UTILIZATION OF ENVIRONMENTAL ENGINEERING TECHNOLOGY IN PALM OIL INDUSTRY: CURRENT STATE

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Abstract
In many attempts, remote sensing has been utilized to assist agriculture in the best management practice to improve production and minimize its impact on the environment. In palm oil agriculture in Indonesia, conversion of high conservation value forest into palm oil plantation area is a continuous major environmental concern. Many efforts have been done using remote sensing technology such as Landsat 8 and Landsat 4-5 TM imagery to obtain information. However, the degree in which the information has been used effectively to assist policy and other decision, limited research has been done. To add to the knowledge, this paper aims to present a review of recent studies on remote sensing and exemplify some of the main challenges to optimally support the attempt to minimize deforestation, at the same time improve palm oil production in Indonesia.

Key words**:** *Remote Sensing, Palm Oil, Deforestation, Indonesia*

INTRODUCTION

Currently Palm oil became one of the most controversial market-driven crops in the world. Palm oil serves as the main type of vegetable oil consumed by the global market, yet its productions in the producer countries have led to deforestation, distinctions of endangered animals, and displacement of indigenous people *(Lee, Ghazoul, Obidzinski, & Koh, 2014; Obidzinski, Andriani, Komarudin, & Andrianto, 2012)*. Indonesia is currently the main producer of Palm Oil. It dominates the global market with European union and China as the main absorbers of Indonesian Palm Oil *(Teoh, 2010)*.

As part of the government effort to improve the sustainability of Indonesia Palm Oil, In 2016 Indonesian President Jokowi instructed moratorium of palm oil land expansion and intensification of the existing area *(Wicaksono, 2018)*. This instruction was driven mainly by the continuous major environmental concern in Indonesia Palm Oil Industry and that is the conversion of high conservation value forest into palm oil plantation area. There are many debates on the impact of palm oil plantation expansion on deforestation in Indonesia. Data suggested that together with the world's second biggest producer of palm oil, Malaysia, the total areas of palm oil plantation of both countries covered 17.0 Mha as for 2015 and upward trend was shown as from the year 2000 *(Chong, Kanniah, Pohl, & Tan, 2017)*.

To assist the instruction, research has been generated using remote sensing. Satellite data imagery from remote sensing technology such as Landsat 8 and Landsat 4-5 TM imagery was obtained to gain information *(Andrianto, Komarudin, & Pacheco, 2019; Austin et al., 2017; Gaveau et al., 2018)*. However, the degree in which the information has been used effectively to assist policy and other decision, limited research has been done. To contribute to the knowledge, this paper aims to present a review of three recent studies on remote sensing and exemplify some of the main challenges to optimally support the attempt to minimize deforestation, at the same time improve palm oil production in Indonesia.

MATERIALS AND METHODS

The current study used qualitative approach with secondary source of data collection. Secondary data includes journal articles obtained from web of knowledge and google scholar database. To select related journal articles that serve the aim of this study, search was limited to studies derived between year 2016 and 2019 using keywords palm oil, remote sensing, deforestation, and Indonesia.

RESULTS AND DISCUSSION

Recent study on the current application of remote sensing in palm oil agriculture has stated three main aims of advancement of remote sensing for land cover change classification *(Chong et al., 2017)*. These

three aims are firstly, to detect conversion of forest cover and other high conservation value land such as peatland into palm oil plantation, secondly, to identify degraded or other suitable non-forest area for palm oil plantation, and thirdly, to analyze related social and environmental impact of land conversion.
Research on forest loss and industrial plantations in Borneo has been conducted using cloud-free LANDSAT image mosaics to understand land use change between the period 2000 – 2017 *(Gaveau et al., 2018)*. The study has found that in the 17 years period, forest in Borneo has declined by 14% (6.04 Mha) and 3.06 Mha were forest converted into industrial plantation with distribution of forest loss between Indonesian Borneo and Malaysian Borneo as below (Figure 1.). Although both oil palm and pulpwood industry share the total 170 % of plantation expansion, oil palm industry responsible for the 88% of the total. However, after 2016 there was a decline in forest loss in 2017. Possible derived of the decline are low palm oil prices, wet conditions, and improved fire prevention.

