ASSESSMENT THE IMPACT OF DROUGHT IN VEGETATION AREA IN CENTRAL REGION OF THAILAND BY USING MODIS

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ABSTRACT

Many countries in the world against a mainly natural disaster like drought including Thailand. Thailand is an agricultural country. Especially in the central region that is a corrugated plain area suitable for agriculture. Causing the central region is an important agricultural area (Meteorological Development Bureau, 2015). Hence, the central region is interesting to assess the impact of drought. The objectives of this research were to obtain NDDI maps to compare them together and assess drought in the central region. This research aims to assess drought in vegetation areas in the central region of Thailand by using the Normalized Difference Drought Index (NDDI). NDDI was created by evaluating the index from satellite images of MODIS09 terra 500 m resolution. Satellite images 10 years from January 2010 to December 2019, Monthly data were used in this research, and cloud in every image was removed by using the conditional technique. The calculation of NDDI was based on Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI). NDDI maps were created to compare themselves each year. The research was shown in the form of a map of NDDI within the last 10 years, the assessment of drought using NDDI shown most of the drought is in 2010, 2014 to 2016, and 2018 to 2019. In 2010, there was an abnormally low rainfall due to El Nino at the beginning of this year. Since 2014, Thailand has had abnormally low rainfall and the rainy season was slower than usual, possibly as late as June and lightly than before.

Keywords: *Drought, MODIS, NDDI, NDWI, NDVI*

1. INTRODUCTION

Currently, drought is mainly a natural disaster in the world including Thailand. It affects the environment and socio-economic. The cause of the drought is both human and natural. Humans are the main drivers of climate change from deforestation and industrial development. Also, drought has natural causes. For Thailand, the monsoon move through that brings the cold and drought faster than usual. Including a tropical cyclone moving through Thailand. Thailand is an agricultural country. Especially in the central region that is a corrugated plains area suitable for agriculture [1]. Causing the central region to have many agricultural areas. Hence, the central region is interesting to verify the impact of drought. Agricultural drought is a meteorological drought. It causes damage to cultivation season, agricultural products, and affects agriculturists and economies [2]. So, drought monitoring is important.

This research aimed to assess drought areas in the Central region of Thailand by using spatial resolution images to created maps and compared them together. NDDI has been used to assess vegetative drought. The research focused from January 2010 to December 2019.

2. STUDY AREA

The study area of this research is the Central region of Thailand covering 91,799 km (latitude N13°15'-N17°45' and longitude E98°55'- E101°35'). The topographical features of the Central region are a vast plain that looks like a large gutter consisting of mountains on the east side and west side which stretched parallel from the north down to the south. thickest and most extensive sediment plain. Upper Central Plains is a river plain and corrugated plains. (Hills interspersed with plains). The lower central plains Is a wide plain formed by the deposition of sediments and The Chao Phraya River Delta. Eastern and western plains are a river plain alternating with corrugated. There are not high mountains scattered [2].

3. DATA USED AND VEGETATION INDEXES FOR DROUGHT MONITORING

3.1. DATA USED

In this research, MODIS Terra satellite images were used to create the maps. The MODIS09 Terra is the Surface Spectral Reflectance product with 500 m resolution [3]. The satellite images available on NASA, LAADS DAAC website. Every image from January 2010 to December 2019 in the study area was collected. There are 726 images were used in this study. The conditional technique was used to removed cloud cover the image of the study area.

3.2. VEGETATION INDEXES FOR DROUGHT MONITORING

There are 3 equations were used in this research, showed as below:

$$NDVI = \frac{NIR - RED}{NIR + RED} \tag{1}$$

Normalized Difference Vegetation Index or NDVI use to determine the density of green on land. The calculation is dividing the difference and summation between surface reflectance from red light and near infrared bands [6] as shown in Eq. (1).

NDVI always ranges from -1 to +1. The increasing of NDVI means the greenness is increasing, +1 mean the land was covered by healthy vegetation, and lower values indicating stress in vegetation. Negative values represent water and high moisture content [4].

NDVI is the most widely used for evaluating drought conditions [4].

$$NDWI = \frac{NIR - SWIR}{NIR + SWIR} \tag{2}$$

Normalized Difference Water Index or NDWI is useful for drought monitoring, it sensitive to the change of liquid water content of vegetation. The calculation of NDWI is dividing the difference and summation between surface reflectance from near infrared and short-wave infrared bands [4] as shown in Eq. (2).

