Assessment of Forest Cover Change in PT Internusa Jaya Sejahtera (PT IJS) Concession, South Papua Province

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ABSTRACT

This assessment aims to classify land use and land cover status, as well as to identify liability of land use changes over the last 5 years in PT Internusa Jaya Sejahtera (PT IJS) concession in South Papua. This assessment used Landsat 8 TM aerial image data from late 2015 to early 2023 at 1-year intervals, concession boundary map, forest cover baseline map of Ministry of Environment and Forestry (MoEF), and peatland map. The delineation process in the concession was conducted using ArcGIS 10.5, based on land use and land use change information and data. Land use/cover is classified based on 6 broad land use categories of the Intergovernmental Panel on Climate Change (IPCC)'s Best Practice Guidance for land use classification. The process of visual/on-screen digitisation was carried out to delineate and classify year-to-year changes in forest cover. The palm oil plantation area of PT IJS increased from 1,251.92 ha in 2016 to 11,347.18 ha in 2023. This expansion in the palm oil plantation area can be attributed to the conversion of Secondary Dryland Forests and Secondary Swamp Forests, resulting in liability in 2016-2023. The forest area within PT IJS concession experienced a significant decline from was 10,667.41 ha (approximately 79.42% of the total concession area) in 2016 to 1,635.89 ha (12.18% of the total concession area) in 2023. This assessment results indicate that during the period of 2016-2023, PT IJS converted 9,031.52 ha of secondary forests.

Keywords: *PT IJS, liability, ArcGIS, on-screen digitisation, IPCC*

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I. INTRODUCTION

In the webinar titled “Palm Oil Industry, A Solution to Alleviate Poverty in Papua” by Forum Wartawan Pertanian (FORWATAN), it was noted that Indonesia's total palm oil land cover is 16.38 million ha, with the eastern region (Sulawesi, Maluku, and Papua) accounting for 553,952 ha (3.38%) of this national total. Papua and West Papua Provinces have a total palm oil areas of 58,656 ha and 110,496 ha, respectively. Palm oil land covers span accros various districts in West Papua, including Manokwari, Sorong, South Sorong, Maybrat, Teluk Bintuni, and Fak Fak. Similarly, in Papua, they are found in Nabire, Jayapura, Keerom, Boven Digoel, Mappi, and Merauke. The prospective development of palm oil in the eastern region of the country should be sustained, as it seeks to alleviate poverty and boost local economic growth, resulting in a multiplier effect. Initiatives aimed at poverty alleviation through palm oil cultivation include Community Palm Oil Replanting Programme (PSR). This programme was focused on replanting a total area of 540,000 ha accros 21 provinces, involving around 43,000 smallholders during the period of 2020-2022. Particularly in Papua, the PSR target for 2020-2022 was set at 6,000 ha. “In Papua, the PSR target for 2020-2022 was 3,000 palm oil areas in both West Papua and Papua,” Musdhalifah explained.

Challenges to palm oil plantation development in Papua include factors such as low productivity of community palm oil plantations, insufficient transportation infrastructure and facilities, social conflicts with Indigenous Peoples, and limited local community capacity.

In Merauke District, such challenges include complexities related to land tenure, inadequate supporting infrastructure and facilities, and insufficient information dissemination to Indigenous Peoples on palm oil plantation investments. Therefore, the roles of local government in promoting palm oil industry. This includes granting permits and investment incentives, disseminating information to companies about investment policies, overseeing monitoring, control and evaluation processes, and providing supporting infrastructure, such as roads, canals, bridges, and telecommunication networks.

Imam Azis, Special Staff to the Vice President of the Republic of Indonesia for Poverty Reduction and Regional Autonomy, emphasised that palm oil industry unquestionably holds a significant position in poverty reduction, thus underlining the importance of extending palm oil development to the eastern regions of Indonesia. There is also an urgent need for enhanced governance in the palm oil industry, including various aspects such as plantation management and the engagement of smallholders in palm oil development.

Tungkot Sipayung, the Executive Director of the Palm Oil Agribusiness Strategic Policy Institute (PASPI), pointed out that palm oil plantations play a significant role in fostering the

emergence of new economic growth centres in Papua, particularly in Keerom, Sorong, South Sorong, Manokwari, Teluk Bintuni, Fak Fak, and Merauke. In broader context, Tungkot Sipayung highlighted two key advantages of palm oil development that are have significant impact: rural poverty alleviation and the creation of direct and indirect employment opportunities.

The development of community palm oil plantations necessitates several government policies. These include the implementation of initiatives, such as the PSR programme, improvement of infrastructure and multimodal programmes in Papua, the enforcement of a moratorium on palm oil plantation permits, the establishment of a national action plan for sustainable palm oil plantations, and the adoption of the Indonesian Sustainable Palm Oil (ISPO) certification system. According to Justina Sianturi, the Head of Merauke Capital Investment Agency and One-Stop Integrated Service (DPMPTSP), the palm oil industry plays a significant role in the development and investment of Merauke District. This industry provides employment opportunities for 2,474 indigenous Papuans, generates income through plasma plantations, and contributes to the improvement of local economy by creating new job opportunities. In addition, palm oil industry contributes significantly to community empowerment by serving as a platform for marketing local agricultural products, fostering environmental enhancements, and promoting community education and awareness.

