VEGETATION ANALYSIS BASED ON PLEIADES IMAGES AT UMK AGROPARK

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ABSTRACT: Forests are important in ecosystems for sustaining biodiversity, environmental and human services worldwide. In a developing country of South-East Asia have confronted the serious problem such as forests degradation due to socio-economic and socio-politics. Much research on the vegetation of forest area and its deforestation, reforestation, and dynamics have been performed in some parts of the world. The factors of the changes in forest tree in the degradation areas due to the anthropogenic activities. Forest vicinity supposed effortlessly measurable indicator for sustain and its changes is a vital where management of natural sources can be handled in larger areas. The analysis of vegetation based on forest canopy density is a primary aspect in evaluating the status of the forest. It is also an essential indicator for feasible management involvement. Fragmentation of the forests brings out the effect of the various stressing factors on the spatial extent of the forests particularly the inappropriate application that increasing population and industrialization, which has constantly affected the forested regions in the form of deforestation for conversion of forest land for cultivation purposes and business purposes. Hence, there is a need for spatial assessment and continuous monitoring of the forested regions. So, it is very crucial to analyse the vegetation at Universiti Malaysia Kelantan (UMK) Agropark based on Forest Canopy Density (FCD) to assess the quality of the forest. It is feasible that there is no changes in forest area but the forest canopy density is changed. The research was conducted in UMK Agropark, Jeli, where the study area covers about 462010.53 m^2. During this study, the methodology involved is a radiometric correction, reclassified, and parameters such as Advanced Vegetation Index (AVI), Bare Soil Index (BSI) and Canopy Shadow Index (SI) are used to study vegetation of forest area based on FCD and lastly correlation coefficient analysis. Pleiades image in 2018, is first formalized and then utilized in ENVI and ArcGIS 10.2 software to calculate FCD. The final results of the area consist of 29.12% very dense vegetation, 28.59% moderately dense vegetation, 16.50% low dense vegetation, 7.36% shrub and 6.74% bare soil. The highest value of r^2 among three graphs was r^2 = 0.93 which was graph scatter plots, FCD versus SI, which means that about 93% of the variation can be explained. This method is beneficial to discover and estimate the vegetation of forest area based on forest canopy density over large place in a time and cost high-quality manner.

1. INTRODUCTION

Forest plays an essential role in assisting the lifestyles of mankind. For example, supplying protection from sturdy winds, storing water, providing timber, purifying the atmosphere and reducing landslides or debris flows. Forest vicinity supposed effortlessly measurable indicator for sustain and its changes is a vital where management of natural sources can be handled in

larger areas (Kleinn, 2001). The analysis of forest trees based on forest canopy density is a primary aspect in evaluating the status of the forest. It is also an essential indicator for feasible management involvement.

Additionally, practices of forest management such as extraction of forest products which are major and minor from forests and based on forest canopy density, the implementation of interventions could be rearranged partly. Importantly, based on satellite images, the canopy of the forest can be used to measure and recognize the forest tree circumstance effectively (Urquizo *et. al*, 1999). It is crucial for an understanding of forest canopy density because proper reputation of forest tree can be analyzed, which is one of the essential indicators to be used for forest management and assets. Forest canopy density can be detected either via remote sensing or ground survey techniques. The basal area, canopy closure and quantity of timber per unit area are normally taken as variable to compute density through a ground survey. Anyway, a ground survey is not suitable to carry out for a large area. Digital picture analysis strategies have viable to provide a particular estimation of canopy density.

Remote sensing is frequently used in the research. Satellite images assist to produce information on land cover. The information about the land cover is regularly obtained from satellite images using algorithms classification (Franklin *et. al*, 1986, Md Rodi *et. al*, 2018). In this study, the three indices such as Advanced Vegetation Index (AVI), Bare Soil Index (BSI) and Canopy Shadow Index (SI) will be used to create an FCD model. Pleiades images will be processed in the software of ENVI and ArcGIS to discover FCD classification. Lastly, the aim of this study is to assess the ability of Pleiades Images in analyzing forest trees based on forest canopy density.

2. STUDY AREA

The study was carried out at Universiti Malaysia Kelantan (UMK) Agropark. The latitude of UMK Agropark is 5.6955°, meanwhile, its longitude is 101.8389° and nonetheless have flora and fauna. Pleiades 1A image with multispectral data of 2 m resolution was used in this study. The image was pre-processing of radiometric correction for further analysis. This study used Pleiades images with spectral bands which were 4 bands such as Red, Green, Blue, and Near-Infrared (NIR) with the resolution of spatial is 2 m (AIRBUS, 2012).

