OPTICAL SATELLITE TIME SERIES ANALYSIS FOR GANODERMA BONINESE ATTACK DETECTION ON OIL PALM PLANTATION

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Abstract: One of the causes of the decreasing in oil palm production is the presence of pests and diseases on the oil palm. Various efforts have been made to prevent an increase in the intensity of pest and disease attacks, especially Ganoderma boninense which frightens farmers. This study aims to detect the presence of Ganoderma attacks on oil palm plants by monitoring the greenery of oil palm plants using optical satellite data, namely Landsat. The method used is regression and time series analysis of the greenness index of oil palm plants, namely NDVI, with the study area of oil palm plantations in North Sumatra, Indonesia. The analysis was carried out on oil palms that were not attacked by Ganoderma and those that were attacked by Ganoderma. The results of the analysis showed that the oil palms that were most affected by Ganoderma were at age more that of 4 years and before 6 year with 0.04 difference of NDVI with health oil palm , and at the next age there was a decrease in the NDVI value of 0.17 due to a decrease of number of oil palm fronds followed by oil palm deaths. With the gap of the NDVI value at a certain age of oil palm, Ganoerma attacks can be detected quickly so that preventive action to increase the intensity of attacks can be carried out quickly as well.

1. INTRODUCTION

1.1.Ganoderma attack on oil pam

Ganoderma basal stem rot was first detected as an old palm disease before it was found in much younger palms, largely on land that previously planted with coconuts or replanted from oil palm (Turner, 1981). The first symptom is like the drought impacted palm. The young leaves failed to open, indicating the damage of the stem and the root system that cause problem on water uptake. In old palms, the lower leaves turn pale, and die starting from the tip and fall. And in more serious cases, the stem turns black and the whole trunk may collapse. This change of physical appearance makes the early detection using remote sensing may be promising.

This disease is caused by at least three types of Ganoderma. G. *boninese* (type A) was significantly more aggressive than G. *miniatocintum* and G. *zonatum* (type B) while G. tornatum (type C) is only classified as a minor pathogen in oil palm (Pilotti, 2005). It is more commonly found on the coastal clays and peat than on inland soils. The occurrence in the area planted after coconut was also found to be much higher than after rubber or forest because some live coconut palms suffer symptomless G. *boninense* (Idris, et al., 2001). Ganoderma can spread by root contact when the healthy palm's root contacts an inoculum from decayed infected palm. It can also spread by spores (Flood et al., 1998).

Ganoderma can cause yield reduction both from the death of palms and reduced yields of infected living palm. Rao et al. (2003) showed that infected palms yielded about 40% less than the symptomless palms at the same age. Although Ganoderma has been a serious problem in Indonesia and many studies had been done to understand and control the distribution of this disease, several aspects of this disease remain obscure.

Tabel 1. Criteria for levels of Ganoderma infection on oil palm (Santoso et al, 2017)

Level	Code	Criterion
Level 0	L 0	Healthy plant, normal growth, perfect canopy
Level 1	L1	Appearance of two spear leaves, or yellowing leaves, but rotting in the basal stem

Level 2	L2	Appearance of two or more spear leaves, yellowing leaves while new leaves growing smaller, early senescence on old leaves, frond fracture incidence, rotting on basal stem, palm still producing fruits,
Level 3	L3	Appearance of more than three spear leaves, frond facture in most of the old leaves, yellowing leaves followed by necrosis, rotting on basal stem or appearance of Ganoderma fruiting body, no fruits in the palm
Level 4	L4	Necrosis on all leaves or collapsed tree

1.2. The relationship between SPAD chlorophyll and disease severity index

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The estimation of chlorophyll content in the infected seedlings possibly could provide a good indicator for degree of disease or infection, and changes during pathogenesis. There was study to evaluate the relationship between disease severity index (DSI) and chlorophyll content in Ganoderma infected oil palm seedlings. It was found that the relationship between DSI and SPAD chlorophyll value was inversely proportional (R = -0.92) in a linear trend (R2 = 0.85). Furthermore, the increasing trend of the DSI across the weeks were fitted in a quadratic model (R2 = 0.99). In contrast, the SPAD chlorophyll value declined in a linear trend (R2 = 0.98). The SPAD chlorophyll value could be considered as a better alternative over the DSI as the SPAD chlorophyll value was strongly related to DSI, as well as able to detect physiological changes in the infected oil palm seedlings at the early stages of pathogenesis.