The transformation of sustainable palm oil industry governance started in 2015 through the introduction of the No Deforestation, No Peat, No Exploitation (NDPE) policy. The voluntary policy, initially released by Wilmar, encompasses various commitments, including but not limited to, the cessation of deforestation and peatland clearance. Additionally, the policy emphasises the importance of respecting the rights of communities living within the company's concessions and throughout its supply chain. This means that palm oil plantation developments that violate such regulations will be cut off from the supply chain.

Since then, the NDPE policy has been adopted by many prominent traders, resulting in a substantial decrease in deforestation rates over the past decade. In addition, implementation of Principles & Criteria of the Roundtable on Sustainable Palm Oil (RSPO) and the moratorium policy have also contributed significantly to reducing deforestation. According to Chain Reaction Research (CRR) report, approximately 50% of the deforestation rate decreased in 2017-2018. This decrease was attributed to the top 10 palm oil companies in Malaysia, Indonesia (specifically Kalimantan, Sumatra, Sulawesi, West Papua, and Papua), and Papua New Guinea. The report also suggests that the deforestation rate is predicted to decrease further if farmers, traders, and buyers adhere to the NDPE commitment. This can be achieved by

engaging multiple stakeholders in comprehensive governance improvements, particularly targeting those who have not yet implemented this policy.

The contribution of NDPE policy to halting deforestation and improving the governance of sustainable palm oil industry should be embraced. However, research on the effective implementation of this policy remains limited, and the systematic evaluation has yet to yield promising outcomes (Garrett *et al.*, 2018). This occurs due toinfrequent reporting of progress by companies, and certain cases of non-compliance persist within companies that have pledged to commit to NDPE principles (Cuff, 2016), which in turn contributes to continued deforestation (Hansen et al., 2013).

The implementation of this voluntary policy may require a certain period of time to be fully executed. PT Internusa Jaya Sejahtera (PT IJS) has demonstrated its commitment to the adoption of sustainable practises in the palm oil industry through the implementation of NDPE policy and its associated measures. The company has established implementation and monitoring mechanism, one of which is the NDPE Assessment and Validation Tools (NAV-T). NAV-T is an independent assessment tool that incorporates the participation of academics in its verification and validation processes. NAV-T system is built upon the comprehensive range of all NDPE components linked to ISPO, RSPO, the International Sustainability and Carbon Certification (ISCC) certification standards, as well as non-certification criteria such as the Implementation Reporting Framework (IRF), the Accountability Framework initiative (AFi), FPCA, and Sustainable Development Goals (SDGs).

This report provides results of liability assessment conducted in PT IJS concession. The objective of the assessment was to identify the conversion of primary and secondary forest areas that occurred after December 2015. To achieve this objective, Hylobates Awara Foundation conducted a forest cover change analysis using the IPCC Standard approach. Essentially, this approach is designed to track and determine the extent of deforestation, serving as a reference point for devising restoration plan that ensure the company's future supply chain is free from deforestation. Additionally, this approach aims to identify required level and nature of compensation to offset negative effects of biodiversity loss, carbon emissions, and their impacts on local community's livelihoods.

II. OBJECTIVE

Aligned with the above description, the objectives of this land cover change assessment are as follow:

1. To identify and analyse changes from forest-covered to non-forests areas occurring since late 2016 to 2023; and.
2. To formulate remediation plans based on land cover change assessment and its environmental conditions, which include biophysical aspect as well as social, economic, and cultural dynamics of the community.

The remediation plan documentation will serve as a guiding reference for PT IJS in implementing remediation measures, including activity focus, type, timeline, and stakeholders involved.

III. TERM LIMITATION

The following terms are used and discussed throughout this document:

1. Primary Dryland Forest refers to forests growing on mineral soils with no signs of logging activities or disturbance.
2. Secondary Dryland Forest refers to forests growing on mineral soils with signs of logging activities and disturbance.
3. Secondary Swamp Forest refers to all forests in swamp forms, with signs of the logging activities.
4. Scrublands refer to areas characterised by the presence of small-diameter woody plants (<40 cm) and heights ranging from 0.6-10 m.
5. Land cover change refers to any changes in vegetation cover conditions observed after December 2015, as determined through the analysis of available Landsat image data.
6. Data used in this assessment is Landsat TM 8 image data from 2015-2021.
7. The assessment uses an on-screen digitisation method with the largest scale of 1:25,000.
8. Land cover change analysis uses the 2021 baseline data
9. Remediation plan refers to PT IJS's commitments and actions aimed at consistent restoration of land cover changes by considering ecological/environmental factors, including climate and biodiversity habitat, socio-economic and cultural factors, as well as technical factors.

IV. METHODOLOGY

1. Location

PT IJS is a legal entity in Indonesia that engages in palm oil plantation and processing operation, headquartered in South Papua. The company started its palm oil operations in Papua since 2015, upon request of the local government. The company holds concession of 13,430.65 ha divided among three estates, i.e., Estate Maro (MOE), Estate Kumbe (KBE), and Estate Novak (NOE) as shown in Figure 1.

