The use of NDVI and NDBI techniques for monitoring the growth of maize: a case study of Mae Phrik District, Lampang Province

Prasit Mekarun, Sirintorn Tongkam and Sittichai Choosumrong*

Department of Natural Resources and Environment,Faculty of Agriculture Nature Resources and Environment, Naresuan University, Phitsanulok Province, Thailand 65000

* **Corresponding author**: **E-mail**: sittichaic@nu.ac.th.

ABSTRACT

Maize are very important to the animal husbandry industry, the demand for domestic maize has increased considerably, the production of maize is insufficient to meet the demand and the volume is uncertain due to the production. With the soil, the weather causes heat to heat from the very quiet and risks having to compete with other economic crops that yield better returns than usual. Mae Prik District, Lampang Province, most farmers cultivate maize for animal husbandry.This study was conducted to study the classification of maize acreage areas using the Vegetation Index (NDVI) and the Building Index (NDBI) for classification and comparison. It was correct that both techniques were effective. Different or not according to the growing period, divided into 3 phases: start planting, growing, harvesting. To compare the statistical value

1. INTRODUCTION

Maize is considered a very important farm plants. The need of maize in the country tends to be increasing after the animal culture has been expanded since 1992. Nowadays, planting maize is not enough for internal usage. The quantity is inconstant because the production depends on the weather so that there is a risk of drought. The area for planting is in need to compete with other kinds of plants for more income in the following 4-5 years. The Government solves these problems by managing a Project of Maize Planting to be in accordance with academic principle, to reduce the area of planting maize at the inappropriate area and increase the planting area in drought season for maize planting, in order to have enough production for the market demands.

Since Mae Phrik District, Lampang Province, farmers from this District like to plant several maizes. The researcher emphasizes the production of maize so the study of NDVI and NDBI technique is conducted to find out which technique is more accurate and efficiency for planting maize, and whether they are different. The study employs satellite photos, Sentinel-2, as a tool to evaluate the planting area. Statistical methods are compared with the production of Mae Phrik District.

The purposes of this study are to 1) apply the techniques of NDVI and ADBI to track the maize planting in 2019, Mae Phrik District, Lampang Province; and 2) compare the efficiency values (NDVI, NDBI) of the maize planting.

2. STUDY AREA

The study area covers all the area of Mae Prik District, Lampang Province. It is in the southern west of the province, geographic location falls on 17 degrees, 26 minutes, 54 northern seconds; and 99 degrees, 6 minutes, 54 western seconds. The area covers 538.921 square kilometers (208.079 square miles). There are 16,021 populations. The density of population is 29.72 people/square kilometer (77.0 people/square miles). The location is 268.80-meters above sea level. This area is connected to Li District (Lamphun Province) and Thoen District in the north. It relates to Thoen District in the North, Ban Tak and Sam Ngao Districts (Tak Province).

In the South, it is connected to Sam Ngao District (Tak Province) and Li District (Lamphun Province).

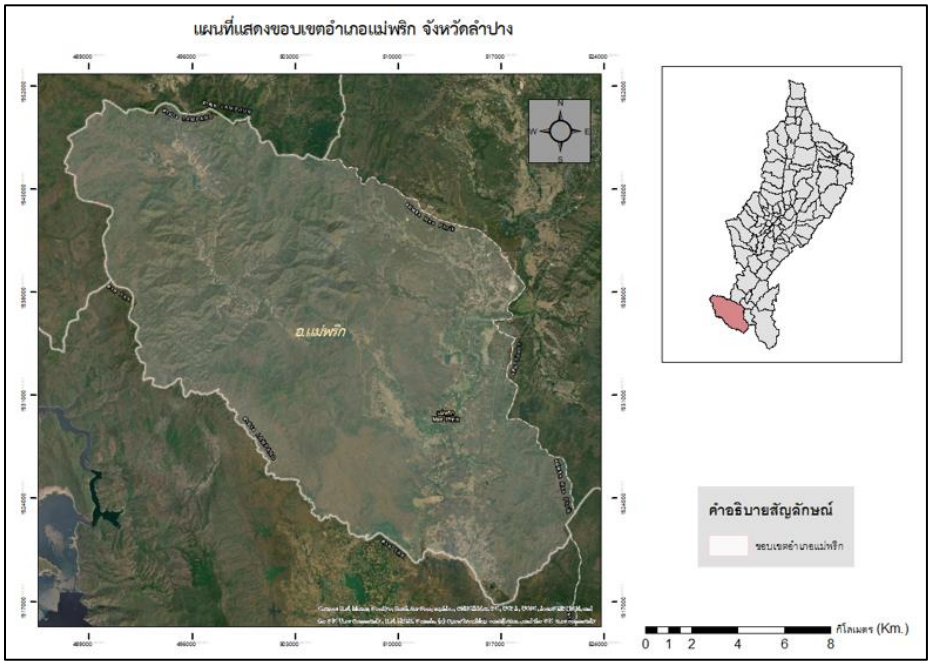

Figure 1 Study area

3. TOOLS and METHODOLOGY

3.1 Normalized Difference Vegetation Index: NDVI

Vegetation Index is the portion of vegetation by calculating the vegetation waves related to vegetation. A famous method is Normalized Difference Vegetation Index (NDVI). The different reflection of the surface between the waves near infrared and the range of waves seen in red color by eyes are portioned with the adding values of the two ranges of waves to become the normal distribution as shown in Equation 1. Therefore, NDVI values are between -1 to 1, which is easier