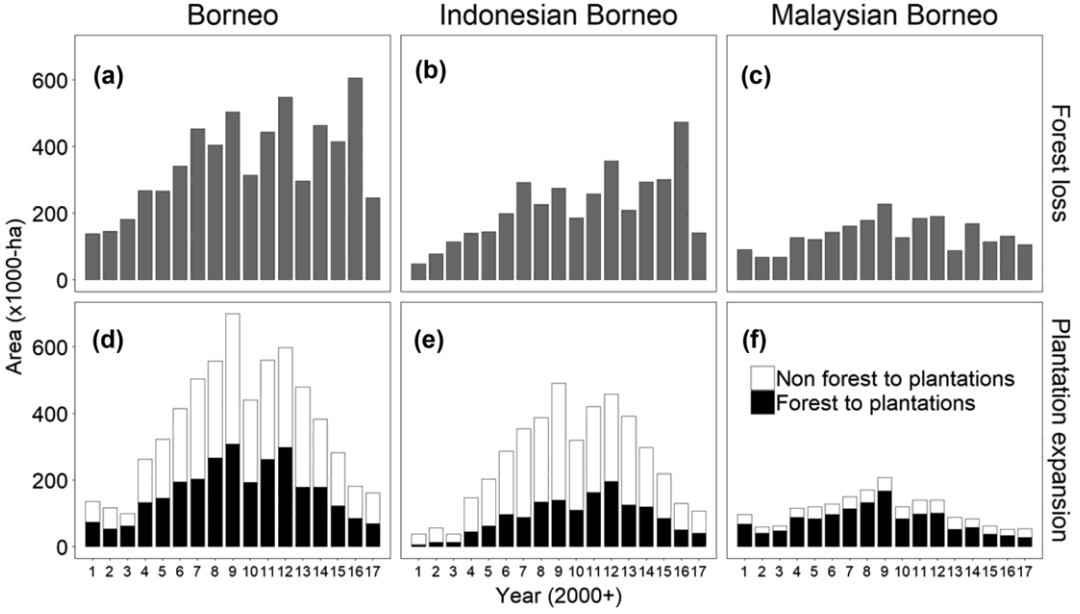

Fig. 1 Time-series (2001-2017) of Borneo's land use change, derived by observing LANDSAT imagery (source: *Gaveau et al. 2018*)

Another study on land cover change conducted by *Austin et al (2017).* Mapped of large-scale oil palm plantations was done using Global Land Survey Landsat composites and Landsat 4-5 TM imagery by identifying grid patter, and associated infrastructure including roads, mill facilities, and management buildings and recently cleared areas adjacent to existing area that may have been prepared for cultivation of palm oil based on the grid formation *(Austin et al, 2017)*. The study analyzed proportion and area of plantations converted from forest up to 2015 across Sumatra, Kalimantan, and Papua. During 1995 – 2015 expansion of palm oil plantation in Indonesia occur at an average rate of 450.000 ha/year and 117.000 ha/year were forested area.
Information also obtained regarding 30.2 million hectares of non-forest land nationwide that are suitable for palm oil cultivation based on biophysical characteristics of the area. This areal consist of 15.2 Mha located in Sumatra, 13.0 Mha in Kalimantan, and 2.0 Mha in Papua *(Austin et al, 2017)*. However, due to the lack of mechanization of the current regulation for expansion towards suitable non-forest area, utilization of the suitable land was not optimized yet.
Meanwhile, another study was done from 2013 – 2014 to understand investments conducted by five large-scale oil palm plantations and the implications for local landowners and environment in the Boven Digoel and Merauke Districts *(Andrianto et al., 2019)*. Using data gathered by Landsat 8, the study identify some of the area designated for large-scale agricultural development which are located closer to big rivers such as the digoel and Bian Rivers. The benefit of the location is that it will ease the transport of fresh fruit bunch to the mills as well as crude palm oil to the refinery mill. The implication of the plan is the reduced of welfare of the indigenous people due to loss of livelihoods and impacts on food security. However, the

local spatial plan was designed with the aim for job creation, infrastructure provision and wellbeing of the local community.

CONCLUSIONS

Land cover classification of Landsat images is one of the most important and common application used in any research of land cover change *(Phiri & Morgenroth, 2017)*. The information gathered can inform policy makers, company, and community regarding land conditions including social and environmental impacts related to the land use. However, there are challenges on how the data gathered can assist the efforts to minimize deforestation and optimize the suitable non-forest area for palm oil plantation. The research present in this study exemplified some of the challenges. As many studies have confirmed, palm oil development has benefit to higher opportunity for employment, improvement of livelihoods in rural and remote areas *(Dib, Krishna, Alamsyah, & Qaim, 2018; Euler, Krishna, Schwarze, Siregar, & Qaim, 2017; Gatto, Wollni, & Qaim, 2015)* and stimulate growth and infrastructure development in the local areas *(Teoh, 2010).* For this reason, land expansion towards forest cover area is still an option and gaps on the mechanisation of the current regulation to regulate the practice have hindered the attempts to minimize deforestation. This also includes the mechanisation to optimize suitable non-forest area for palm oil plantation to achieve the national fresh fruit bunch production goal.

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