NDWI always ranges from -1 to +1, with negative values of NDWI indicating dry vegetation and positive values indicating, green vegetation [5].

NDWI was used to estimate the moisture condition of vegetation [6], it is the most widely used for evaluating drought conditions [4].

$$NDDI = \frac{NDVI - NDWI}{NDVI + NDWI} \tag{3}$$

Normalized Difference Drought Index or NDDI is the vegetation index that combines information on both vegetation and water of surface reflectance from near infrared and short-wave infrared bands [6]. NDVI and NDWI were used in the NDDI calculation as shown in Eq. (3).

NDDI always ranges from -1 to +1, The increase of NDDI means the dryness is increasing while the decrease of NDDI means the greenness is increasing.

Equation (3) is the main equation in this research to create maps (NDDI maps).

4. METHODOLOGY

To assess drought areas in the central region of Thailand by using NDDI maps. NDDI was calculated by using 2 indexes, including NDVI and NDWI. From 726 of MOD09 Terra images, the conditional technique was used to remove cloud cover over the study area. Monthly NDVI was calculated using surface reflectance from red and near infrared bands while monthly NDWI was calculated using surface reflectance from near infrared and shortwave infrared bands showed [6] as table 1. The data were processed monthly from January 2010 to December 2019.

Table 1 This is an spatial resolution bands were used in this research

Wavelength (nm)	MODIS09	NDVI	NDWI
Red (625-740)	Band 1	/	-
NIR (800-2500)	Band 2	/	/
SWIR (1400-3000)	Band 6	-	/

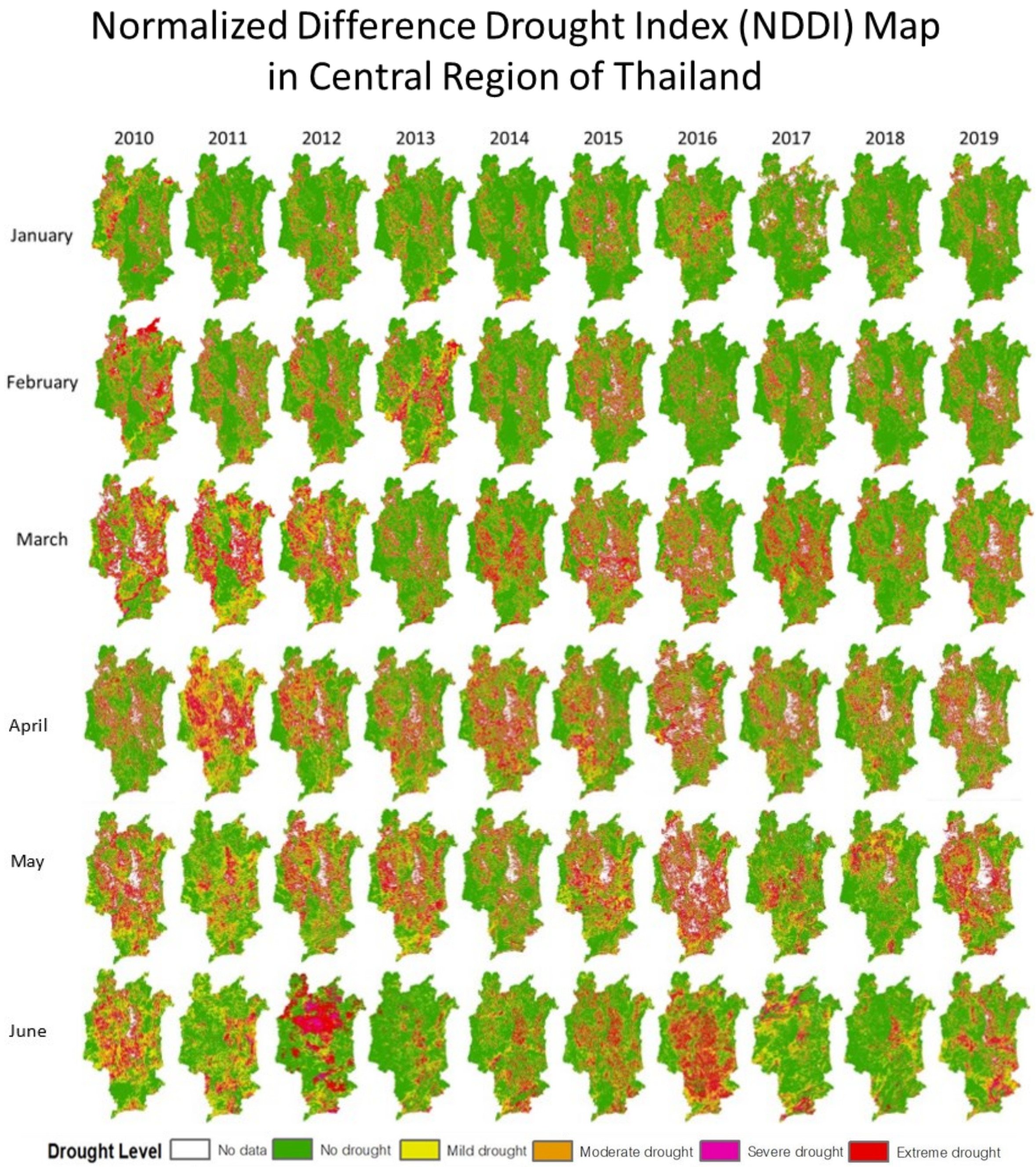

Figure 1 NDDI maps of January to June of years 2010 to 2019

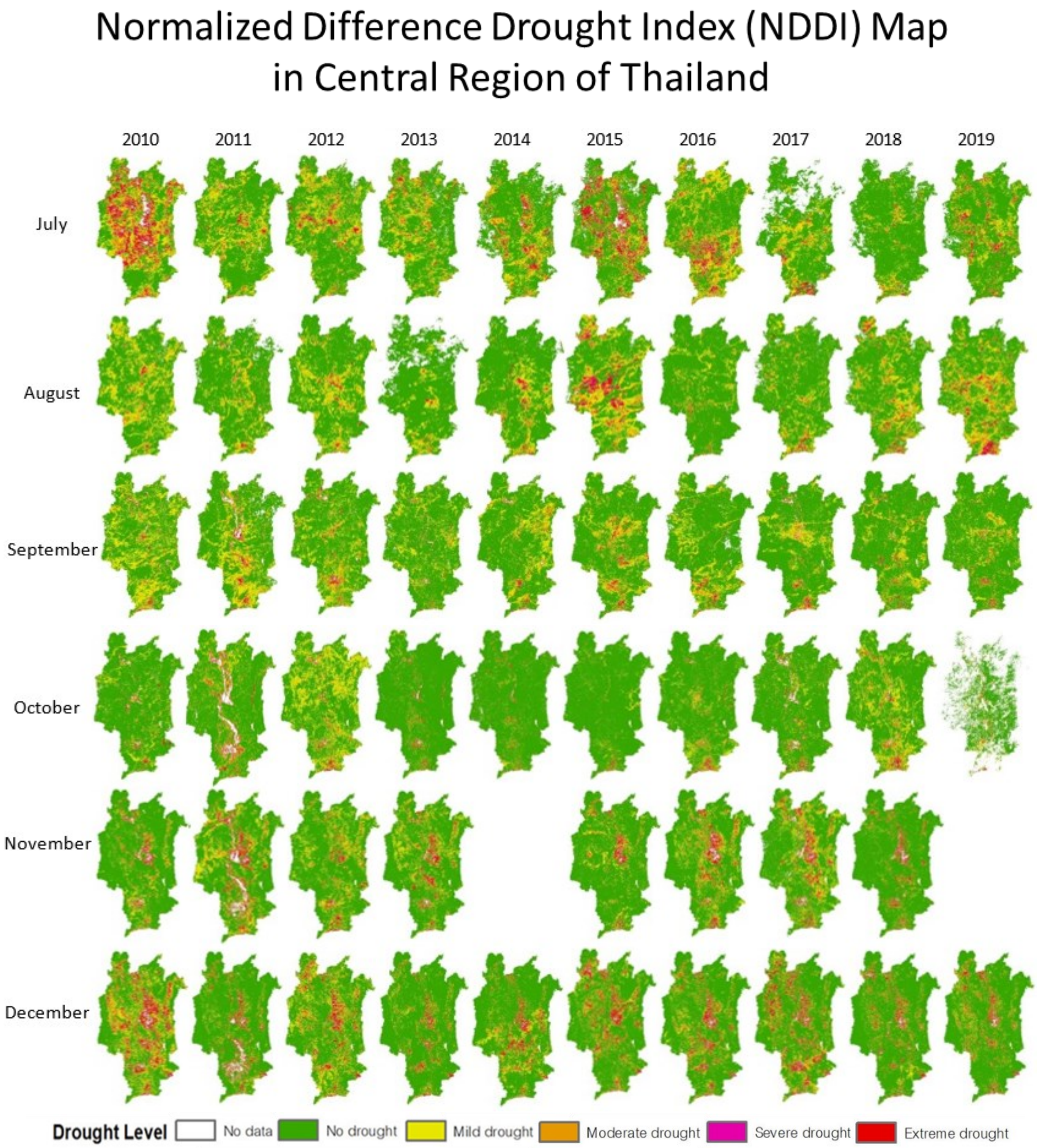

Figure 2 NDDI maps of July to December of years 2010 to 2019

NDVI and NDWI were calculated, The NDDI has been used to assess vegetation drought, it incorporates information of vegetation from NDVI and water content from NDWI [7]. The NDDI was classified into 5 classes showed in table 2.

Table 2 NDDI classification.

Drought classes	NDDI
Extreme drought	0.5 to 1
Severe drought	0.4 to 0.5
Moderate drought	0.3 to 0.4
Mild drought	0.2 to 0.3
No drought	-1 to 0.2

From table 2 NDDI values were classify by let NDDI values lower than 0.2 represent the study area cover by healthy vegetation or no drought and NDDI values that higher represent mild drought, moderate drought, severe drought, and extreme drought, respectively.

5. RESULTS

According to the objective of the research, NDDI maps over central region of Thailand are present in Fig. 1 and Fig. 2, the NDDI maps obtained from NDDI monthly of the study period in the central region of Thailand that was classify to 5 class as shown no table 2. Fig 1. shown NDDI maps of January to June of years 2010 to 2019, the map showing the extreme drought class spread in the study area every year in March, April, May, and some years in June. The drought trend across the study area in the summer season. January and February is also have extreme drought in some area but clearly looks less than summer season

6. CONCLUSION

This research analyzed drought in the central region of Thailand from January 2010 to December 2019 by using MODIS09 Terra satellite images to evaluate the data. The NDDI based on satellite images was used to create drought maps. According to the methodology, high NDDI values represent drought is more risk. The NDDI maps show drought classes in central region of Thailand. From