to be dynamic. This means that 0 is that there are no green plants in the observable area. Meanwhile 0.8 or 0.9 means that there are several green plants in the area. In case of area covered with vegetation, the reflection value near the infrared is higher than the waves seen in red color with eyes. So, ADVI value is positive. In the meantime, the soil surface has reflection value between the two ranges of waves similarly so that NDVI value is nearly zero.

In case of water surface, the reflection value near the infrared is lower than the waves seen in red color by eyes. As a result, NDVI is negative. These values are normally between 0.1 - 0.7 only, as shown in the following Equation.

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

When

NDVI is Normalized Difference Vegetation Index

NIR is the reflection waves near infrared

RED is red visible light of the wave's reflection

3.2 Normalized Difference Built - up Index: NDBI

The Normalized Difference Built - up Index (NDBI) is the analysis of relationship between the surface temperature and types of soil used, or soil covers. The analysis employs the data from the satellite which reflect the built-up objects in both nighttime and daytime, and the temperature of each period (Dousset and Gourmelon, 2003), as shown in the following Equation.

$$\text{NDBI} = \frac{(SWIR - NIR)}{(SWIR + NIR)}$$

When

NDBI means Normalized Difference Built - up Index

SWIR means Short-wavelength infrared

NIR means Near infrared spectroscopy

3.3 Research methodology

The researcher employs pictures from Sentinel-2 Satellite during May 2019 - January 2020. The study is classified into 3 phrases as described below.

1) Starting to plant phrase; 2) growing phrase; and 3) harvesting phrase, these phrases employ Normalized Difference Vegetation Index and Normalized Difference Built - up Index to classify the area for planting maize in each identified period. The results from the program are statistically analyzed to compare that which technique out of those two techniques is more accurate for planting maize.

Data and Data Resource

1. Pictures from Sentinal-2 satellite during May 2019 - January 2020.
2. Data of maize planting at Mae Prik District, Lampang Province during 2019 - 2020.

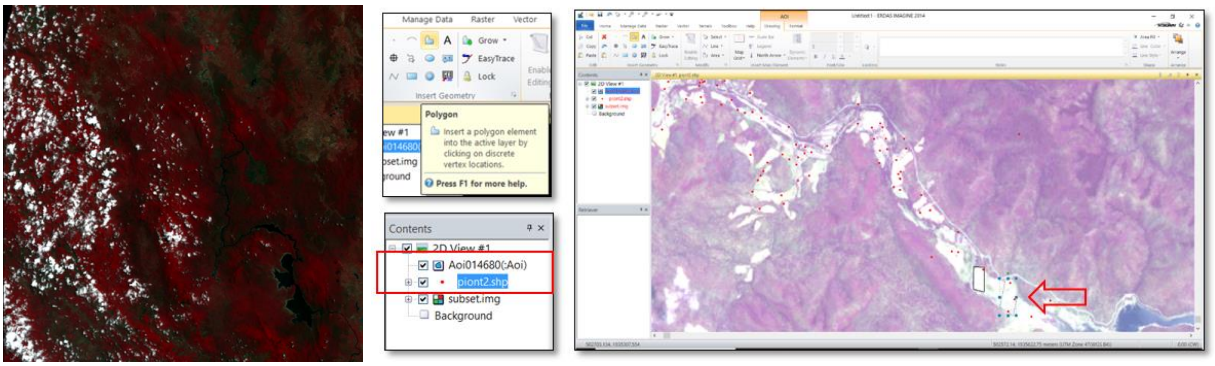

Figure 2 Sental-2 satellite image and maize planting in study area

Data Analysis

1. Pictures from Sentinal-2 satellite during May 2019 - January 2020 are selectively downloaded.
2. All pictures from each period are collected into bands.
3. Study area are selected.
4. Areal data including maize planting are displayed as points of the field.
5. The pictures from satellite are mosaiced in order make the pictures affixed.
6. Pictures from the satellite are
7. The field area of maize planting is digitized.
8. NDVI and NDBI are analyzed.
9. NDVI and NDBI are compared whether they are related or not.

4. RESULT

4.1 Comparison of NDVI and NDBI via T-Test of the maize

The study is conducted to classify maize planting area, which the data are from the analysis of NDVI and NDBI of the satellite pictures for three phrases: planting, growing, and harvesting, during 2019 - 2020.