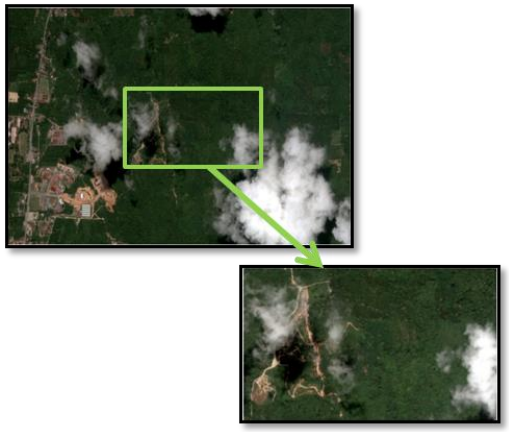


Figure 1: The location of UMK Agropark, Jeli

3. METHODOLOGY

Several steps need to be taken in order to calculate FCD as in Figure 3. Firstly, a conversion of DN to at-sensor radiance need to be identified. Digital Number (DN) was converted to Radiance based on Equation (1) as follows:

$$L_\lambda = (DN/GAIN) + BIAS \quad (1)$$

where L_λ is radiance of spectral at an aperture of the sensor (W/(m^2 sr µm)), DN refer to digital number of the cell value, GAIN = The gain value of the specific band and BIAS is the bias value of the specific band. Radiance was converted to top of atmosphere (TOA) based on Equation (2) as follows:

$$P_\lambda = \frac{\pi \times L_\lambda}{ESUN_\lambda \times \cos \theta_s} \quad (2)$$

where P_λ refer to TOA reflectance of the planetary (unitless), L_λ is radiance of spectral at aperture of sensor (W/(m^2 sr µm)), $ESUN_\lambda$ = Exoatmospheric solar irradiance mean (W/(m^2 µm)) and θ_s = Angle of solar zenith (degree/radians).

Three parameters were used to calculate the Forest Canopy Density Index (FDI) includes Advanced Vegetation Index (AVI), Bare Soil Index (BSI) and Shadow Index (SI). Table 1 shows the combination of tree indices characteristics.

Table 1: Combination of tree indices characteristics

	Hi-FCD	Mid-FCD	Low-FCD	Shrub	Bare soil
AVI	Hi	Hi	Mid	Hi	Low
BSI	Low	Low	Low	Mid	Hi
SI	Hi	Hi	Mid	Low	Low

Advanced Vegetation Index (AVI) was used because this involves the power degree of infrared which highlights the categories of vegetations such as grassland and forest cover. The power degree enables AVI to be more physiognomic vegetation indices and sensitive to forest density. If the vegetation cover increases, AVI will increase which was calculated using Equation 3 (Rikimaru *et. al*, 1999 & Godinho *et. al*, 2016).

$$AVI = \sqrt{(NIR + 1)(DNmax - Red)(NIR - Red)} \quad (3)$$

Bare Soil Index (BSI) is an index that was suitable for investigating soil and discovered the differences between agriculture and non-agriculture vegetation. It was sensitive to separation of bare soil, dense canopy and sparse canopy. BSI was calculated using Equation 4 (Rikimaru *et. al*, 1999 & Godinho *et. al*, 2016).

$$BSI = \frac{(NIR+Green)-Red}{(NIR+Green+Red)} \quad (4)$$

Canopy Shadow Index, SI has assessed the different shadow patterns, primarily based on the age, the distribution of species, structure, and others by crown management in the forest through affecting the responses of spectral each time. The pattern of shadow was depended on trees and forest layout patterns. The young plants have canopy shadow value was low

compared to the shadow of old natural forest (Banerjee *et. al*, 2014). SI was calculated using Equation 5 (Rikimaru *et. al*, 1999 & Godinho *et. al*, 2016).

$$SI = \sqrt{((DNmax - Green)(DNmax - Red)} \quad (5)$$

Vegetation Density (VD) is the procedure that was synthesized VI and BSI. The method of processing has used the analysis of the principal component. Basically, BSI and VI had a high negative correlation. Then, a zero and a hundred percent point scale was set. Scaled Shadow Index (SSI) is a value that was relative. It was used for the calculation normalized value with different parameters. SSI was suitable for integrating two values, VI and SI.