the NDDI maps, there are clearly different in summer season when comparison with the others. Droughts occur in summer (March to June) and some of the mild drought area in the rainy season. The risk area of drought is in the upper central region of Thailand. Most of the risk area is always extreme drought at the same period every year. This research could be used to study drought trends and find areas that deserve special surveillance to prepare for dealing with in the future. However, this research still must be further improvements in the future.

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8. REFERENCES

[1] British Broadcasting Corporation. (n.d.). About Characteristics of droughts. Retrieve September 19, 2020, from: https://www.bbc.co.uk/bitesize/guides/zt9ncwx/revision/1

[2] Meteorological Development Bureau. (2015). Topography of Central part and General Climatic Conditions. Climatological Group

[3] NASA. (n.d.). About MODIS Surface Reflectance. Retrieve September 20, 2020, from: https://modis.gsfc.nasa.gov/data/dataprod/mod09.php

[4] Du L.T., Bui D.D., Minh D.N., Hyonki L. (2018). Satellite-based, multi-indices for evaluation of agriculture droughts in highly dynamic tropical catchment, Central Vietnam. *Water* **10**, 1-24. DOI: 10.3390/w10050-659

[5] Gao C. (2016). A normal difference water index for remote sensing of vegetation liquid water from space. *Water* **10**, 257-266. DOI: 10.3390/w10050-659

[6] Khampeera A.N., Yongchalermchai C., Techato K.A. (2016). Drought monitoring using drought indices and GIS techniques in Kuan Kreng peat swamp, Southern Thailand. *Walailuk Journal of Information and technology* **15**(5), 357-370.

[7] Renza D.E., Martinez E.T., Arquero A.G., Sanchez J.V. (2010). Drought estimation maps by means of multidate Landsat fuse images. *Remote Sensing for Science, Education, and Natural and Cultural Heritage*, 775-782.