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Potential Use of Sentinel-2 Data for Discrimination of Tectona grandis L Healthy and Non-healthy Tree Species Using Spectral Angle Mapper †

Ashwini Mudaliar *

Department of Botany, Faculty of Science, The Maharaja Sayajirao University Of Baroda Vadoda-ra-390002, Gujarat state, India
* Correspondence: ashwini144@gmail.com
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Abstract: The functional activity of a tree is affected by various biotic and abiotic factors. The vitality and health status of a tree also affects the growth. Recent remote sensing technologies provide powerful means for monitoring forest health. The aim of this study is to discriminate Tectona grandis L. healthy trees from non-healthy or infected trees using the Spectral Angle Mapper (SAM) algo-rithm. The present study site was located in a Southern Tropical Dry Deciduous Forests, of Guja-rat, western India. The forest was dominated by Tectona grandis L. The healthy and the unhealthy plots of T.grandis were chosen for the present research. Vitality of T. grandis was understood after detailed study on damage assessment in 45 different plots distributed in the study area. A mask for forest area from non-forest area was applied to extract forest area from the data. Pure endmembers of the masked dataset for healthy and non-healthy or infected tree were extracted. By utilizing the derived pure endmembers, spectral angle mapping was applied to differentiate between healthy and non-healthy or infected trees in the image.The results show that SAM of Sentinel-2 data can provide T.grandis maps that compare favorably with ground truth. Suggest-ing that there is a great potential of discrimination of T.grandis healthy trees from the non-healthy or infected using Sentinel-2 data

Keywords: Tectona grandis L;.Sentinel-2; Spectral Angle Mapping

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1. Introduction

The environmental health of our planet depends heavily on forestland. Globally, forests are under strain from both human and natural sources. The air we breathe and the goods we consume come from forests. The world's forests, which are the planet's largest terrestrial ecosystems, are im-portant for promoting social, economic, and ecological well-being [1,2]. Threats to forests, includ-ing severe drought and insect scourges, are present. Pests could permanently harm vegetative cover. The state of the forest stand, however, has a considerable impact on the overall service pro-vided by them [3]. The key to monitor forest health is through use of satellite data, specifically, multispectral imagery. Multispectral imagery has been the most widely used data in species com-position mapping studies [4], in forest biomass and carbon [5-8] and forest diversity [9, 10] and various parameter retrieval. Satellite image with high spectral capabilities such as hyperspectral sensors also, monitors earth surface. It contains a continuous narrow band surface allows to capture the biochemical composition of vegetation [11, 12]. They provide a fair level of detail. Therefore, in many studies hyperspectral data are better than multispectral images.

With now free availibility of high resolution and multi-spectral data, such as Sentinel-2 data, which can be proven to be beneficial for forest mapping. High resolution images have demon-strated to be useful in isolating indivual trees also.

Therefore, in the present study, the potential of Sentinel-2 data will be utilized for mapping Teak health conditions. The objectives of the present study were to: (1) discrimination of Tectona grandis L healthy and non-healthy tree species using Spectral Angle Mapper

2. Study Area

The Shoolpaneshwar Wildlife Sanctuary forests in south Gujarat are remnants of some of the finest forests in the Narmada District, Gujarat. It is spread out between 21° 38' 0'' North, 73° 35' 0'' East. They are home to a variety of natural resources and a diversity of flora and fauna. The two Forest types found in the area are not distinctly reflected on topography. The moist Tectona grandis L. (Teak) forests are found in Fulsar, Piplod, and Sagai ranges of the sanctuary. The composition of teak is usually 25% of the total crop. The dry teak forests also occur in the same locality within a short distance but mostly on poor soils, hill ridges and areas subjected to biotic interference.

