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A Comparison of the vegetation index of KorKor 49 rice field from orthomosaic map and video by using unmanned aerial vehicle

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Abstract

A comparison of the vegetation Index of KorKor 49 rice field from orthomosaic map and video by using unmanned aerial vehicle (UAV) aim to study a possibility of the RGB color index analysis for calculate the vegetation Index such as VARI, EXG, YIELD and Chlorophyll by using photos and videos from the UAV during the tillering, booting, flowering, and pre-harvesting stages. The RGB color index was analysis by 2 cases, Case 1 creating an orthomosaic map from photo (the photos were taken from UAV) by the process of photogrammetry using Agisoft Metashape program then analyzing the RGB color index by using QGIS program, Case 2 analysis the RGB color index by using video processing technique from MATLAB program. The result of the RGB color index from 2 case shown that it can be used to analysis the vegetation index, yield and chlorophyll which different situation. The comparison between 4 parameters shown that, VARI index the MATLAB analysis method has a trend to be consistent with rice growth than the QGIS method, EXG index the QGIS analysis method has a trend to be consistent with rice growth than the MATLAB method, chlorophyll value the MATLAB analysis method has a trend to be consistent with rice growth than the QGIS method and yield shown that, the QGIS analysis method can give precise a rice yield prediction than the MATLAB method which was error 14% in the pre-harvest stage.

Keywords: Unmanned aerial vehicle (UAV), Vegetation Index, Image processing

1. Introduction

Rice is an important economic crop of Thailand. In the first 10 months of 2023 (January - October), the total export volume was 6,922,649 tons. The export volume grew by 11.4 percent when compared to the same period of 2022, with a value of 136,289.84 million baht, an increase of 24.7% [1]. It can be seen that even though Thai rice exported approximately 7 million tons in 2023, Thai rice is still ranked 3rd in export compared to India and Vietnam. In the past, Thai rice exported as number 1 in the world. Therefore, if there is an acceleration of development in both quantity and quality, increasing competitiveness in the world market, Thai rice will be able to return to being number 1 exporter as in the past, especially white rice, which is the country's number 1 exporter. Statistics from January - May 2023 show that Thailand exported a total of 1,890,824 tons of white rice [2]. Many varieties of Thai white rice are cultivated in many areas, especially in the Northeast.

The lower northern and central regions, and the northeastern region have rice planting areas accounting for 57% of the country. Khon Kaen Province has a total area of 6.8 million rai, with 2,385,713 rai of rice planting areas, accounting for 68% of the area [3]. From past statistics, rice is still an important economic crop in Khon Kaen Province. From the Khon Kaen Provincial Development Plan (2023-2027) revised for fiscal year 2024, it was found that at the end of 2019, the outbreak of the coronavirus disease 2019 (COVID-2019) affected the economy of Thailand and Khon Kaen Province, especially income from tourism and employment decreased, causing society to be vulnerable to recovery and development. In addition, the existing economic development problems of the province, both in terms of productivity and low agriculture, due to the lack of application of technology to increase productivity.

New-generation farmers lack opportunities to develop their potential to become entrepreneurs. Access to sources of funding Agricultural costs have been continuously increasing and agricultural product prices are volatile. Low agriculture due to the lack of application of technology to increase productivity. New-generation farmers lack opportunities to develop their potential [4]. The characteristics of rice planting areas are large areas that are difficult to access because the soil is muddy and flooded, making it difficult for farmers to access the problems that occur in the plantation. In addition, there are many other problems with Thai rice, such as production problems, production efficiency problems, problems from low-quality rice, fertilizer application, and problems with diseases and pests.

In the past, technology was not developed to help agriculture much. Therefore, there was a high investment and no clear return. Currently, technology has significantly improved the development of agriculture. However, precision farming requires modern technology to help survey the growth of agricultural crops in detail to identify areas that are not growing. In the past, high-angle surveys required satellite images to interpret the meaning, which was slow and expensive. However, in the present era, there has been development in remote sensing technology with drones, which is a real-time survey technology because it can survey areas quickly and efficiently.

