic activity rather than natural seasonal variation. The moderate loss zone (322 hectares) surrounding the significant loss areas may indicate:

- Edge effects from clearing activities

- Gradual degradation

- Areas at risk of future loss

5.3 Limitations

- Seasonal variations between December and November may affect NDVI values

- Cloud masking may not capture all atmospheric interference

- 10-meter resolution may miss small-scale changes

- Phenological differences in vegetation types not accounted for

6 Recommendations

1. **Field Verification:** Deploy personnel to verify the 176.67 hectares of significant loss areas and determine the cause of vegetation change.

2. **Hotspot Prioritization:** Focus initial investigation on areas showing the most severe NDVI decline (approaching -0.7).

3. **Continuous Monitoring:** Establish monthly monitoring cycles to detect new changes early.

4. **Historical Analysis:** Conduct multi-year trend analysis to distinguish between seasonal patterns and permanent land-use changes.

5. **Cross-Reference:** Compare findings with:

   - Approved development permits
   - Fire incident reports
   - Encroachment complaints

7   Conclusion

The satellite-based analysis of Thane Range reveals a **HIGH alert** condition due to approximately 177 hectares of significant vegetation loss detected between December 2023 and late 2024. While the overall forest cover remains stable, the localized loss areas require immediate field investigation to determine causation and appropriate response measures.

This automated monitoring approach demonstrates the feasibility of using freely available satellite imagery for regular forest surveillance, enabling early detection of potential illegal activities or environmental threats.

Data Sources: Copernicus Sentinel-2 via Google Earth Engine
Analysis Platform: Forest Watch API v0.1.0
Report Generated: December 19, 2025