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

Haslina Hashim[1], Zulkiflee Abd Latif [2], Nor Aizam Adnan [3]

[1]Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA,
40450 Shah Alam, Selangor, Malaysia. - haslinah8118@gmail.com
[2]Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Perak Branch,
32610 Seri Iskandar, Perak, Malaysia. - zabdlatif@gmail.com
[3]Applied Remote Sensing and Geospatial Research Group, Centre of Studies for Surveying, Science and Geomatics, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia..-
adnannoraizam@gmail.com

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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) were employs 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 visual 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):

$$NDVI = (NIR - RED) / (NIR + RED) \quad \ldots\ldots\ldots (1)$$

(NIR : Near Infra 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 Pleiades images of 2017 as the data source. 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.

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

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 overalls accuracy of the classification result. This result will reflect the ability of the high resolution Pleiades imagery for urban vegetation mapping.

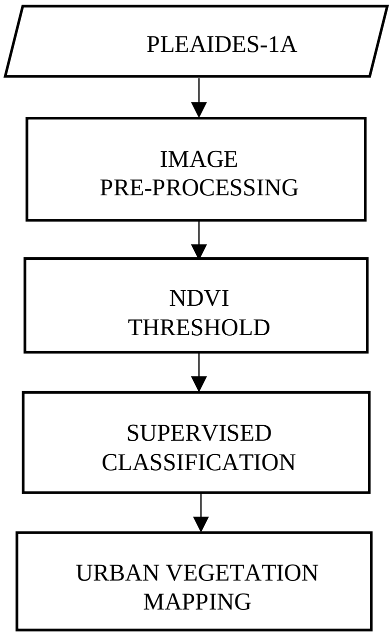

Figure 2: Research flow chart of urban vegetation mapping

Table 1 Urban vegetation classes and NDVI value

Bil	Vegetation Classes	Description	NDVI Value
1	Non-Vegetation	Barren areas, build up area, road network	: -1 to 0.199
2	Low Vegetation	Shrub and grassland	: 0.2 to 0.5
3	High Vegetation	Temperate and Tropical urban forest	: 0.501 to 1.0

3. RESULTS AND DISCUSSION

In this study, three types of land cover in the study area were extracted and classify using remote sensing and its high-resolution imagery. Figure 2 shows the result of urban vegetation mapping with NDVI threshold approach where green indicates high vegetation, purple for low vegetation and red for non-vegetation area. This vegetation cover was identified using the NDVI threshold value method. The NDVI threshold value able to identify the vegetation types in urban area. For example, the NDVI value threshold from 0.501 to 1.0 indicate the high vegetation like trees in urban areas, while lower value represents low vegetation and non-vegetation. With the use of remote sensing classification approach the vegetation classification can be mapped accurately.

The classification result is based on NDVI threshold value to classify non-vegetation (-1 to 0.1999), low vegetation (0. 2to 0.5) and high vegetation (0.501 to 1.0). The supervised classification with maximum likelihood algorithm was used to classify the vegetation types in the study area. From the classification result, the user and producer accuracy will reflect the effectiveness of classification methods for urban vegetation mapping. Field data collection were referred to validate the vegetation types from the classification process. Thus, reliable result will be achieved and vegetation in urban area can be mapped accurately.

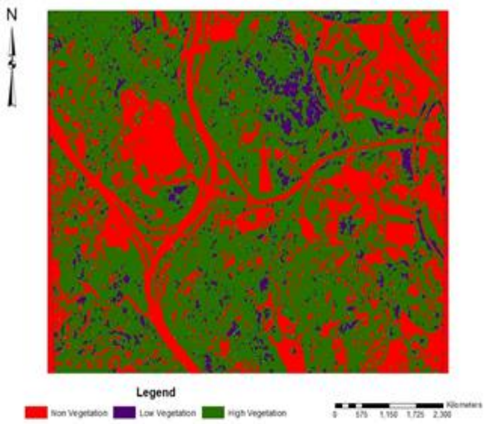

Figure 2: Classification result

3.1 Accuracy Assessment

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

Land Use/Land Cover	Producer's	User's
	Accuracy (%)	
Non-Vegetation	94.64	97.70
Low Vegetation	38.41	35.16
High Vegetation	55.16	56.49
Overall Accuracy	70.740%	
Kappa Coefficient	0.5	

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

Abd Latif, Z., Aman, S. N. A., & Ghazali, R. 2011. *Delineation of tree crown and canopy height using airborne LiDAR and aerial photo. 2011 IEEE 7th International Colloquium on Signal Processing and Its Applications*.doi:10.1109/cspa.2011.5759902

Abd Latif, Z., Zamri, I. & Omar, H., 2012. Determination of trees species using WorldView-2 data. *IEEE 8th Int. Conf. on Signal Process Appl. and Technol.(ICSPAT)*, 383–387.