Drones use the principle of GPS, allowing them to survey areas that are difficult for humans to access. It uses the principle of taking photos or videos, combining images, and analyzing the abundance of vegetation using ready-made programs or analyzing them immediately with multispectral camera technology installed on drones. However, the limitations of these programs and technologies are quite high in cost, which in the research [5] using the RGB images obtained by UAV to estimate leaf Area Index (LAI) in rice has been referred to that, the UAV surveillance with an RGB camera have potential as a low-cost efficient tool for monitoring crop growth.

. Therefore, in this study, the photographs and videos from the UAV were analyzed for RGB color index to calculate the vegetation index, the difference in visible spectrum in the atmosphere (VARI), the vegetation greenness index (EXG), the yield and the chlorophyll value. The ready-made program was used to combine the photographs from the UAV into an orthomosium image, then analyzed the RGB color index using the QGIS program and analyzed the RGB color index immediately from the video recording using the MATLAB processing technique. Then, the values of the three vegetation indexes were compared to find the feasibility of analyzing the RGB color index of both methods.

2. Materials and methods

2.1 Study area

This study was conducted at the rice field of farmers located at Ban Kai Na, Tambon Samran, Amphoe Mueang Khon Kaen, Khon Kaen Province, Thailand, located at latitude 16°32'39.5" North, longitude 102°50'58.4" West, as shown in Figure 1. The general topography is a rolling plain with an elevation of approximately 165 meters above sea level. The cultivated soil is sandy loam. The general climate is wet and dry. The study was conducted during the wet season from February to May 2023 of the Khao Khao 49 rice variety, and the rice was grown using the broadcasting method.

Figure 1 Study area of Ban Kai Na, Samran Subdistrict, Mueang Khon Kaen District, Khon Kaen Province

2.2 Processing of images from drones

The objectives of this study, the researcher divided the test into 2 parts: the analysis of RGB color index values from the ormosaic images and the analysis of RGB color index values directly from the video using a drone.

2.2.1 Analysis of RGB color index values from ormosaic images the study was conducted by planning the flight route (Flight Planning) over the dry season rice cultivation area via the PIX4D Capture application to record high-resolution images and videos in the visible spectrum, consisting of red, green, and blue spectrums. The parameters were set at an altitude of 32 meters, an overlap of 80%, a sidelap of 70%, a GDS value of 0.87 cm/pix, and an ortho photo map was produced using the Agisoft Metashape processing system. Data were recorded from March 2, 2023 to May 1, 2023, with 4 data sets: Stage 1, tillering stage, Stage 2, pregnancy stage, Stage 3, flowering stage, and Stage 4, pre-harvest stage. The orthomosiac images were then imported into QGIS to analyze the RGB color index values as shown in Figure 2. The vegetation fertility and yield indices were then calculated using the Raster layer unique values report command. The data tables were exported for comparison.

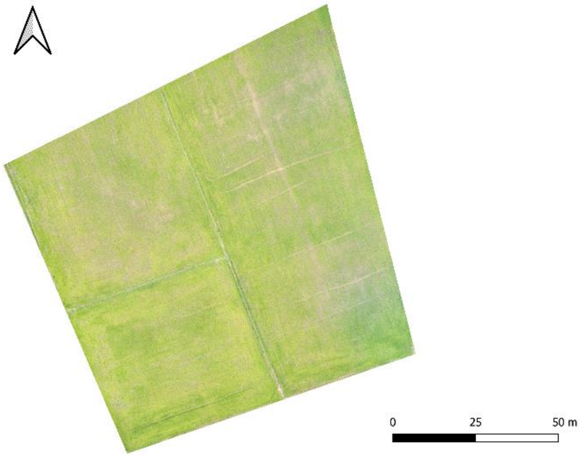

Figure 2 Orthomosaic image obtained with Agisoft Metashape program

2.2.2 Analysis of RGB color index values directly from videos the study was conducted by importing videos of the study area obtained from unmanned aerial vehicles into the MATLAB program using video processing techniques to analyze RGB color index values (Thai patent application number 2303002849, 2566) and using them to calculate the vegetation fertility and productivity index as shown in Figure 3.