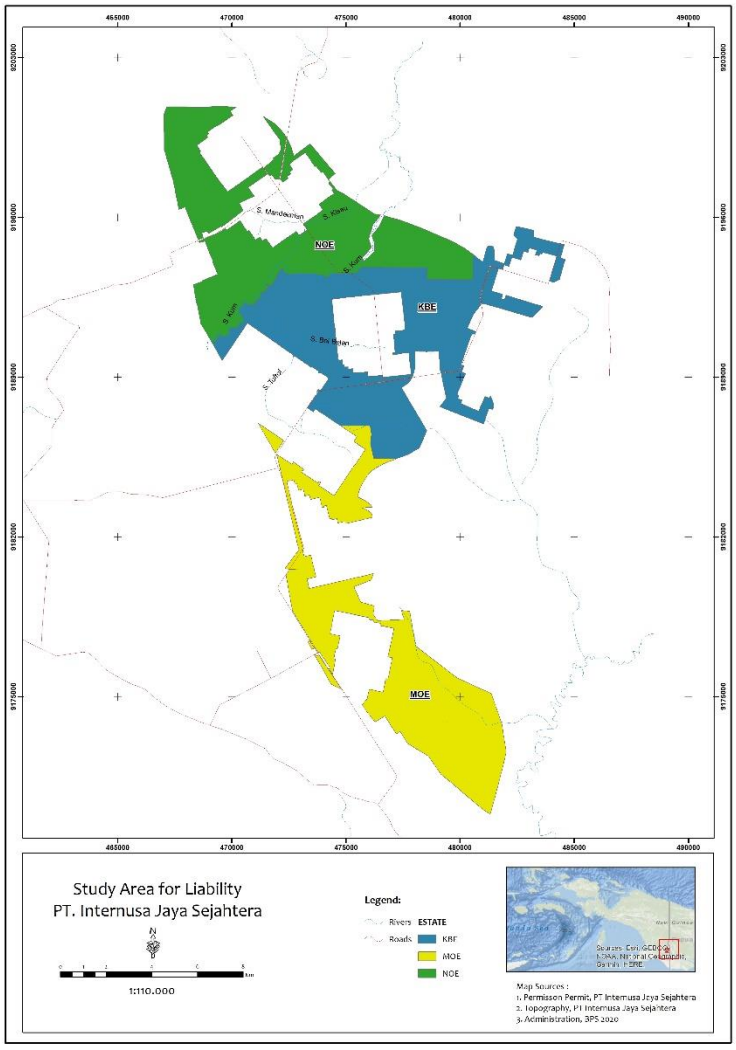


Figure 1. Map of assessment areas and PT IJS location in South Papua Province

2. Data

This assessment involves the selection and identification of the highest quality aerial images, with the aim of avoiding clouds and other major issues commonly encountered during

imege interpretation in tropical regions (Asner 2001; Hansen *et al*., 2008; Margono *et al*., 2012). See Table 1 for the list of the selected available Landsat images.

Table 1. Specification of Satelite Images used in PT IJS liability assessment

Aerial Image Data	Path/row	Image Date	Band Number	Spatial Resolution
Landsat 8	LC08_L1TP_100065_20160112_20200907_02_T1.TIF	12/01/2016	6,5,3	30 m
Landsat 8	LC08_L1TP_100065_20171216_20200902_02_T1.TIF	16/12/2017	6,5,3	30 m
Landsat 8	LC08_L1TP_100065_20180728_20200831_02_T1.TIF	28/07/2018	6,5,3	30 m
Landsat 8	LC08_L2SP_100065_20191019_20200825_02_T1.TIF	19/10/2019	6,5,3	30 m
Landsat 8	LC08_L1TP_100065_20200818_20200920_02_T1.TIF	18/08/2020	6,5,3	30 m
Landsat 8	LC08_L1TP_100065_20211109_20211117_02_T1.TIF	09/11/2021	6,5,3	30 m
Landsat 8	LC08_L2SP_100065_20221112_20221121_02_T1.TIF	12/11/2022	6,5,3	30 m
Landsat 8	LC08_L1TP_100065_20230421_20230429_02_T1.TIF	21/04/2023	6,5,3	30 m

This land cover change analysis uses the Landsat-8 OLI-TRIS image satellite with medium resolution. Eight images from the *Landsat scene path/row 100/65, which is part of the* Landsat Worldwide Reference System (WRS) were downloaded. These images have been selected to represent the assessment areas. A selection of Landsat time series data from 2016-2023, with one year interval, has been chosento extract information on landuse and land cover change in the assessment area. The aerial images are downloaded from the United States Geological Survey (USGS) website (https://earthexplorer.usgs.gov/).