Aburas, M. M., Abdullah, S. H., Ramli, M. F., & Ash'aari, Z. H., 2015. Measuring Land Cover Change in Seremban, Malaysia Using NDVI Index. *Procedia Environmental Sciences*, 30, 238–243. doi:10.1016/j.proenv.2015.10.043

Adnan N A, Noralam N F F, Salleh S A, Abd L Z. Utilizing Landsat imageries for land surface temperature (LST) analysis of the Penang Island. In International Conference on Space Science and Communication, 2015, pp. 193-198

A.Verheyden, F. Dahdouh-Guebas, K. Thomas, W. De Genst, S. Hettiarachchi and N. Koedam., 2002. "High-resolution vegetation data for mangrove research as obtained from aerial photography," *Environment, Development and Sustainability*, 4, 113-133

Bharathkumar, L., & Mohammed-Aslam, M. A., 2015. Crop Pattern Mapping of Tumkur Taluk Using NDVI Technique: A Remote Sensing and GIS Approach. *Aquatic Procedia*, 4, 1397–1404. doi:10.1016/j.aqpro.2015.02.181

Backlund, P., Janetos, A., & Schimel, D., 2008. The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States. Synthesis and Assessment Product 4.3. Washington, DC: U.S. *Environmental Protection Agency, Climate Change Science Program*. 240 p.

Ceballos-Silva, A., & López-Blanco, J., 2003. Delineation of suitable areas for crops using a MultiCriteria Evaluation approach and land use/cover mapping: a case study in Central Mexico. Agricultural Systems, 77(2), 117–136. doi:10.1016/s0308-521x (02)00103-8

Chikr El-Mezouar, M., Taleb, N., Kpalma, K., & Ronsin, J., 2010. A high-resolution index for vegetation extraction in IKONOS images. *Remote Sensing for Agriculture, Ecosystems, and Hydrology* XII. doi:10.1117/12.866187

Immitzer, M., Atzberger, C., & Koukal, T., 2012. Tree Species Classification with Random Forest Using Very High Spatial Resolution 8-Band WorldView-2 Satellite Data. *Remote Sensing*, 4(9), 2661– 2693. doi:10.3390/rs4092661

Jianbo Hu, Wei Chen, Xiaoyu Li, & Xingyuan He., 2008. Roof confusion removal for accurate vegetation extraction in the urban environment. *2008 International Workshop on Earth Observation and Remote Sensing Applications.* doi:10.1109/eorsa.2008.4620309

Karlson, M., Ostwald, M., Reese, H., Bazié, H.R., Tankoano, B., 2016. Assessing the potential of multi-seasonal WorldView-2 imagery for mapping West African agroforestry tree species. *Int. J. Appl. Earth Obs. Geoinf.* 50, 80–88.

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

Miloud Chikr El-Mezouar, Nasreddine Taleb, Kidiyo Kpalma, Joseph Ronsin., 2010. A high resolution index for vegetation extraction in IKONOS images. SPIE. *Proceedings of the SPIE on Remote Sensing for Agriculture, Ecosystems, and Hydrology*, Sep 2010, Toulouse, France. SPIE, 7824 (XII), pp.78242A-1 - 78242A-9

Nichol, J., & Lee, C. M., 2005. Urban vegetation monitoring in Hong Kong using high resolution multispectral images. *International Journal of Remote Sensing*, 26(5), 903–918. doi:10.1080/01431160412331291198

Pu, R., & Landry, S., 2012. A comparative analysis of high spatial resolution IKONOS and WorldView-2 imagery for mapping urban tree species. *Remote Sensing of Environment*, 124, 516– 533. doi:10.1016/j.rse.2012.06.011

Pu, R., Landry, S., & Yu, Q. 2018. Assessing the potential of multi-seasonal high resolution Pléiades satellite imagery for mapping urban tree species. *International Journal of Applied Earth Observation and Geoinformation*, 71, 144–158. doi:10.1016/j.jag.2018.05.005

Rogan, J., & Chen, D., 2004. Remote sensing technology for mapping and monitoring land-cover and land-use change. Progress in Planning, 61(4), 301–325. doi:10.1016/s0305-9006(03)00066-7

Tigges, J., Lakes, T., & Hostert, P., 2013. Urban vegetation classification: Benefits of multi-temporal RapidEye satellite data. *Remote Sensing of Environment*, 136, 66–75. doi:10.1016/j.rse.2013.05.001

Tooke, T. R., Coops, N. C., Goodwin, N. R., & Voogt, J. A., 2009. Extracting urban vegetation characteristics using spectral mixture analysis and decision tree classifications. *Remote Sensing of Environment*, 113(2), 398–407. doi:10.1016/j.rse.2008.10.005

Yanjun Su, Qinghua Guo, Danny L. Fry, Brandon M. Collins, Maggi Kelly, Jacob P. Flanagan & John J. Battles 2015: A Vegetation Mapping Strategy for Conifer Forests by Combining Airborne LiDAR Data and Aerial Imagery, *Canadian Journal of Remote Sensing*, DOI: 10.1080/07038992.2016.1131114

Yu, F., Price, K.P., Ellis, J., and Kastens, D., 2004. Satellite Observations of the Seasonal Vegetation Growth in Central Asia: 1982-1990. *Photogrammetric Engineering & Remote*, 2004, 70(4): 461-469

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