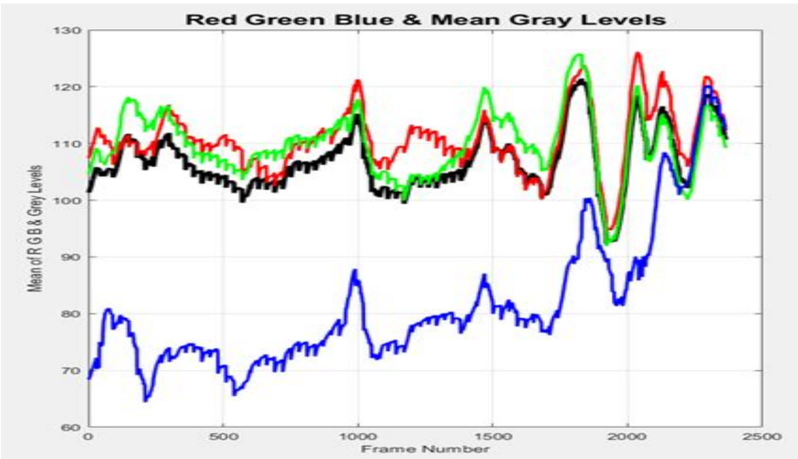

Figure 3 RGB color index values analyzed directly from the video using MATLAB

2.3 Indicators used in the study

2.3.1 Variation in visible spectrum in the atmosphere (VARI) The vegetation greenness index from leaf surface and in some cases, plant health predictions are derived from the RGB color values of aerial photographs taken by UAVs, as shown in Equation 1 [6].

$$VARI = (g - r)/(g + r - b) \quad (1)$$

Where $g = G/(R + G + B)$
$r = R/(R + G + B)$
$b = B/(R + G + B)$
R = reflectivity in the red band from the RGB image
G = reflectivity in the green band from the RGB image
B = reflectivity in the blue band from the RGB image

2.3.2 Vegetation greenness index (EXG) The vegetation index was calculated from the UAV RGB image using all three reflectivity bands: blue band, green band, and red band. It can be calculated from Equation 2 [7].

$$EXG = 2(g-r-b) \quad (2)$$

2.3.3 Yield The yield value was calculated from the VARI index as shown in Equation 3 [8].

$$YIELD = 6098\ln(VARI) + 19442 \text{ (kg/ha)} \quad (3)$$

2.3.4 Chlorophyll value The chlorophyll value was predicted from the mean of full leaf rice photos by multiple linear regression analysis of the mean of red, green and blue compared to the relationship value read from the chlorophyll meter as shown in Equation 4 [9].

$$\text{Chlorophyll} = 53.3 - (0.242xR) - (0.138xG) + (0.145xB) \quad (4)$$

3. Results and discussion

3.1 Comparison of the Visible Atmospheric Difference Index (VARI)

From the analysis of RGB color index values from orthomosaic images using QGIS and the analysis of RGB color index values directly from videos using MATLAB using a drone, the results of the comparison of the average values of the Visible Atmospheric Difference Index (VARI) are shown in Figure 4.

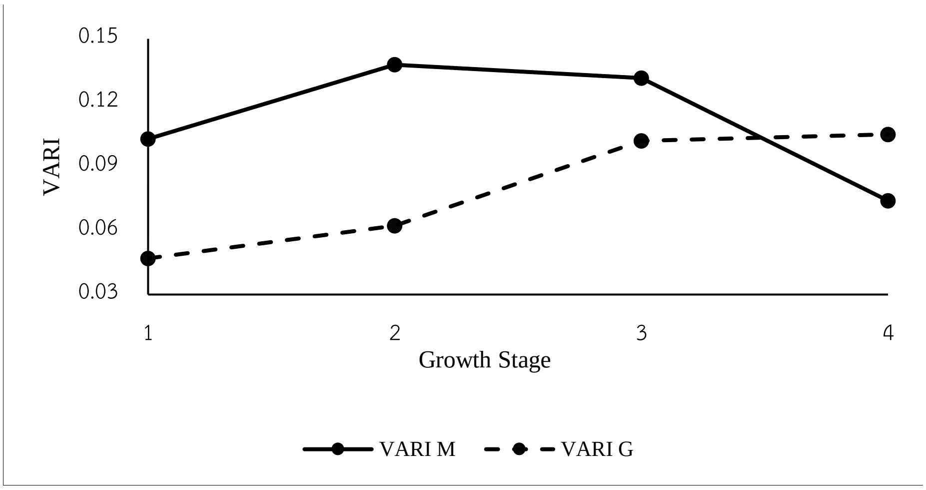

Figure 4 Comparison results of the mean VARI index between the analysis using MATLAB and QGIS

From Figure 4, it was found that the VARI vegetation index obtained from both analysis methods showed different trends during the flowering and pre-harvest stages. The VARI index value analyzed using orthomosaic images tended to increase according to the rice growth stage, while the VARI value analyzed directly from the video tended to decrease.

