1. Abstract

We investigated the potential of integrating multi-frequency Synthetic Aperture Radar (SAR) data: ALOS PALSAR-2, Sentinel-1b and TanDEM-X, in combination with field data to identify and classify different levels of forest disturbance in a secondary forest in Colombia, that has been under pressure from gold mining and selective logging at different intensities. Hereafter, we assessed the capabilities of Sentinel-1 to discriminate between the classes already identified.

2. Introduction

Forest disturbances (i.e. deforestation and degradation) are a serious problem significantly contributing to greenhouse emissions and biodiversity loss [1]. Quantifying the impact of forest degradation on the carbon budget is challenging because of the diversity of definitions, varying scale of the changes, and many drivers that are applying pressure on the forests. As a result, the measuring and mapping of forest degradation is still a technical challenge [1-3].

Radar (SAR) data is very promising for detecting and monitoring forest degradation considering its sensitivity to above ground biomass and forest structure [4].

There is also evidence that the integration of sensors in combination with field data can provide more precise results when monitoring changes in forest [5].

3. Methods

5.1. Dataset combination

Multi-source SAR data (ALOS PALSAR-2, TanDEM-X and Sentinel-1) were used in combination with field data to classify spatially different levels of forest disturbance. We applied statistical methods to detect patterns in the radar data, and machine learning methods to classify disturbance levels identified in the field.

6. Results

6.1. Field data classification

Optimal number of clusters identified using a gap statistic analysis

Field plots Cluster classification

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean disturbed</th>
<th>Moderate disturbed</th>
<th>Severe disturbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBH (mm)</td>
<td>11.28</td>
<td>13.81</td>
<td>17.04</td>
</tr>
<tr>
<td>Height (m)</td>
<td>3.94</td>
<td>6.41</td>
<td>9.46</td>
</tr>
<tr>
<td>Biomass (Mg/ha)</td>
<td>2.27</td>
<td>3.41</td>
<td>5.05</td>
</tr>
<tr>
<td>Species/ha</td>
<td>16.8</td>
<td>45.6</td>
<td>56.6</td>
</tr>
<tr>
<td>Plot tree density</td>
<td>63.5</td>
<td>98.7</td>
<td>127.4</td>
</tr>
</tbody>
</table>

The accuracy assessment showed a Kappa coefficient of 0.72 and an overall accuracy of 66.2%.

6.2. SVM Classification results

Multi-sensor classification of the three levels of forest disturbance observed.

7. Conclusions

Most definitions from the literature agree that forest degradation is related to the detriment of forest structure. We investigated whether it was possible to assess significant differences in forest structure and link them to different levels of disturbance. A key aim of our research was to gain a better understanding of the state of the forest in our study area from the field data in order to investigate the capabilities of multi-frequency SAR data in discriminating variances in structure. Results from the SVM show a good approximation to categorize these forests by classes of deterioration. Results from the multi-temporal observations from Sentinel-1 show the variation in the backscatter related to changes. It is particularly important for this area, as it has been subject to intense selective logging and gold mining for decades. This study is the first insight into the structural variability of this forest from a remote sensing perspective.

4. Field site

Location: Located in the Bajo Calima municipality – in the Pacific coastal region at the Department of Valle del Cauca in Colombia. The area belongs to the Chocó-Darién bioregion: a national and international important area in terms of biodiversity and ecosystem services [6-7].

Ecosystem: Very moist tropical forest. Precipitation oscillates between 4000 and 8000 mm, therefore it is permanently cloud cover. Its altitude varies between 0 and 700.

Forest conditions: Very degraded forest due to historical illegal logging and gold mining.

5. Availability of data

The forest in the study area is assessed, and hence it can be seen as the no correlation between the projection and the ranges in backscatter for a forest area.

6.3 Multi-temporal analysis Sentinel – 1

7. Further work

This methodology can be applied and tested in other study areas and hence contribute to the scarce knowledge of how to assess forest disturbances and degradation. Further research will explore the temporal dynamics of Alos PalSAR and Alos-2.

References