Study of oil palm plantation on peatland under spatial policies in Jambi Province, Indonesia

Ernan Rustiadi\textsuperscript{1,2,*}, Setyardi P Mulya\textsuperscript{1,2}, Didit O Pribadi\textsuperscript{1,3}, Asmadi Saad\textsuperscript{4}, Supijatno\textsuperscript{1,2}, La Ode S Iman\textsuperscript{1}, Andrea E Pravitasari\textsuperscript{1,2}, Mia Ermyanyila\textsuperscript{1} and M Nurdin\textsuperscript{1}

\textsuperscript{1}Center for Regional System, Analysis, Planning and Development (P4W/CRESTPENT), IPB University, Bogor, Indonesia
\textsuperscript{2}Department of Soil Science and Land Resource, IPB University, Jalan Meranti, IPB Campus, Darmaga, Bogor, Indonesia
\textsuperscript{3}Center for Plant Conservation Botanic Gardens, Indonesian Institutes of Science (LIPI), Indonesia
\textsuperscript{4}Department of Soil Science, University of Jambi, Jalan Raya Jambi, Muara Bulian KM 15, Mandalo Darat, 36361, Jambi, Indonesia
\textsuperscript{5}Department of Agronomy, IPB University, Jalan Meranti, IPB Campus, Darmaga, Bogor, Indonesia

*E-mail: ernan@indo.net.id

Abstract. According to The State of Indonesia's Forest 2020 report, 23.96 M ha of peat ecosystems in Indonesia are currently damaged. Peat ecosystems have a high level of vulnerability to landscape changes. Some of the main functions of peatland are ecological conservation, energy, and agriculture. One of major agricultural activities on peatland is oil palm plantation. Extra strict land management is needed to reach sustainability and minimize disaster (e.g., land fires) following The Guidelines for the Utilization of Peatlands for Oil Palm Cultivation, regulated by the Minister of Agriculture No. 14/2009. Still, many other policies also control aspects of protection and cultivation on peatlands. The research focused on analyzing dynamics of spatial policy on peatlands for oil palm cultivation. Spatial policies used included spatial pattern of Jambi Province, land permits, and maps of the status of forest areas. This study analyzed inconsistency of policies on spatial patterns, permits, and forest areas status in oil palm plantations on peatland. This research was conducted in Jambi Province, where 13.86% (121,290 ha) was on peatland. The analysis used a logical alignment matrix and GIS. The results showed that oil palm plantations on peatland with HGU/other permits generally aligned to spatial planning, permit, and forest area status. Its area reached 50,598 ha. Peatland utilization should go through suitable technical planning stages and considering actual land use/tenure and water system functioning.

1. Introduction
Palm oil (Elaeis guineensis Jacq.) is one of Indonesia's mainstay commodities of non-oil and gas foreign exchange sources. Oil palm plantation industry and its various derivative products, including crude palm oil (CPO), are recognized as superior products in this state. Development of domestic palm oil has rapidly increased, especially in the last two decades. Based on the Ministry of Agriculture data [1], total extent of Indonesia's oil palm in 2012 reached 9,074,621 hectares, mainly located in Sumatra Island.
Total area of oil palm plantations has increased significantly to 14,030,573 hectares in 2017, of which around 60% were located in Sumatra, 35% in Kalimantan, and 5% in Sulawesi, Java, Maluku, and Papua. Total production of oil palm in Indonesia within 2017 was about 37,812,628 tons [2].

In 2019, Jambi ranked fourth in Sumatra with total extent of oil palm plantation in about 1.06 M ha and 2.99 tons of crude palm oil (CPO) production [3]. Distribution of oil palm spread out in almost 300 villages or 22.17% of the total villages in the Province. Therefore, oil palm became one of the leading commodities in Jambi that can support local income sources [4]. Although the province has extensive oil palm plantations, there are many overlapping issues or inconsistencies with various policies [5].