3.2 Comparison of vegetation greenness index (EXG)

From the analysis of RGB color index values from orthomosaic images and the analysis of RGB color index values directly from the video using a drone, the results of the comparison of the average values of vegetation greenness index (EXG) were shown in Figure 5.

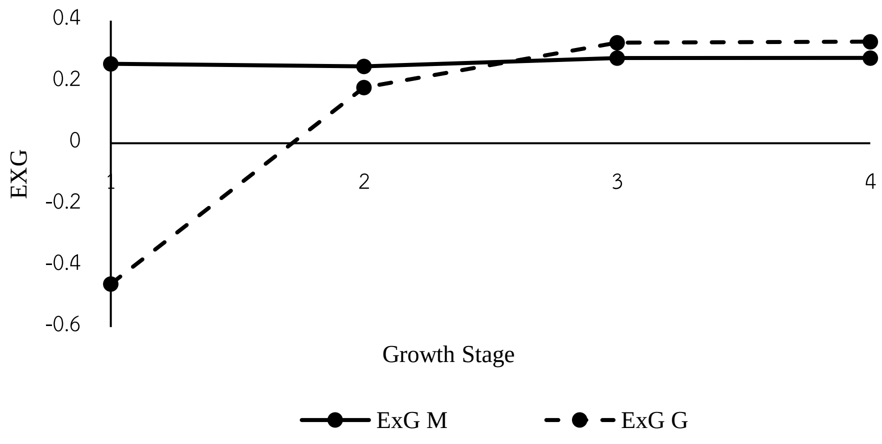

Figure 5 Comparison results of the average vegetation greenness index (EXG) between MATLAB and QGIS analysis

From Figure 5, it was found that the EXG index obtained from the two analysis methods tended to be different. The ExG index of the MATLAB analysis tended to be constant with a slight increase in the EXG index in the 3rd and 4th periods. However, when analyzed with QGIS, it was found that the EXG index tended to increase with the growth stage.

3.3 Comparison of chlorophyll values

From the analysis of the RGB color index from the ormosaic image and the analysis of the RGB color index directly from the video using a drone, the results of the comparison of the average chlorophyll values are shown in Figure 6.

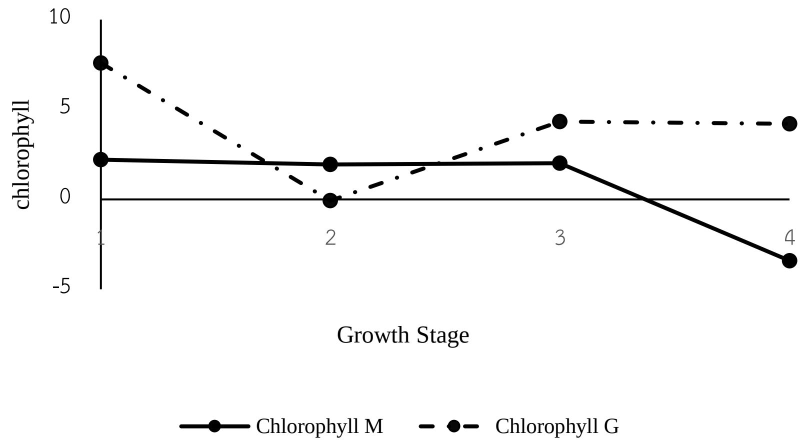

Figure 6 Comparison of chlorophyll values between MATLAB and QGIS analysis

From Figure 6, it was found that the chlorophyll values obtained from the two analysis methods tended to be different. The chlorophyll values should increase with the growth stage in each stage of the rice and decrease when the rice flowers and harvests, which is consistent with the results of the analysis of the chlorophyll values from the RGB color index directly from the video using MATLAB.

3.4 Comparison of the yield values

From the analysis of the RGB color index from the ormosaic image and the analysis of the RGB color index directly from the video Using drones, the results of the average yield comparison are shown in Figure 7.

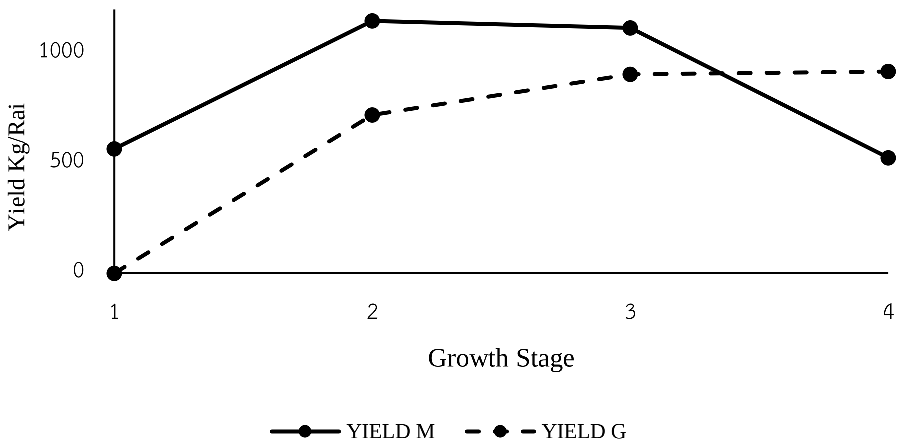

Figure 7 Comparison of yield values between MATLAB and QGIS analysis

From Figure 7, it was found that the yield values obtained from the two analysis methods tend to be different, especially in periods 3 and 4. However, when compared with the actual yield that farmers harvested, which was 800 kg/rai, it can be analyzed that the analysis using the orthomosaic map creation method provides more accuracy in predicting yield than the analysis using the RGB color index directly from the video using MATLAB, with an error value of 13 and 15% in the tillering and pre-harvest stages, respectively. The analysis using MATLAB provides an error value of 40 and 34% in the tillering and pre-harvest stages, respectively. Furthermore, if analyzed from period 1, which is the tillering stage, it can be seen that most of the rice fields are soil (Figure 8), making it impossible to analyze yield, which is consistent with the analysis method from QGIS using the orthomosaic map creation method.

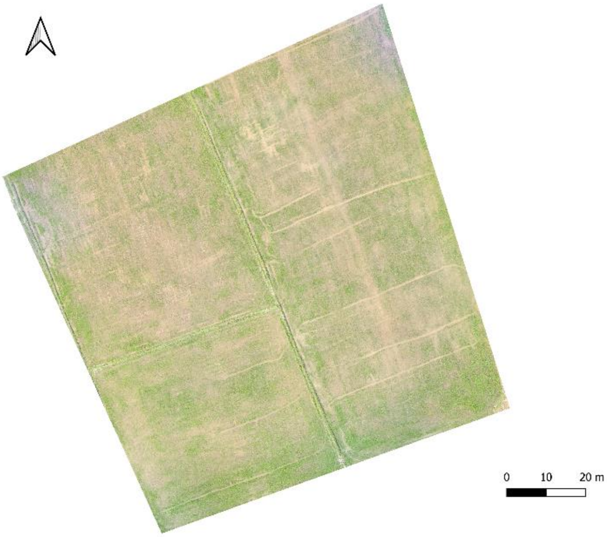

Figure 8 Test area during period 1

4. Conclusions

From the comparative study to find the feasibility of analyzing the vegetation index of rice variety RD49 from orthophoto mosaic map and video using a drone, it was found that the RGB color index values obtained from the 2 methods of analysis can be used to predict the vegetation index, growth and yield differently. It can be seen from the results of the VARI index comparison that the MATLAB analysis method has a graph trend that is more consistent with rice growth than the QGIS method. The results of the EXG index comparison, the analysis method from the orthophoto mosaic map with QGIS has a graph trend that is more consistent with rice growth than the MATLAB method. The trend of rice growth will increase sequentially until reaching the highest growth point. Then it decreases according to the greenness of the rice leaves that will decrease when approaching the harvest season [10]. The results of the chlorophyll value analysis found that the MATLAB analysis method has a graph trend that is more consistent with the rice growth than the QGIS method, and the results of the yield value comparison found that the QGIS analysis method provides more accuracy in predicting yield than the analysis method from the RGB color index directly from the video with MATLAB.

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