The results of research by Siti Khairunniza-Bejo (2015) who performed measurements using a multispectral camera and therman showed that there was a decrease in the color index value on leaves when the severity of Ganodherma disease increased

1.3.Detection of Ganoderma by Satellite

Satellite remote sensing (RS) technology using optical and radar remote sensing techniques have been used successfully in various applications related to earth resource studies and environmental monitoring. Some advantages of these techniques are cost effectiveness , wide coverage, near real-time data acquisition and frequent revisit capability

RS has significant potential to aid palm oil plantation monitoring and detection efforts. It also provides a cost-effechow tive method to map oil palm and at the same time provides site-specific assessments of management practices and growth performance of the palms.

A large area of G. boninense infection could be quickly monitored using analysis of satellite imagery, compared to manual monitoring which is a slow and laborious process (Nasfariza et al. 2016). Vegetation index from Quickbird satellite imagery has been used to identify and to draw the map of BSR incidences in an oil palm plantation (Santoso et al. 2010), while Izzuddin et al. (2015) used airborne imagery for the similar objective

Research by Wiratmoko (20..) study were to identify levels of G. boninense infection in oil palm based on spectral difference by counting the vegetation index from the multispectral image of UAV and mapping the distribution of BSR infection.

1.4.Study Area

The Study Area of this study is : Oil Palm Plantation area of Indonesia Oil Palm Research Institute (IOPRI) , Deli Serdang, South Sumatera, Indonesia. Figure 1 shows the area, and the SPOT (MS and Panchromatic) data that used for this study,

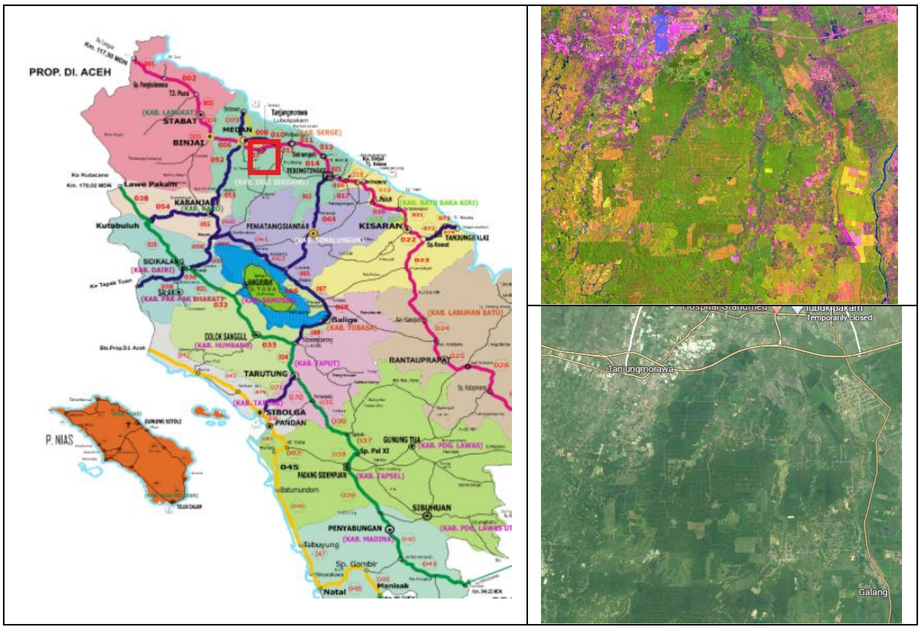

Figure 1. Location of Palm Oil in South Sumatera and optical data of the area
(source : map-Local Government of South Sumatera, Optical data: Google Earth and OR PA LAPAN BRIN)

1.5.Purposes

The purpose of this study is to detect the Ganoderma level that attack oil palm trees by using time series of NDVI..

2. METHOD

2.1.Data

Satelite data that were used for this research are Sentinel 2 (from 2014 to 2021.) and LS8 (from 2010 to 2021)
Measurement daya

Survey was done in IOPRI and done by IOPRI staffs to get data and information about year of plantation, level of severity due to Ganoderma, SPAD chlorophyll and the position of the palm oil trees.

2.2.Methodology

In this study we follow this flowchart.

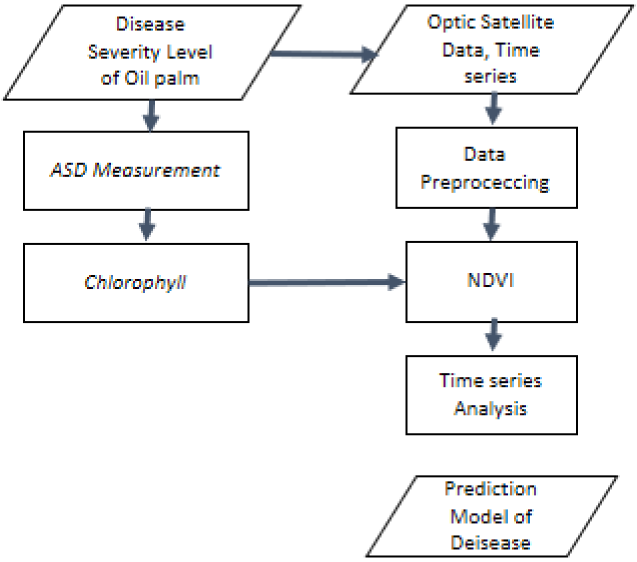

Figure2. Flow chart of reseacrh

3. RESULT AND DISCUSSION

Figure 3 shows the location of oil palm area and block (in yellow plots) where the measurement was done. Every block has different planting year. The first area is Aik Pancur and the Second area is Sei Aik Pancur

Figure 3. Location of Measuremen

The oil palm with different severity are shown in figure 4. This area is located in Aik Pancur Block 3.