1. The hypothesis whether NDVI and NDBI of the maize planting area are different in utilizing other kinds of soil. The reliability is 95%.

Hypothesis

- Major hypothesis: the area of planting maize and other purposes of soil using are not different.
- Minor hypothesis: the area of maize planting and the other purposes of soil using are different.

ประเภท	NDVI	NDBI
ข้าวโพดเลี้ยงสัตว์	0.053	0.177
พื้นที่แหล่งน้ำ	0.029	0.022
พื้นที่ป่า	0.242	0.242
พื้นที่หมู่บ้าน	0.289	0.289

t-Test: Paired Two Sample for Means		
	NDVI	*NDBI*
Mean	0.15325	0.1825
Variance	0.01726425	0.013557667
Observations	4	4
Pearson Correlation	0.87655392	
Hypothesized Mean Difference	0	
df	3	
t Stat	-0.924860248	
P(T<=t) one-tail	0.211626649	
t Critical one-tail	2.353363435	
P(T<=t) two-tail	0.423253298	
t Critical two-tail	3.182446305	
α	0.05	
Significanae	UnSig	

Figure 3 display the results of the analysis Statistical value at the beginning of cultivation of maize compared to Other land use in hypothesis 2

4.2 Result of the test program

The analysis results reveal that the two-tail P(T<=t) value of NDVI and NDBI of maize comparing to the other purposes of planting is 0.42. It is higher than the significant value, 0.05. Therefore, it rejects H1 but accepts H0. This means that NDVI and NDBI of maize are not significantly different from other kinds of planting.

ประเภท	NDVI	NDBI
ข้าวโพดเลี้ยงสัตว์	0.457	0.352
พื้นที่แหล่งน้ำ	0.181	0.249
พื้นที่ป่า	0.508	0.352
พื้นที่หมู่บ้าน	0.452	0.413

t-Test: Paired Two Sample for Means		
	NDVI	*NDBI*
Mean	0.3995	0.3415
Variance	0.021859	0.00463
Observations	4	4
Pearson Correlation	0.851838039	
Hypothesized Mean Difference	0	
df	3	
t Stat	1.199643441	
P(T<=t) one-tail	0.1581909	
t Critical one-tail	2.353363435	
P(T<=t) two-tail	0.3163818	
t Critical two-tail	3.182446305	
α	0.05	
Significanae	UnSig	

Figure 4 display the results of the analysis Statistical value during growth of maize compared to Other land use in hypothesis 2

5. DISCUSSION AND CONCLUSION

The adaptation of Sentinel-2 Satellite data to study the area of maize planting in 2020, at Mae Prik District, Lampang Province, with the techniques NDVI and NDBI. The Sentinel-2 Satellite includes the measurement tool called Multispectral Instrument (MSI), which consists of 12 bands and the analysis of NDVI and NDBI analysis from the Satellite.

NDVI = (NIR-Red)/(NIR+Red)

Sentinel-2 :(Band8-Band4)/ (Band8+Band4)

NDBI = (R1650-R830)/(R1650+R830)

Sentinel-2 :(Band11-Band8)/ (Band11+Band8)

According to the analysis of NDVI and NDBI classification when analyzed, it reveals that the applications of soil are different from other purposes of planting; for example, maize, water resource, forests, villages, etc., in different periods (planting, growing, and harvesting). As a result, all types of the Normalized Difference Vegetation Index, in 2019 - 2020, and Normalized Difference Built - up Index, in 2019 - 2020, slightly different in every period.

According to the analysis of classification of maize planting areas comparing with other purposes of planting; for example, maize, water resource, forests, villages, etc., with NDVI and NDBI, the results of the other purposes of planting by analyzing hypothesis via T-test manifest that NDVI and NDBI of planting area has two-tail P(T<=t> is significantly different from other purposes of planting, 0.5. Therefore, it accepts H0 and rejects H1, which means that NDVI and NDBI of the maize planting area are not significantly different with 95% reliability.

In conclusion, the area of maize planting at Mae Prik District, Lampang Province is obviously not different from other purposes of soil using in plantation.

6. REFERENCE

D. W. Triscowati, B. Sartono, A. Kurnia, D. Dirgahayu and A. W. Wijayanto, "Classification of riceplant growth phase using supervised random forest method based on landsat-8 multitemporal data", International Journal of Remote Sensing and Earth Science, vol. 16, no. 2, pp. 81-90, 2020.

Kshetri, T. B. NDVI, NDBI & NDWI Calculation Using Landsat 7, 8.

Macarof, P., & Statescu, F. (2017). Comparasion of ndbi and ndvi as indicators of surface urban heat island effect in landsat 8 imagery: A case study of iasi. Present Environment and Sustainable Development, 11(2), 141-150.

"United states department of agriculture (usda): world agricultural production july 2020", Circular Series WAP 7-20, vol. 2019, 2020.