Forest Canopy Density, FCD model was to investigate the quality of the forest. VD and SSI integration ability alteration for the value of forest canopy density. These parameters have the density of percentage scale unit and dimension so that both indices were synthesized with corresponding each of unit and scale. The combination of VD and SSI for FCD calculation based on equation 6 and the scale was used from 0% to 100% (Rikimaru *et. al*, 1999).

$$FCD = \sqrt{(VD \times SSI + 1)} - 1 \quad (6)$$

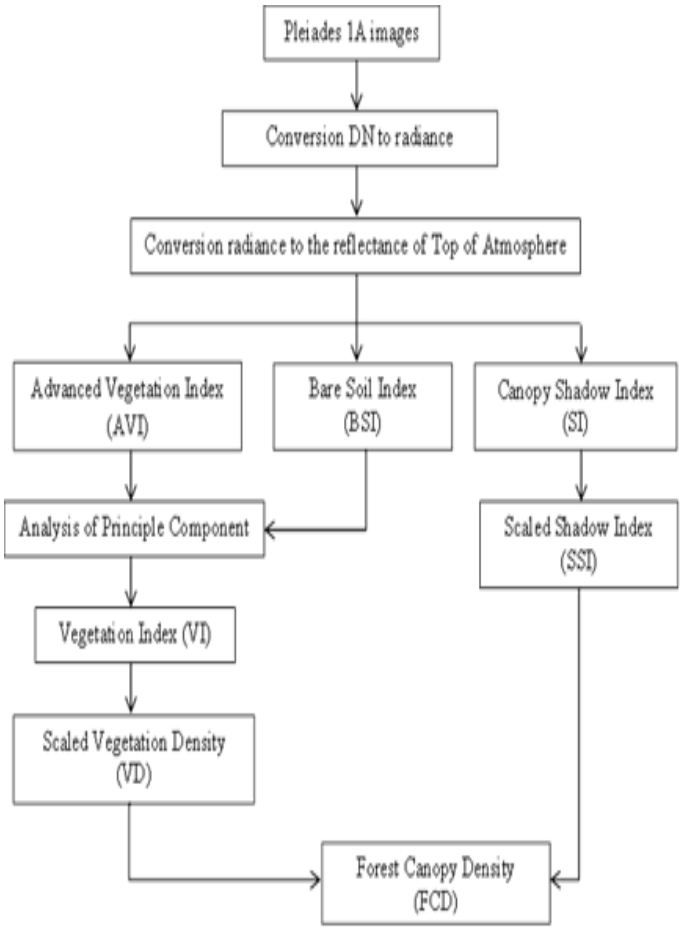
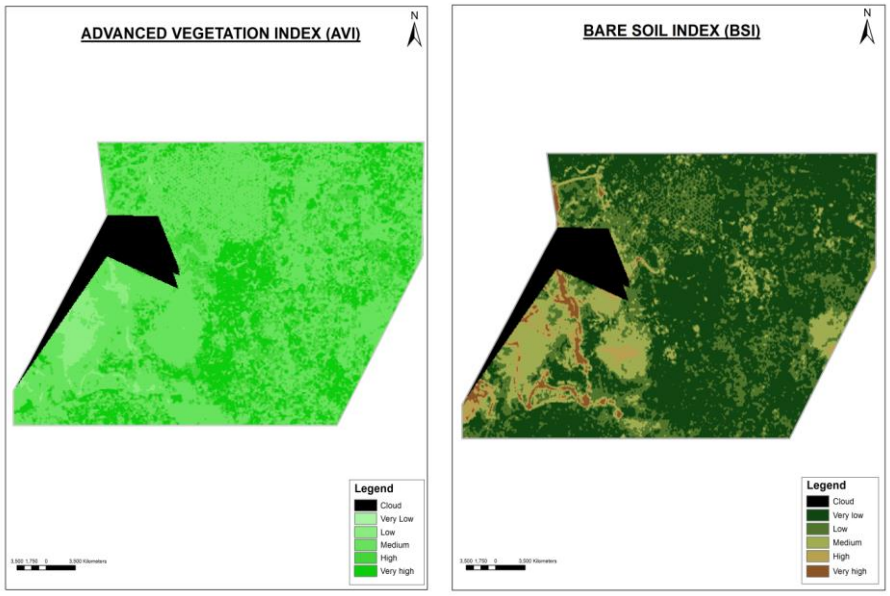


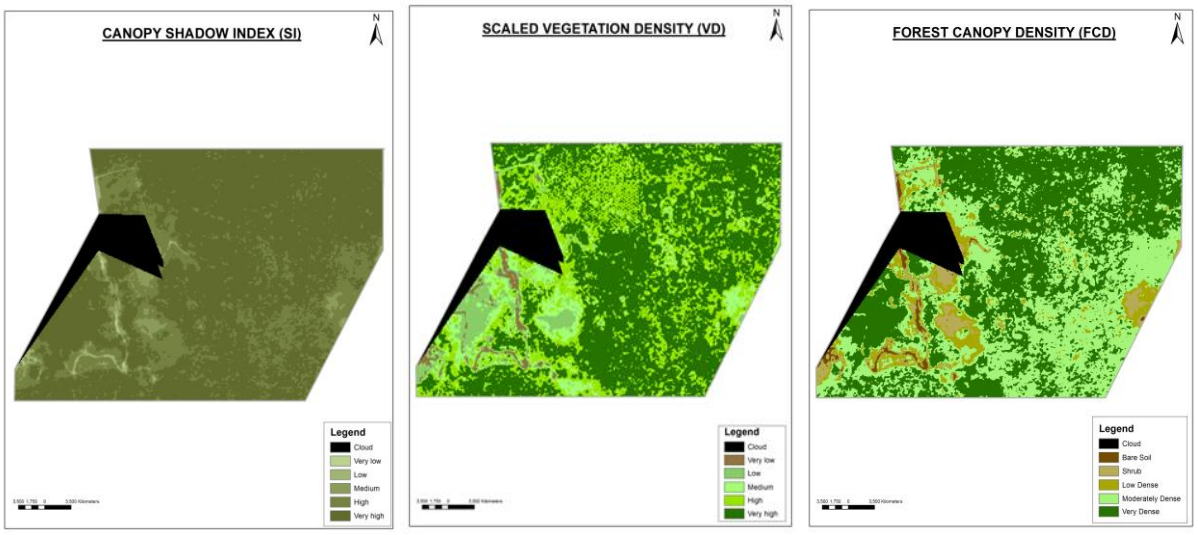
Figure 2: Flowchart of research methodology

4. RESULTS AND DISCUSSIONS

This study aimed to highlights that Pleaides data was used in analyzing the forest tree based on forest canopy density of a UMK Agropark area with acceptable accuracy. Moreover, the density of forests in this area is quite good for the biodiversity of UMK Agropark. The final forest canopy density map was classified into five classes of forest canopy density excluding the cloud based on the percentage such as very dense, moderately dense, low forest, shrub and bare soil.



(a) Advanced Vegetation Index (AVI) (b) Bare Soil Index (BSI)



(c) Canopy Shadow Index (SI) (d) Scaled Vegetation Density (VD) (e) Forest Canopy Density (FCD)

Figure 3: Results of (a) Advanced Vegetation Index (AVI), (b) Bare Soil Index (BSI), (c) Canopy Shadow Index (SI), (d) Scaled Vegetation Density (VD) and (e) Forest Canopy Density (FCD)

Result revealed that Forest Canopy Density (FCD) as in Figure 3(e), that approximately 30% area is covered by forest canopy density of more than 70% (very dense), while 31% area with

the density class of 40% - 70% (moderately dense), 20% area with the density class of 10-40% (low dense), 6.5% area with the density class of less than 10% (shrub) and 4.5% area with the density class of 1% - 5% that excluding any of the above density which was bare soil or non-forest. The cloud with 8% area was excluded in the classification of forest tree based on forest canopy density and it was set as null value. The availability of low dense which was low forest area based on the map helps the quantities of good habitat for prey and predators.

Table 2: Category of Forest Canopy Density area.

No.	FCD Class		Area (%)
1	Cloud	0%	8.0%
2	Bare Soil	1% - 5%	4.5%
3	Shrub	<10%	6.5%
4	Low Dense	10% - 40%	20.0%
5	Moderately Dense	40% - 70%	31.0%
6	Very Dense	>70%	30.0%

Forest canopy density is one of the significant parameters in the management of a forest or protected area (Rikimaru *et. al*, 1999). Canopy density is an important parameter to assess and analyze the elements influencing the growth of forest, its regeneration and ensuring examination of vegetation management initiatives and the status of regeneration (Chauhan, 2004). The satellite data of multi-spectral with fitting ground measurements can be widely adapted to large geographical regions, and this has critical points of advantages for forest management, especially in areas where forests are located in remote or inaccessible locations (Blodgett *et. al*, 2000).

Lastly, the satellite remote sensing is most appropriate for analysis forest tree based on forest canopy density, while modeling biophysical spectral responses for stratification of forest density particularly in dry deciduous forests. The approach for measuring forest tree based on forest canopy density is valuable when managing fragile and unique ecosystems in forest or protected areas (Prasad *et. al*, 2010).

5. CONCLUSION

Forest resources protection and management play an extremely vital role for study area. Using Pleaides Images (satellite data) and GIS as to analyze the forest tree based on forest canopy density, the results that were achieved have high reliability. The satellite images can provide beneficial data in the research based on the properties of physical and spectral reflection of the objects on the surface rather than ground truth that had disadvantages in terms of time and cost to get the results of forest tree. Pleaides images was utilized to calculate the variations of dense forest in large scale in this study. The map of Forest Canopy Density was revealed the situation of UMK Agropark forest via canopy density level. However, this study can advance further by using statistics to get accurate results and use many satellite images in different periods. This helps for evaluating the changes of forest tree based on forest canopy density over time. This is one of vital criteria for assessing the quality of forest and contribute information the management of forest.

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