				
Health	Stadium 1	Stadium 2	Stadium 3	Stadium 4

Figure 4. Condition of oil palm in different level of severity due to Ganoderma

The measurements by using SPAD on different level of severity give the relation as described in Figure 5. This linear regression give conclusion that SPAD chlorophyll has negative correlation with level of severity due to Ganoderma, It means when Ganoderma has attack oil palm means the amount chlorophyll in oil palm leaves will dcrease. It means we can monitor condition of oil palm and the level of severity by using NDVI that generated from satellite data.

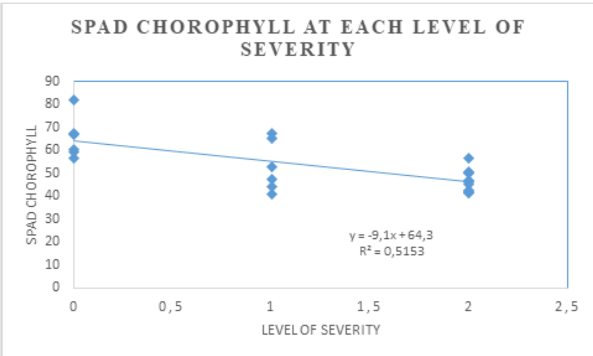

Figure 5. Regression model of SPAD chlorophyll with level of severity
(y = -9,1x + 64,3 with R^2 = 0,5153)

The condition of oil palm that attacked by Ganoderma can be seen from the changes of leaves color due to the changes of chlorophyll and soil moisture of leaves as well as the number of fond. NDVI that generated from near infra red and red channel of optic satellite data has been chosen to describe this changes.

The analysis of time series for the NDVI of oil palm that planted in 2009 give the result that shown in Figure 6

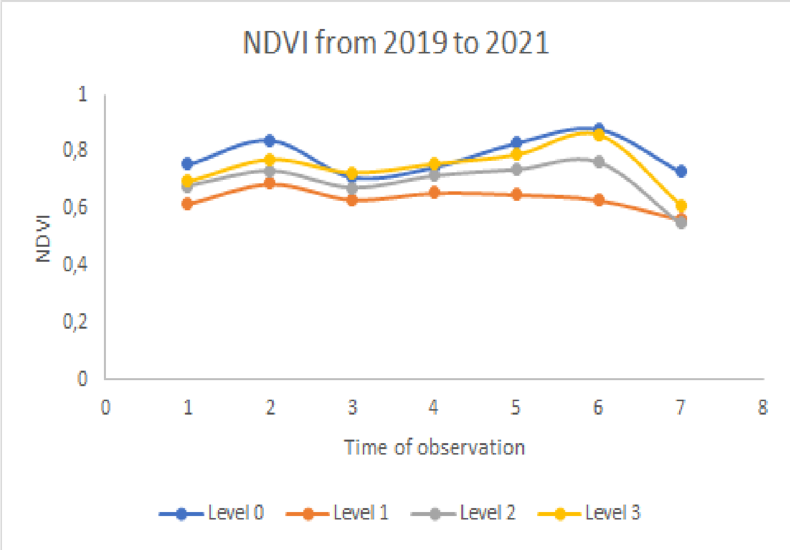

Figure 5. Time series of NVI for oil palm from 2019 to 2021(Planting year : 2009)

Figure 5 is the describes the changes of NDVI from 2019 to 2021 at different level of severity. In general NDVI increase from 2019 to 2021 mean from age 10 y.o to age 12 y.o. Health oil palm has higher NDVI, meanwhile the other oil palms which attacked by Ganoderma has lower NDVI. After age 12 y.o the NDVI start decrease due the changes of chlorophyll amount. Oil palms with level 1 severity has slow decrease of NDVI, level 2 has fast of NDVI, measnwhile but oil palm with levl 3 of severity has very fast decrease of NDVI.

Figure 6 is the result of time series analysis of NDVI for oil palm whch planting year in 2013, the graphic describes the changes of NDVI from age 8 y.o tp 10 y.o. The condition of NDVI changes are as same as on oil palm which planted in 2009, but in overall the NIDVI are lower than oil palm with age 10 to 12 y.o.because of the development of oil palm itself.