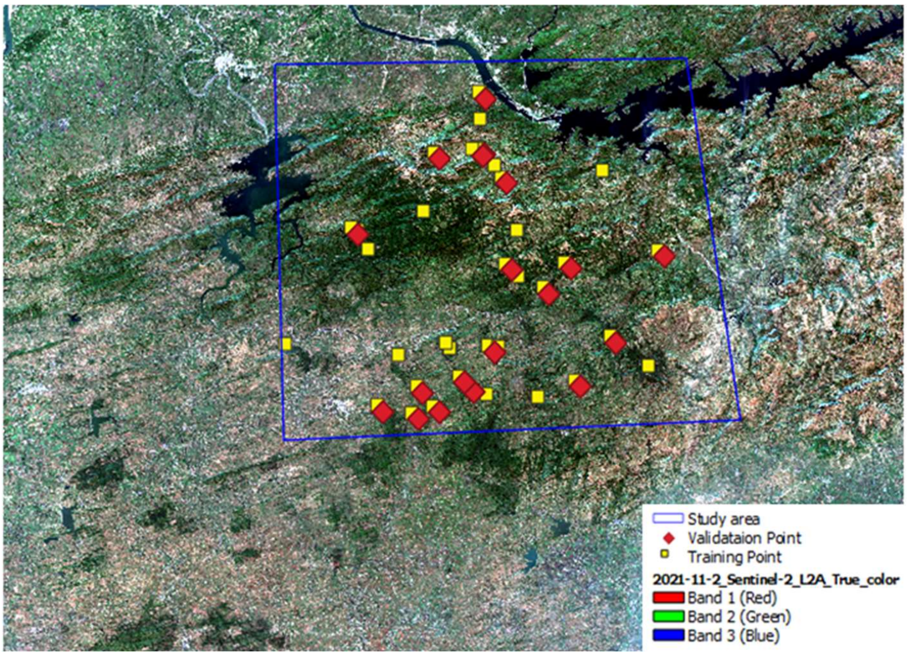

Figure 1. True color composite (665, 560, 443 nm, RGB) of Shoolpaneshwar Wildlife Sanc-tuary derived from Sentinel-2A data. Blue box shows study area.

3. Methodology

For Present Study Pure Tectona grandis L. plot were selected .We established 45 plots located Shoolpaneshwar Wildlife Sanctuary Dediapada of Narmada District .At each stand plot was marked with 30 m × 30 m (900 m2) and bounded by a buffer zone of 10 m wide having composition and structure, to avoid edge effects. Each plot was divided into 9 subplots with 10 x 10 m size. At each quadrat, the total number of trees was thoroughly counted. All woody species that were within the plots at Breast Height (DBH) (1.3 m) were identified counted at species level. The coordinates of the plot boundary and the location of each tree were recorded using a handheld global positioning system with sub-meter accuracy. Tree health was identified through visual inspection, taking account of various parameters, such as Unbalanced crown, Weak or yellowing foliage ,Defoliation, Dead or broken branches, Poor branch attachment ,Lean ,Pruning scars, Basal / trunk scars ,Conks, Rot / cavity, Cracks, Girdling roots, Exposed surface roots. Based upon the parameters rating was provided on scale of 1-5, 1 indicating poor health status and 5 indicating Healthy tree species.

3.1. Model Development

In the present study, freely available Sentinel-2 images (Level-2A product reflectance) downloaded from the Copernicus Open Access Hub (https://scihub.copernicus.eu/), for 28, November 2021, this month was chosen, because tree shows maximum leaf and growth. The data was resampled at 10m resolution. Based upon the above rating, healthy and non-healthy tree species signature was derived from the Sentinel-2 data. Which was further used for discriminating healthy tree species to non-healthy tree species using Spectral Angle Mapper (SAM). Out of 45 plots 20 plot was kept aside for data validation.

4. Result and Discussion

Discriminating of Healthy and Non-Healthy Teak plants were retrieve using three steps. First identification of healthy and non-healthy in 45 plots using visual inspection of tree species, secondly spectra was collected from Sentinel-2 data after resampling at 10m resolution and lastly the spectra (Figure-2) was utilized for Spectral Angle Mapper (SAM) based classification. Image was then subjected to data validation

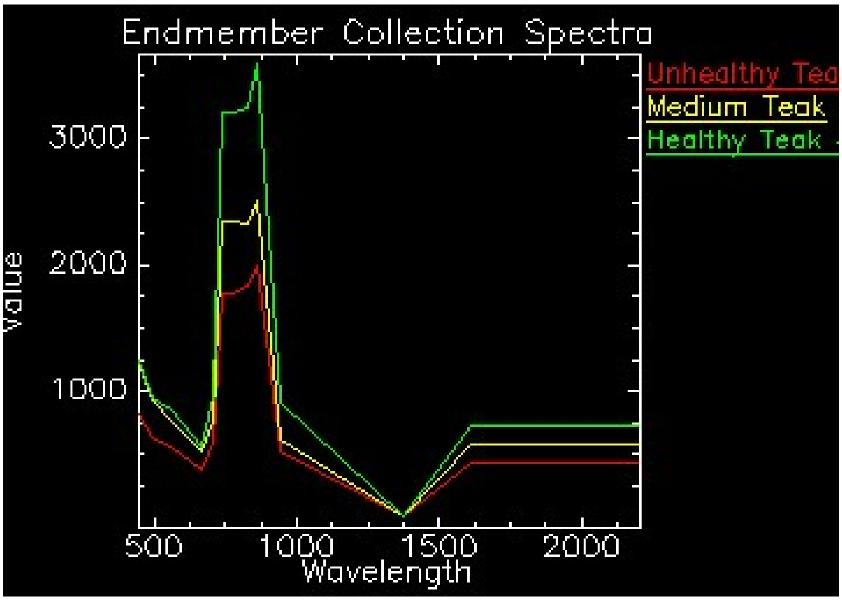

Figure 2. An average of spectra for Tectona grandis L in 45 plots.