Other data required for conducting land cover change analysis in PT IJS are as follows:

a. ***Forest cover –*** Forest cover information was sourced from secondary sources, specifically referring to land cover conditions in 2019 provided by the Ministry of Environment and Forestry (MoEF).
b. ***Deforestation alerts data*** – The dataset includes advanced alerts for deforestation (vegetation removal) provided by the World Research Institute (WRI) and Global Forest Watch (GFW) and are openly accessible to public. These data were used to assist in the identification of vegetation loss (deforestation).
c. ***PT IJS concession boundaries –*** *These were acquired from PT IJS.*

Table 2. Data used in PT IJS liability assessment

No	Type of Data	Description	Scale/Resolution	Source
1	Satellite Image	Landsat Path/Row	30 m	USGS
2	SHP	Land Cover/Landuse in 2019	1:250.000	MoEF
		Concession boundaries	1:50.000	Indonusa Group
		Administrative boundaries	1:50.000	BPS
3	Deforestation Alert	Tree cover loss data	30 m	WRI-GFW 2016-2023

3. Pre-processing

To reduce radiometric errors, standard radiometric and geometric corrections were implemented. Since none of the available bands have layers in GeoTIFF output format, the downloaded band files were aligned using ArcGis 10.5 for analysis.

- Geometric correction

  In this assessment, aerial image maps are standardised through data pre-processing. These steps include projection of aerial images into Universal Transverse Mercator (UTM), WGS 1984 Datum, zone 54 South (54S) coordinate system.

- Radiometric Correction

  Radiometric correction employs Apparent Reflectance function in Atmospheric Correction method. This function serves to calibrate digital image brightness values (Digital Number/DN) from some satellite sensors, similar to atmospheric correction. The calibration process relies on several factors, including the sun's elevation, acquisition date, and sensor properties (gain/bias settings for each band).

- The Apparent Reflectance function employs ArcGIS software tools to refine reflectance or brightness values of certain satellite images by factoring in scene illumination and sensor gain settings. Such images have been calibrated to aaccount for theoretical general illumination condition. As a result, there may be slight variation observed between scenes captured on different dates and by different sensors. This technique is useful in the fields of image classification, colour balancing, and mosaicking. The visual

radiometric correction output show no significant difference in the display, yet the value range of the atmospheric correction output has now changed to 0-1.

- Image Enhancement

  Landsat 8 has 11 bands, each featuring different spatial resolution values. Bands 1, 2, 3, 4, 5, 6, 7, and 9 exhibit spatial resolution of 30 m, while bands 10 and 11 are characterised by a spatial resolution of 100 m. Meanwhile, band 8 features a spatial resolution of 15 m. The Pan-Sharpening (fusion) technique can be used to enhance spatial resolution of the natural colour composite band 653, which currently has spatial resolution of 30 m. This enhancement is achieved by adding band 8 (Panchromatic) into the process. The sharpening process was carried out using the ESRI method and 'Create Pan-sharpened Raster' tool available in ArcGIS software.

4. Analysis of land use/land cover change detection

Baseline data was generated through on-screen digitisation of harmonised maps, which included the 2016 medium-resolution aerial image map (corrected Landsat 8 TM), forest cover map from MoEF, and the concession boundaries map. Detection and delineation outcomes from these three map layers indicate land cover situation within PT IJS concession in 2016.

The aim of land cover change detection is to obtain information about any transitions or changes that have occurred within a specific timeframe between two different years. The assessment involved analysing land cover change from 2016 to 2023, with change detection interval of one year. The process of map harmonisation was carried out using baseline data and annual imagery maps of interest. The next step entailed delineation/digitalisation of land cover loss, particularly to palm oil plantation or other land uses. This process involved comparing actual condition to identify any changes in patterns of land cover use. As a result, polygons were generated on the maps to indicate changes in the land use within the company's palm oil concession after 2015. Data generated from the delineation includes the loss of forest covers in specific years or the specific types of forest covers that have been lost. This extensive data is subsequently presented in tabulated format, providing details about the area of forest loss and the corresponding time period, and is further visualised on maps. The interpretation of aerial images serves as an initial depiction of land cover changes in 2016-2023. The following is a flowchart of the land cover change analysis.

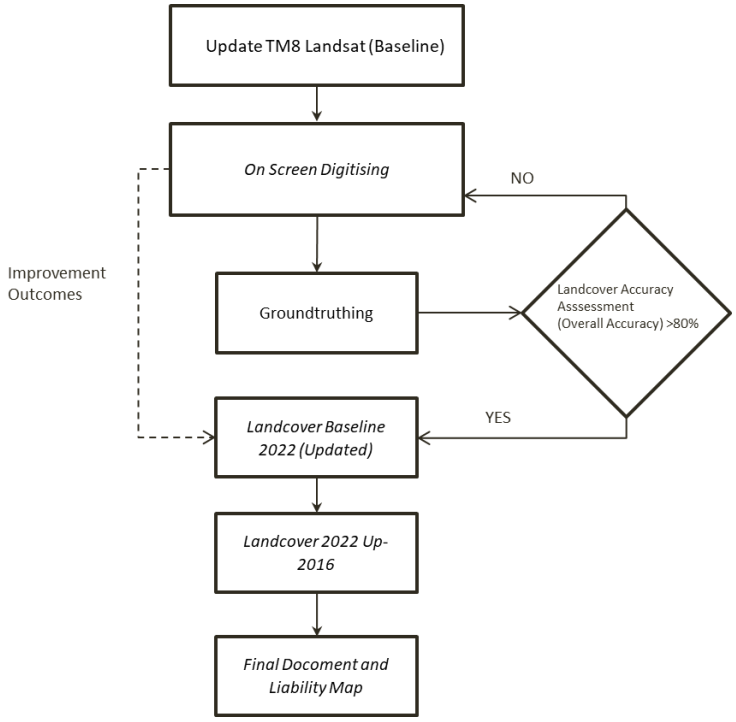


Figure 2. Flowchart outlining the steps involved in analysing land cover change within PT IJS concession