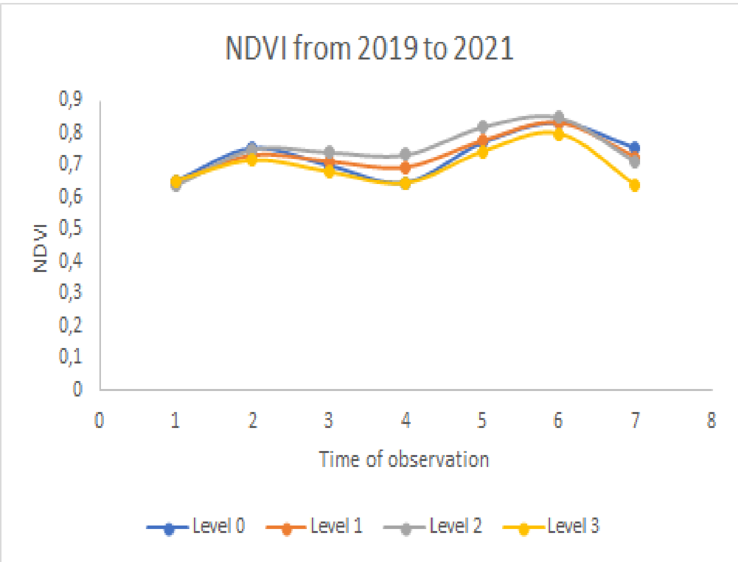

Figure 5. Time series of NVI for oil palm from 2019 to 2021(Planting year : 2013)

The difference of NDVI of health oil palm with NDVI of level 1 Ganoderma is 0.029, with level 2 is 0.0415 and with level 3 is 0.1775 in current time (2021) or , meanwhile the difference of NDVI start in middle year of 2019 or after 6 years of planting with 0.04 difference of NDVI.

For oil palm with planting year in 2009, the difference of NDVI has been raised since before 2019, it means the Ganoderma has attack the oil palm trees before 10 y.o, and the difference of NDVI are : 0.06 to 0.138 and in the current time (2021) or at 12 y.o are 0.17 to 0.182 difference of NDVI

4. CONCUSION

- Monitoring of oil palm that attacked ny Ganoderma can be used by NDVI time series analysis. It will be useful for anticipating of Ganoderma attact and the development of Ganoderma in oil palm trees.

- Results show that the raise of Ganoderma can be seen by difference of NDVI around 0.04

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6. Reference

Flood, J., Cooper, R.M., & Lees, P.E., 1989. An investigation of pathogenecity of four isolates of Fusarium oxysporum from South America, Africa, and Malaysia to clonal oil palm. J. Phytopathol., 124, pp. 80-88.

Idris, A.S., Ariffin, D., Watt, T.A., & Swinburne T.R., 2001. Distribution of species of Ganoderma basal stem rot of oil palms in relation to the environmental conditions in Peninsular Malaysia. In: Proc. 2001 Int. Palm Oil Congr. Agriculture, p. 385, Malaysian Palm Oil Board, Kuala Lumpur.

Pilotti, C.A., 2005. Stem rots of oil palm caused by Ganoderma boninense: pathogen biology and epidemiology. Mycopathologia, 159, pp. 129-137.

Rao, V., Lim, C.C., Chia, C.C., & Teo, K.W., 2003). Studies on Ganoderma spread and control. Planter, 79, pp. 367-383.

Turner, P.D., 1981. Oil palm diseases and disorders. Oxford University Press, Kuala Lumpur.

Corley, R.H.V., Tinker, P.B. 2015. The Oil Palm, 5th edition. Wiley Blackwell, pp. 416-426.

Santoso, Gunawan HT, Jatmiko RH, Darmosarkoro W, Minasny B. 2010. Mapping and identifying basal stem rot in oil palm in north sumatera with quick bird imagery. Precis Agric. 12:233-248. DOI: 10.1007/s11119-010-9172-7.

Siti Khairunniz, Bejoa, Yusnida Yusoff, Nik Salwani Nik Yusoff, Idris Abu Seman, Mohamad Izzuddin Anuar,Identification of Healthy and BSR-Infected Oil Palm Trees Using Color Indices

Dhimas, W, et all, 2018, Identification of Ganoderma Boninense Infection on Oil Palm by Using Vegetation Index. International Journal of Oil Palm, Vol 1 no 3, pp : 110-112:

M.R.M. Rakib1, A.H. Borhan , A.N. Jawahir. 2019. The relationship between SPAD chlorophyll and disease severity index in Ganoderma-infected oil palm seedlings. J Bangladesh Agril Univ 17(3): 355–358, 2019