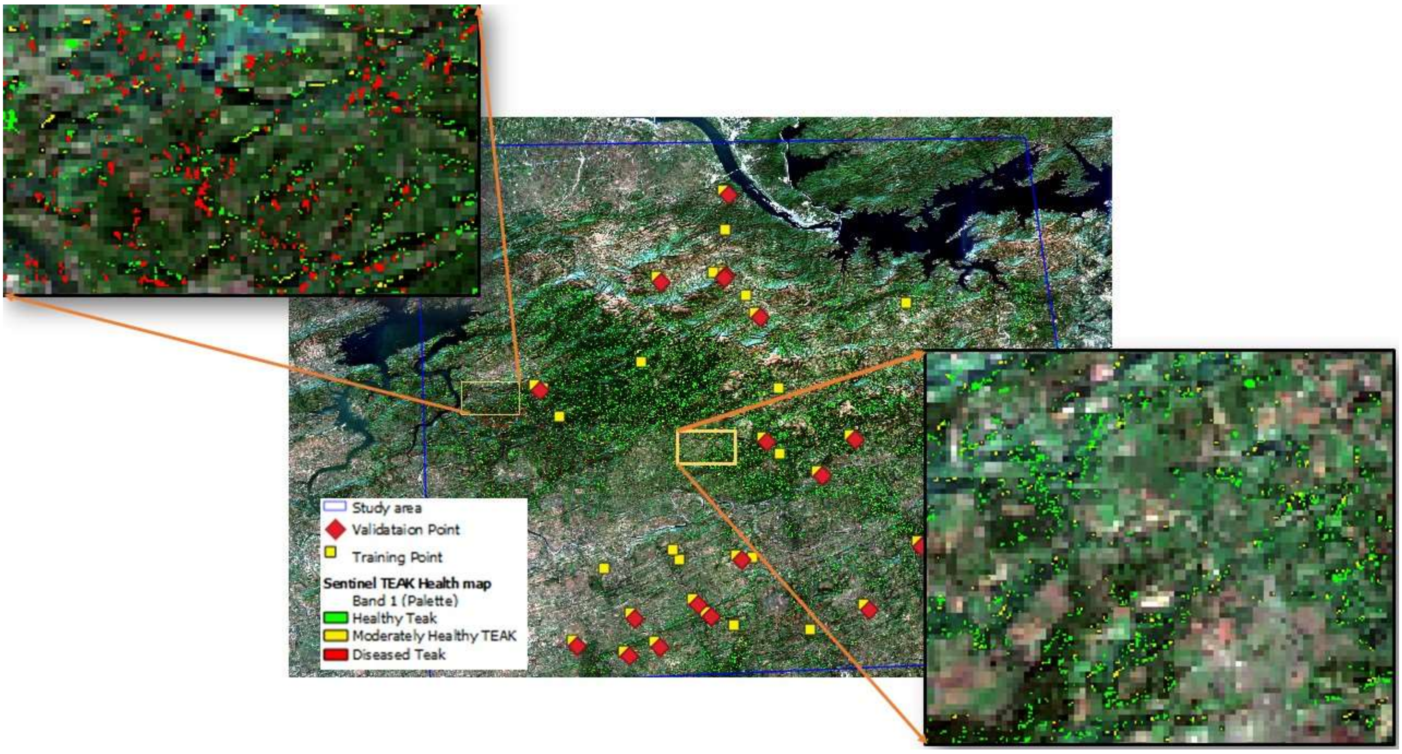

Figure 3. Mapping of Tectona grandis L using Sentinel-2 data.

Spectral Angle Mapper is a physical based classification system known as Spectral Angle Mapper (SAM) utilize an n-D angle to match pixels to reference spectra. The algorithm calculates the angle between two spectra. The distance between bands is measured to determine the similarity between two spectra. This method, when practiced in calibrated reflectance data, is relatively insensitive to light and light reflection. Endmember spectra can be directly extracted by the ROI mean spectra from the image. SAM then computes the angle or the angle distribution of each pixel vector in n-D space and indicates which pixels represent good matches to each endmember. Pixels further than a specified maximum angle threshold are not classified. SAM classification assumes reflectance data . The results showed that SAM was able to discriminate Healthy Teak from Non-healthy Teak species. (Figure-3).

4.1. Accuracy

Based on Table-1, the 20 validation plots were plotted in Tectona grandis L health map. Out of 20 plots surveyed from ground, the accuracy of the data was founded to be 75 %.

5. Conclusion

The results show that SAM of Sentinel-2 data can provide T.grandis maps that compare favorably with ground truth. Suggesting that there is a great potential of discrimination of T.grandis healthy trees from the non-healthy or infected using Sentinel-2 data The overall good performance with 75% accuracy shows better potential of Sentinel-2 data

For forest monitoring and it will effectively improve the monitoring of Forest health mapping and can utilized by forest managers for planning purpose

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