Locations of oil palm plantations that are not in line with spatial policies tend to be less productive and ignore sustainability aspects in their management [6]. Lands that are not in line with policy terms (community gardens and company plantations) or called conflicted lands, in general, cannot be submitted for assistance (subsidies) [7]. Land legality issues can indirectly determine productivity. Policies and legality of lands in question are spatial planning, location permits, the status of forest areas, and peatlands. Overlapping oil palm plantation permits with mining concessions have already close to 300 thousand hectares. Plantation Business License of oil palm plantations with HGUs also overlaps with HPH and HTI, which means that HGU for oil palm plantations is granted within forest areas. This condition shows that policy overlap (inconsistency) exists in the plantation and forestry sectors.

Within the context of spatial planning, Law No. 41/1999 Article 23 states that the definition of plantation land by spatial planning is not allowed in prohibited areas (core zones for community plants, jungle zones in national parks, forest nature reserves), and following land use planning [8]. The purpose of this study was to evaluate consistency of existing oil palm land cover against various policies, including forest area status, regency/city spatial plans, legal permit status (IUP), and peat maps in Jambi Province. Consistency of oil palm land with policies/regulations is essential to consider by government policies. This study developed a matrix-based approach that described consistency between oil palm cover and various spatial policy categories: spatial pattern plans, forestry plans, government permits, and peat area status based on relevant laws and regulations.

2. Methodology

2.1. Study location

Jambi Province is located in the central part of Sumatra Island, facing Karimata Strait and Berhala Strait on the Indonesian Archipelagic Sea Lane (ALKI) I and international traffic. Geographically, Jambi Province is located between 0°74’–2°46.16’ South and 101°12’ - 104° 44’ East. The extent of Jambi Province is 53,435.92 km², divided into mainland of 48,989.98 km² and an ocean of 4,445.94 km² with a coastline length of about 223,025 km (Figure 1).

Figure 1. Study location.
2.2. Data
This study utilized secondary data. Maps were obtained from several agencies, including Jambi Province Plantation Service, Jambi Provincial Bappeda, and the Ministry of Environment and Forestry. Details of the data are presented in Table 1.

Table 1. Data and data source.

| No | Data                                      | Scale         | Source                                      | Data format |
|----|-------------------------------------------|---------------|----------------------------------------------|-------------|
| 1  | Map of licensing rights to cultivate       | 1:250,000     | National Land Agency of Jambi Province       | Shapefile (.shp) |
|    | 2018                                      |               | Jambi Province                              |             |
| 2  | Regional spatial planning (RTRW) 2016-2036 | 1:250,000     | Bappeda of Jambi Province                   | Shapefile (.shp) |
| 3  | Map of forest area status                 | 1:250,000     | Forestry Service of Jambi Province          | Shapefile (.shp) |
| 4  | Peatland map                              | 1:250,000     | Ministry of Environment and Forestry        | Shapefile (.shp) |
| 5  | Land cover map 2019                       | 1:100,000     | Plantation Service of Jambi Province, Ministry of Environment and Forestry | Shapefile (.shp) |

2.3. Methods
Consistency analysis between palm oil plantation and policies/regulation was evaluated by using Geographic Information System (GIS) and developing a policy's alignment matrix of oil palm plantation (polygons). GIS analysis was used for spatial data processing by overlapping land cover map with spatial policy data from various sectors, sources and existing scales. This method is commonly known as Boolean Overlay (overlay) method. Overlay in GIS is a simple method for combining spatial data. A new data layer is formed with a unique spatial unit in which there are combined attributes from data sources [9]. Focus of this research was on land cover of oil palm plantations.

Meanwhile, consistency analysis of land cover (oil palm plantations) with various sectors and scales policies was used to determine dynamics of plantation land status in multiple procedures. This resulted land information that is consistent or inconsistent in various policies, presented in spatial data and tabulation/shortlists (Figure 2). The results of overlay were then analyzed to determine spatial pattern of inconsistencies. There were discrepancies due to map scale used in the analysis. Of course, not every difference will also significantly impact damage or changes in the function of space or area. Therefore, it was necessary to build criteria for non-conformance, which are considered to potentially evaluate the function of the area. According to Figure 2, red-colored boxes indicate inconsistency of palm oil plantation areas with policies/regulations. Green-colored boxes designate the opposite.

Note: NHGU = Non HGU, IL = Other permissions, TS = Inconsistency, S = Consistent, APL = Area for other land use.

Figure 2. Scheme for determining conformity and incompatibility of oil palm estates with policy.
3. Results and discussion

3.1. Overview of licensing policy, spatial planning, forest area status and peat areas
Spatial policy in Jambi Province is divided into four spatial policies: permit maps (HGU, Non-HGU, other permits), spatial patterns (cultivated and protected areas), forest area status (APL and non-APL), peat areas (peat and non-peat). Complete data on the distribution of spatial policies and existing conditions in oil palm plantations are presented in Figure 3.

![Figure 3](image)

Figure 3. Spatial distribution of permit status (a), spatial plan (b), forest area status (c), and peatland in Jambi Province.

3.2. Alignment of oil palm plantation with various policies
Oil palm plantations are evenly distributed in Jambi Province based on data from Jambi Provincial Agriculture Office in 2019. These plantations occupied around 874 thousand ha. In this study, analyzed land use was oil palm land, either managed by local community or corporate farms. Therefore, this research showed existing oil palm plantations in Jambi Province, whether they aligned with current spatial planning, permits, spatial planning, forest area status, and peat protected areas. Thus, it is hoped that this information could provide an overview of the alignment of oil palm plantations with these policies.

Oil palm areas having a combination of HGU/IL | S | S | NG means land that has HGU permits/other permits, in line with spatial pattern and status of forest areas and oil palm land on non-peat land. Combined land area was 160 ha or 18% of total areas of oil palm plantations. The opposite applied to oil palm areas with a combination of NHGU | TS | TS | G, and there was a potential for inconsistency. It covered about 3,000 hectares or 0.43% of oil palm areas in Jambi Province (Figure 4 and Table 2).

The most expansive combination was NHGU | S | S | NG area of 442,000 hectares or 50% of oil palm plantations. It means that the land does not have an HGU permit or could be a smallholder plantation, in line with spatial pattern plan, status of forest areas, and non-peat areas. This category is an ideal land
characteristics and is suitable for smallholder oil palm plantations. Smallholder farmers who cultivate oil palm plantations in this area need to register to the Plantation Office of local regency to get a certificate of plant cultivation registration (Surat Tanda Daftar Budidaya Tanaman, STDB). This legality status is important for farmers for business development (e.g. accessing financial capital, etc.).

**Table 2.** Combination of oil palm plantation consistency with permits, spatial patterns, and status of forest and peat areas.

| No | Combination | Ha   | %  | No   | Combination | Ha   | %  |
|----|-------------|------|----|------|-------------|------|----|
| 1  | HGU | S | S | G   | 31,252.56 | 3.57 |
| 2  | HGU | S | S | NG  | 63,591.07 | 7.27 |
| 3  | HGU | S | TS | G  | 434.63  | 0.05 |
| 4  | HGU | S | TS | NG  | 139.29  | 0.02 |
| 5  | HGU | TS | S | G   | 0.24    | 0    |
| 6  | HGU | TS | S | NG  | 74.71   | 0.01 |
| 7  | HGU | TS | TS | G  | 13.35   | 0    |
| 8  | HGU | TS | TS | NG  | 729.78  | 0.08 |
| 9  | HGU | TS | TS | NG  | 0       | 0    |
| 10 | IL | S | S | G   | 19,345.94 | 2.21 |
| 11 | IL | S | S | NG  | 97,521.30 | 11.15 |
| 12 | IL | S | TS | G  | 236.78  | 0.03 |
| 13 | IL | S | TS | NG  | 3,968.56 | 0.45 |
| 14 | IL | TS | S | G   | 20.41   | 0    |
| 15 | IL | TS | S | NG  | 265.05  | 0.03 |
| 16 | IL | TS | TS | G  | 457.32  | 0.05 |
| 17 | IL | TS | TS | NG  | 1,473.52| 0.17 |
| 18 | NHGU | S | S | G   | 62,196.32 | 7.11 |
| 19 | NHGU | S | S | NG  | 442,141.11 | 50.55 |
| 20 | NHGU | S | TS | G  | 3,232.26| 0.37 |
| 21 | NHGU | S | TS | NG  | 24,485.81| 2.8 |
| 22 | NHGU | TS | S | G   | 321.99  | 0.04 |
| 23 | NHGU | TS | S | NG  | 3,599.00| 0.41 |
| 24 | NHGU | TS | TS | G  | 3,779.08| 0.43 |
| 25 | NHGU | TS | TS | NG  | 115,451.88| 13.2 |
| Total | 874,731.96 | 100 |

**Figure 4.** Combination of consistency of oil palm plantations with permits, spatial planning, the status of forest and peat areas.

4. Conclusion and suggestion

This study has identified inconsistencies of oil palm plantation's spatial distributions with various government regulations in Jambi Province. Of all oil palm plantations covering an area of 847,731 ha,
158,249 ha (18.09%) of oil palm plantations were inconsistent with provincial spatial plan, forest area status, and permit status, of which 8,496 ha were located on peatlands. Dominant category of the inconsistency of oil palm plantation in peat areas was situated in non-HGU and forest areas (7,011 ha). Oil palm plantations with the most widespread inconsistency were in Muaro Jambi Regency, covering 5,043 ha (59% of the total inconsistency in peatland). Sustainable management of peat areas needs to be based on harmony between their use/regulations. Spatial conflicts for oil palm plantations in peat areas require information on spatial distribution and variety of cross-sectoral allocation conflicts.

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**ORCID IDs**

Ernan Rustiadi https://orcid.org/0000-0001-8663-794X
Setyari P Mulya https://orcid.org/0000-0002-7801-5494
Didit Okta Pribadi https://orcid.org/0000-0002-1794-7781
Asmadi Saad https://orcid.org/0000-0002-2761-3072
La Ode S Iman https://orcid.org/0000-0002-8393-7856
Andrea Emma Pravitasari https://orcid.org/0000-0002-3063-9900

**References**

[1] Directorate General of Estate Crops 2013 *Tree Crop Estate Statistics of Indonesia: Palm Oil* ed B S Juga et al (Jakarta: Directorate General of Estate Crops - Ministry of Agriculture)

[2] Sunarso 2018 Pembiayaan kelapa sawit: Perkembangan, permasalahan dan alternatif solusinya *Oil Palm National Symp. Sustainable Smart Plantation* (Bogor) p 137

[3] Sub-directorate of Estate Crops Statistics 2019 *Indonesian Oil Palm Statistics 2019* (Jakarta: BPS - Statistics Indonesia)

[4] Junaidi J, Yulmardi Y, and Hardiani H 2020 Food crops-based and horticulture-based villages potential as growth centre villages in Jambi Province, Indonesia *J. Crit. Rev.* 7 514–9

[5] Rokhim R, Januari A D, Atik U, Shara S and Rusdayanti N 2020 Palm oil social conflict resolution and mediation in Jambi ed S Serpa *Cogent Soc. Sci.* 6 1812831

[6] Rosyani, Edison, and Asmadi 2019 Study on sustainability status of smallholder oil palm plantations Jambi Province, Sumatra Indonesia - IOPscience *IOP Conf. Ser.: Earth Environ. Sci.* ICES 2018 vol 314, ed Putra R R (Bristol: IOP Publishing) pp 1–10

[7] Waluyo J, Berliani H, Suhadi Z, Surambo A, Surisno E, Indonesia T, Fitra S and Prameswari A 2017 *Urgensi Kebijakan Moratorium Perkebunan Kelapa Sawit di Indonesia* (Bogor: TuK Indonesia)

[8] Adhynugraha S 2006 Potensi dan permasalahan pengembangan perkebunan kelapa sawit skala besar di Kalimantan Timur *J. Borneo Adm.* 2 67–82

[9] Sugumaran R and Degroote J 2010 *Spatial Decision Support Systems: Principles and Practices* (Boca Raton: CRC Press, Taylor and Francis Group, LLC)