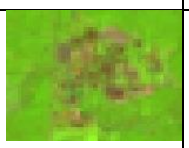
5. Land cover classification

In this assessment, land cover classification follows the IPCC's Good Practice Guidance, which suggests six overarching categories to represent forestlands, croplands, grasslands, wetlands, settlements, and other lands (IPCC 2003). According to this landuse framework, it is recommended that all countries undertake the estimation of carbon stocks and greenhouse gas (GHG) emissions and sequestration, and subsequently report it under the United Nations Framework Convention on Climate Change (UNFCCC). The use of interpretation method may present dubious objects, thus it is necessary to conduct groundtruthing for such object types.

Table 3. Land cover classification based on the IPCC Guidance

No	Land Cover Classification	Description	RGB Display (6:5:3)	Remarks
1	Primary Dryland Forest	Primary forest is defined as intact forest where stands are close to a state of stability. Typically comprised of native tree species, this forest shows		Absent in PT IJS

		minimum indication of human interference, and ecological processes within it remain significantly undisturbed.		
2	Secondary Dryland Forest	Forestland in Indonusa Group concession is defined as secondary forest. In this assessment, secondary forest refers to regenerated forests that have experienced disturbance due to either human activities or natural disasters. Secondary forests include natural forest with timber extraction, maintaining created canopy gaps of up to 50-60 %. Agroforestry and community forests are included under this forest type.		Present in PT IJS
3	Scrubland	Scrubland refers to land with woody vegetation that include shrubs, bushes, and young trees measuring less than 5 m in height. The presence of the latter is often observed following deforestation in the absence of crop cultivation. As such, this land cover classification can be considered as degraded forests.		Present in PT IJS
4	Cropland	Cropland refers to cultivated and tilled land, encompassing both paddy fields and cultivated drylands. The Cropland includes areas covered with temporary cultivated crops, subsequently harvested, and then left		Present at PT IJS

		fallow for certain periods. Palm oil plantations are classified as a subset of Cropland, as they are specifically developed for the purpose of producing plantation crops.		
5	Upland Grassland	Upland grasslands are characterised by the presence of herbaceous plant species, while lacking any form of crop cultivation. The presence of trees and shrubs is observed, accounting for less than 10% of the area. Upland grasslands are typically found at higher elevations in mountainous areas.		Not present at PT IJS
6	Secondary Swamp Forest	The observed landscape consists of a swampy forest area that exhibits signs of previous logging activities.		Present at PT IJS
7	Settlement	Settlements consist of all developed land, including residential areas and other infrastructure, such as transportation roads.		Present at PT IJS
8	Other lands	The category includes open land, rocky terrain, glacial landforms, and any unmanaged land areas that were not accounted for in the preceding classification.		Present at PT IJS

6. Accuracy Assessment Analysis

The classification accuracy testing was conducted using Kappa Coefficient method, which yields values ranging from 0 to 1. The acceptable Kappa Coefficient accuracy value in the land classification/land cover mapping is at least 85% or 0.85 (Anderson, 1976). Consistency determines the acceptability of the Kappa Coefficient value. The assessment takes into account all components of the confusion matrix, including producer's accuracy (as well as omission error) and user's accuracy (as well as commission error).

7. Vegetation Hue

Based on secondary data and field interpretation, vegetation strata in the PT IJS area are as follow:

a. Forest Stratum: Vegetation found in the tree stratum are includes a variety of species such as acacia (*Acacia sp*), *Planchonia sp.*, white paperbark (*Melauleca leucadendra*), *Kingiodendron alternifolium*, *Alstonia sp.*, dammar pine (*Agathis dammara*), *Eugenia spp*., *ketapang* (*Terminalia canaliculata*), and *Vatica papuana*.

b. Yard Vegetation: Vegetation found on yards are of economic significance to the local community, such as secondary food crops (*palawija*), fruits, vegetables, spice plants, ornamental plants, and industrial crops. Most of the observed sites are transmigration areas, where the existing vegetation is cultivated for commercial purposes and local consumption. Orange, rubber, and rambutan are common cash crops, with the latter two being cultivated on well-established community-owned farmlands. Based on general observation, yard vegetation is dominated by trees bearing consumable fruits and herbaceous plants, such as coconut, mango, candlenut, and tamarind.

V. FINDINGS AND DISCUSSION

1. Findings of On-Screen Digitisation Analysis

On-screen digitisation was carried out using images obtained from the USGS.GOV application, spanning the years 2016 to 2023. This process involved referencing the 2019 land cover map from the Ministry of Environment and Forestry, with a scale of 1:250,000.

Figure 3. Example of the on-screen digitising result in PT IJS concession in 2020

2. Classification Accuracy Assessment Analysis

As mentioned in the methodology, accuracy testing using the Kappa Coefficient method requires consistency with a minimum coefficient value with the range of 0.80 (80%), taking into account aspects of producer's accuracy (and relevant commission error and user's accuracy (and relevant commission error). Field sampling involved 189 sample points, distributed accross three collection locations: Maro, Kumbe, and Novak Estates. Following the accuracy test (Kappa), the coefficient of accuracy was calculated to be 0.86 (86%). This result indicated

that the desktop land cover analysis aligns with observation made in the field. Thus, the land cover analysis can serve as the basis for further analysis.

3. Image Classification Outcomes and Analysis

Due to decreasing availability of land for palm oil plantation in Sumatra and Kalimantan, Papua has emerged an investment destination for the palm oil plantation industry in Indonesia. Although the development of palm oil plantations has not been as extensive as in Sumatra and Kalimantan, Papua has also contributed to the expansion of palm oil plantations in Indonesia.

The analysis involved assessing changes in forest cover over an 8-year time span in PT IJS concession in South Papua. The assessment was initiated by generating baseline data on forest cover for the year of 2023, followed by the interpretation of aerial imageries. The documentation presents tabulated format and maps at a scale of 1:50,000, illustrating the reduced forest area, as well as other changes that have occurred due to palm oil development and expansion, and forest degradation within PT IJS concession. Data and information obtained through the process of aerial image interpretation is updated annually, covering the time period from 2016 – 2023, using the same approach.

4. Analysis of Land Cover Changes of PT Internusa Jaya Sejahtera (PT IJS)

The total area of PT IJS's concession is 13,430.65 ha. Based on the analysis, the land covers within PT IJS concession include Plantation, Secondary Swamp Forest, Settlement, Cropland, Secondary Dryland Forest, Scrubland, and Swamp Scrubland. Notably, over the period of land clearing in 2016 to 2023, palm oil cultivation has dominated a significant portion, covering 84.47% of the total concession area, equivalent to 11,345.18 ha.

Table 3 provides insight into the presence of forests that remain and are maintained by PT IJS. The remaining forests include Secondary Dryland Forest of 1,572.02 ha and Secondary Swamp Forest of 63.87 ha. Non-forest covers that have not been converted for expansion of the palm oil plantation include 204.46 ha of Scrub, 41.47 ha of Scrub Swamp, and 74.15 ha of Open Land.

Table 4. Land covers in 2016 - 2023 within PT IJS concession

	Land Cover	2023								Total
		Scrubland	Swamp Scrubland	Secondary Dryland Forest	Secondary Swamp Forest	Open Land	Settlement	Plantation	Cropland	
2016	Scrub	16.45								16.45
	Scrub Swamp		41.47					50.66		92.13
	Secondary Dryland Forest	178.87		1,572.02		74.15		8,567.09	5.51	10,397.64
	Secondary Swamp Forest				63.87			205.90		269.77
	Open Land	10.14					21.10	1,269.60		1,300.84
	Settlement						95.34			95.34
	Plantation							1,251.93		1,251.93
	Cropland								6.55	6.55
Grand Total		205.46	41.47	1,572.02	63.87	74.15	116.43	11,345.18	12.06	13,430.65

As seen on the land cover map of PT IJS in January 2016 (Figure 4), secondary dryland forest (green) dominates land cover in the company's concession, with palm oil plantations (yellow) being slightly present. Additionally, the ongoing expansion of new plantations in the KBE or Kumbe Estate is highlighted in red.

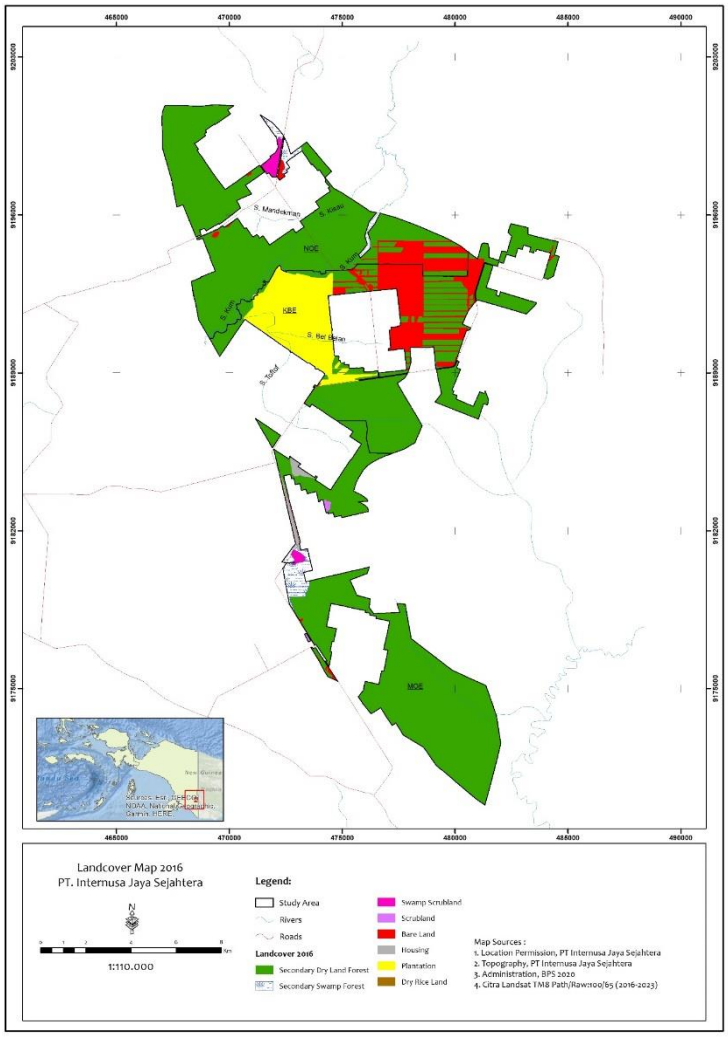


Figure 4. Map of Land covers within PT IJS concession in 2016

Table 5. Land covers in 2016 – 2017 within PT IJS concession

	Land Cover	2017								Total
		Scrub	Scrub Swamp	Secondary Dryland Forest	Secondary Swamp Forest	Open Land	Settlement	Plantation	Cropland	
2016	Scrub	16.45								16.45
	Scrub Swamp		92.13							92.13
	Secondary Dryland Forest			6,199.25		166.99		4,031.40		10,397.64
	Secondary Swamp Forest				269.77					269.77
	Open Land	10.14				10.51	21.10	1,259.09		1,300.84
	Settlement						95.34			95.34
	Plantation							1,251.93		1,251.93
	Cropland								6.55	6.55
Grand Total		**26.59**	**92.13**	**6,199.25**	**269.77**	**177.50**	**116.44**	**6,542.41**	**6.55**	**13,430.65**

According to the data presented in Table 4, in 2017, there was a clearing of 4,031.40 ha of secondary dryland forests, which was converted into palm oil plantations. In addition, an open land area of 166.99 ha was also cleared for palm oil land preparation. In 2016, a total of 1,300.84 ha of open land has been prepared and subsequently transforemed into a of palm oil plantation of 1,259.09 ha in 2017. As a result, by 2017 the total area of PT IJS's palm oil plantations reached 6,542.41 Ha.

In 2017, there was a notable increase in the expansion of PT IJS palm oil plantations. As shown in Figure 5, the expansion of palm oil plantations has extended to the KBE (Kumbe) Estate and started its northward towards the NOE (Novak) Estate. During this same period, there was no expansion in MOE (Maro) Estate, which continues to be dominated by Secondary Dryland Forests.

As illustrated in Figure 5, there is an Open Land (red) in the NOE (Novak) Estate that is intended for future management purposes but has not yet undergone palm oil cultivation.

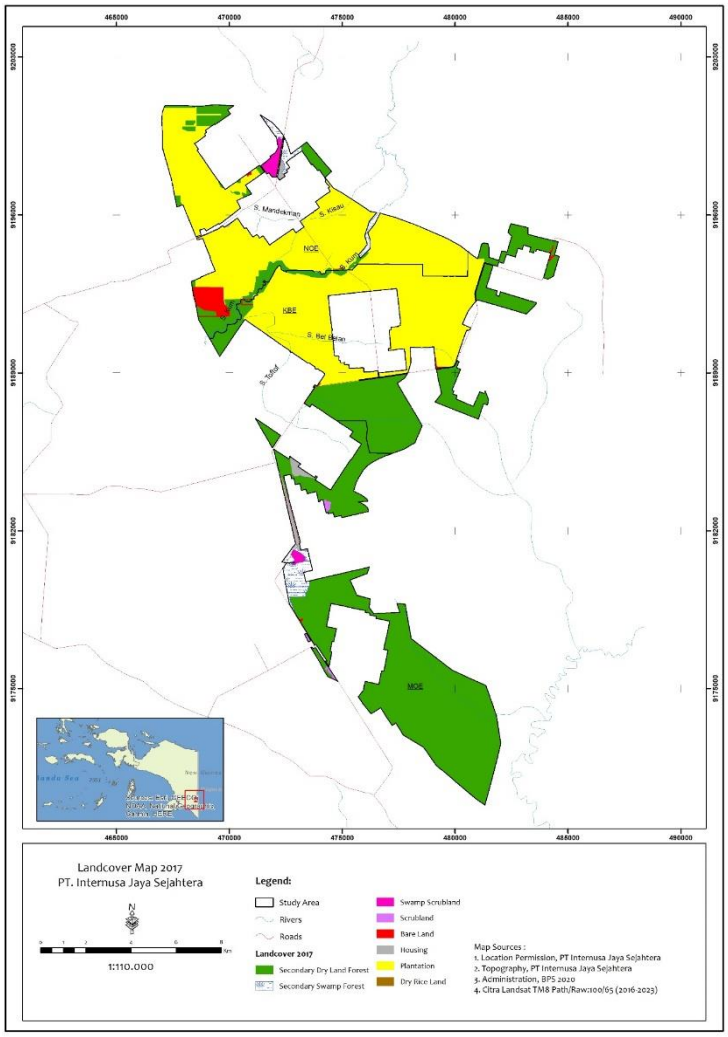


Figure 5. Map of Land covers within PT IJS concession in 2017

As outlined in Table 5, the company's palm oil plantation areas were expanded to a total of 7,164.66 ha in 2017-2018. The expansion occurred through he conversion of secondary forests (553.73 ha) and swamp scrublands (47.58 ha), as well as through planting on open land (20.94 ha). In 2018, a total of 77.93 ha of secondary forests were converted into open lands. In the same year, both secondary forests and secondary swamp forests covered a total area of 5,567.58 ha and 269.77 ha, respectively.

Table 6. Land cover within PT IJS concession in 2017-2018

	Land cover	2018								Area (ha)
		Scrubland	Swamp Scrubland	Secondary Dry Land Forest	Secondary Swamp Forest	Open Land	Settlement	Plantation	Cropland	
2017	Scrubland	26.59								26.59
	Swamp Scrubland		44.56					47.58		92.13
	Secondary Dry Land Forest			5,567.58		77.93		553.73		6,199.25
	Secondary Swamp Forest				269.77					269.77
	Open Land					156.56		20.94		177.50
	Settlement						116.44			116.44
	Plantation							6,542.41		6,542.41
	Cropland								6.55	6.55
Grand Total		**26.59**	**44.56**	**5,567.58**	**269.77**	**234.50**	**116.44**	**7,164.66**	**6.55**	**13,430.65**

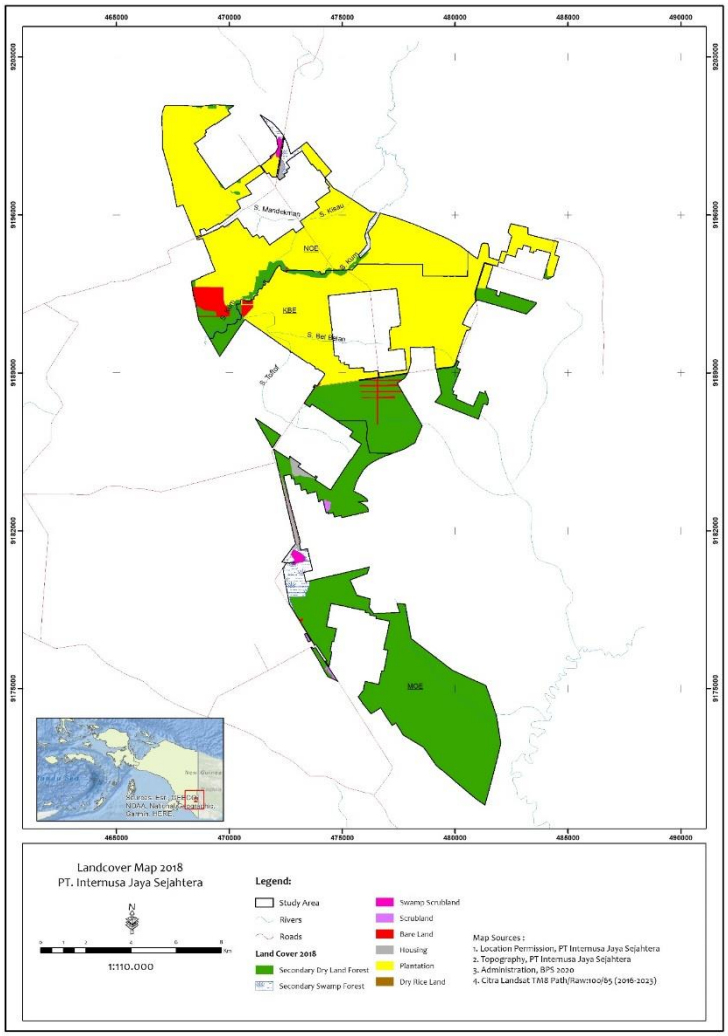


Figure 6. Map of Land cover within PT IJS concession in 2018

In 2018, the southern part of KBE (Kumbe) Estate was cleared and road construction took place to the south of the Estate (see Figure 8). The northern part of NOE (Novak) Estate's

secondary dry land forest has been cleared for palm oil plantation, leaving only a few fragments of the forest. There was no land clearing for palm oil plantation in NOE's secondary swamp forest because of its waterlogged conditions. In 2018, MOE (Maro) was still dominated by secondary dry land forest cover.

Table 7. Land cover within PT IJS concesion in 2018-2019

	Landcover	2019								Area (ha)
		Scrubland	Swamp Scrubland	Secondary Dry Land Forest	Secondary Swamp Forest	Open Land	Settlement	Plantation	Cropland	
2018	Scrubland	26.59								26.59
	Swamp Scrubland		44.56							44.56
	Secondary Dry Land Forest			2,697.00		101.02		2,769.57		5,567.58
	Secondary Swamp Forest				212.70	57.07		0		269.77
	Open Land	154.74				3.21		76.54		234.50
	Settlement						116.44			116.44
	Plantation							7,164.66		7,164.66
	Cropland								6.55	6.55
Grand Total		**181.33**	**44.56**	**2,697.00**	**212.70**	**161.31**	**116.44**	**10,010.77**	**6.55**	**13,430.65**

As indicated in Table 6, the process of forest clearing continued as part of the ongoing development of PT IJS palm oil plantation in 2019. From a total of secondary forest area of approximately 5,567.58 ha, around 2,769.57 ha was cleared for palm oil plantation, and an additional 101.02 ha were also cleared and converted into open land for immediate planting. