URBAN VEGETATION CLASSIFICATION WITH NDVI THRESHOLD VALUE METHOD WITH VERY HIGH RESOLUTION (VHR) PLEIADES IMAGERY

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ABSTRACT:

Recently the sensing data for urban mapping used is in high demand together with the accessible of very high resolution (VHR) satellite data such as Worldview and Pleiades. This article presents the use of very high resolution (VHR) remote sensing data for urban vegetation mapping. The research objectives were to assess the use of Pleiades imagery to extricate the data of urban vegetation in urban area of Kuala Lumpur. Normalized Difference Vegetation Index (NDVI) was employed with VHR data to find Vegetation Index for classification process of vegetation and non-vegetation classes. Land use classes are easily determined by computing their Normalized Difference Vegetation Index for Land use land cover classification. Maximum likelihood was conducted for the classification phase. NDVI were extracted from the imagery to assist the process of classification. NDVI method is use by referring to its features such as vegetation at different NDVI threshold values. The result showed three classes of land cover that consist of low vegetation, high vegetation and non-vegetation area. The accuracy assessment gained was then being implemented using the usual interpretation and overall accuracy achieved was 70.740% with kappa coefficient of 0.5. This study gained the proposed threshold method using NDVI value able to identify and classify urban vegetation with the use of VHR Pleiades imagery and need further improvement when apply to different area of interest and different land use land cover characteristics. The information achieved from the result able to help planners for future planning for conservation of vegetation in urban area.

1. INTRODUCTION

In observing the changes in vegetation and urban organization, the measurement and mapping of the green vegetation in urban area play a vital part to achieve the goal (Chikr El-Mezour et al., 2010). Vegetation gives an important component that affect the urban environment. Vegetation is important because it shows an adaptable resource for effective controlling and moderating a variety of problems associated with urbanization (Li et al., 2016). The spatial distribution and abundance of urban vegetation are recognized as a key factor influencing numerous biophysical processes of the urban environment (Yu et al., 2004).

As the understanding of ecosystem services is getting concerned, researchers are becoming more aware of the importance of urban vegetation towards sustainable of urban ecosystem and environment. In recent years, remote sensing technology gives a deal of benefits for urban vegetation details acquisition and mapping (Tooke et al., 2009; Tigges et al., 2013; Abd Latif et al., 2011; Pu and Landry, 2012; Immitzer et al., 2012).

In the past decades, numerous modern technologies and procedures to produce vegetation maps from remote sensing imagery has expand, including different types of sensors cooperating with variety combination of scale imagery that is attractive and dominant to urban planners and land managers (Rogen and Chen, 2004). Furthermore, the advancement in remote sensing technologies enable to be an effective instrument to extract information of the surface cover accurately (Adnan NA et al., 2015).

Moreover, specific vegetation mapping is known to be critical for natural resources management, ecological analysis and hydrological modelling (Su et al., 2015). Therefore, the use of very high-resolution (VHR) satellite imagery has proven its ability for comprehensive and detailed mapping and classification of tree structure and species for more than two decades (Pu and Landry, 2012; Karlson et al., 2016). Nevertheless, categorization of urban tree cover types and species using very high-resolution (VHR) satellite imagery remains unchange in urban areas due to some essential characteristics of urban environments (Pu et al., 2018). Thus, identification and classification of urban vegetation is important for future conservation planning of urban area. Furthermore, Remote sensing dataset is widely used for land cover classification including vegetation mapping using supervised classification approach has proven to produce high accuracies that more that 80% (Abd Latif et al., 2012).

A lot of vegetation indices have been assembled more focused to the characteristics of low red and high near infrared reflectance, including the most widely used index, Normalized Difference Vegetation Index (NDVI) (Hu et al., 2008). The normalized difference vegetation index (NDVI) is one of the most essential guideline of
vegetation cover in particular region from remotely sensed data gained using the space borne sensors (Ceballos and Lopez, 2003).

The NDVI is obviously used to detect any land cover changes caused by human activities like construction and other developmental projects (Aburas et al., 2015; Ahmad and Sharif, 2016). Moreover, NDVI also had been used broadly to analyse the spatio-temporal changes of vegetation coverage (Statistic Malaysia, 2014). The vegetation index calculates the balance between the energy obtained and emitted by earth objects using the Red and NIR bands (Backlund et al., 2008).

NDVI can be expressed as (1):

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)} \ldots \ldots (1)$$

$$(NIR : Near \text{ Infra} \text{ Red})$$

This paper primarily objective is to fully utilized the remote sensing application for identification and classification of vegetation in urban area. In this paper, high resolution satellite imagery, Pleiades was use as the main data source and NDVI threshold method was selected for classification of vegetation types in urban area.

2. METHODOLOGY

2.1 Research data collection

The study area of this research was covered small part of National Monument Park, Kuala Lumpur as can be referred in figure 1. The main factors of this research is done in the study area are various vegetation types and vegetation density. The study utilized the high-resolution satellite imagery, Pleiades was used as the main data source and NDVI threshold method was selected for classification of vegetation types in the study area accurately based on the NDVI value. Pleiades imagery has a reliable spatial resolution of 0.5 m for panchromatic and 2 m for near infrared. This imagery was used to discover the various vegetation types in the study area accurately based on the NDVI value. Pleiades imagery that has been used was obtained from Malaysia Remote Sensing Agency (ARSM). Ortho systematic and pan-sharpening process was also corrected by the imagery.

2.2 Image Processing

The research flowchart in Figure 2 provides an overview of the methods. High resolution multispectral Pleiades imagery with 2 m spatial resolution was used for vegetation classification by the ENVI software. The overall data processing was split into three main steps as follow: 1) Image pre-processing 2) NDVI threshold 3) Classification of urban vegetation types. The imagery was already corrected for ortho-systematic and processed for pan-sharpening. For the second stage, the selection of NDVI value for vegetation mapping. The Pleiades imagery were categorized into specified classes according to the NDVI threshold value in the supervised classification. The implementation value of NDVI range from -1 to 1 was used to reclassify NDVI maps as refer to vegetation rates based on spectral reflections (Bharathkumar and Mohammed-Aslam, 2015).

The classes created based on the NDVI value that was divided to non-vegetation (-1 to 0.199), low vegetation (0.2 to 0.5) and high vegetation (0.501 to 1.0). Table 1 indicate detail information about the classes and its NDVI value. In the classification stage, a consistent supervised categorization was used for this study. An accurate polygon was created to select and classify the objects as training areas and to introduce the ideal classes for each image separately. As for the classification algorithm, the Maximum Likelihood (ML) algorithm was selected because of its ability to classify object correctly. This classification algorithm was the most common method being used in the land use land cover mapping. Finally, for verification purpose, the classification result was compared with the ground truth data. The accuracy of the classification was analysed using matrix coefficient approach. The result obtained from the confusion matrix was considered from the user accuracy, producer accuracy and overall accuracy of the classification result. This result will reflect the ability of the high resolution Pleiades imagery for urban vegetation mapping.

Figure 1: Pleiades imagery of National Monument Park, Kuala Lumpur (Source: Google)

Figure 2: Research flow chart of urban vegetation mapping
The details of the result are as follows, for non-vegetation the producer and user accuracy was 94.64% and 97.70% respectively. As for low vegetation the producer and user accuracy was 38.41% and 35.16% respectively and for high vegetation the producer and user accuracy was 55.16% and 56.49% respectively. Finally, for the overall accuracy is 70.740 and kappa coefficient was 0.5, this result is satisfactorily accepted. Table 2 shows the detail of the accuracy assessment result for urban vegetation mapping with NDVI threshold values. The findings from this study indicate that high resolution Pleiades imagery are able to extract and classify urban vegetation with satisfactorily result.

Table 2. Coefficient matrix result

<table>
<thead>
<tr>
<th>Land Use/Land Cover</th>
<th>Producer’s Accuracy (%)</th>
<th>User’s Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Vegetation</td>
<td>94.64</td>
<td>97.70</td>
</tr>
<tr>
<td>Low Vegetation</td>
<td>38.41</td>
<td>35.16</td>
</tr>
<tr>
<td>High Vegetation</td>
<td>55.16</td>
<td>56.49</td>
</tr>
<tr>
<td>Overall Accuracy</td>
<td>70.740%</td>
<td></td>
</tr>
<tr>
<td>Kappa Coefficient</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>

4. CONCLUSIONS

Obtaining spatially detailed information of vegetation is challenging and is critical for sustainable forest management. In this study, we assessed the utility of high resolution data for vegetation mapping in urban area. Two types of urban vegetation were classified with NDVI threshold value and supervised classification approach. Based from the result, NDVI is proven to become an important indicator for detection of urban vegetation cover. In addition, NDVI approach has been fully utilized with different types of applicable sensors for vegetation mapping.

This vegetation mapping can be used for future planning of conservation purpose for the green spaces in the urban area. However, classification results would be affected by the different characteristic of sensors obtained. Result of the study confirmed that NDVI threshold approach able to identify vegetation in urban area with low but acceptable result of accuracy assessment.

A better visual interpretation for vegetation distribution in the study area can be provide by the high-resolution vegetation maps produced. In the future, we intent to enlarge the proposed approach to a better high-resolution satellite images and apply the advance classification approach for better result of urban vegetation mapping.

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REFERENCES


Li, F., Han, L., Liujun, Z., Yinyou, H and Song, G., 2016. Urban vegetation mapping based on the HJ-1 NDVI reconstruction. The International Archives of the Photogrammetry, remote Sensing and Spatial Information Sciences, Vol. XLI-BB, pp. 867-871


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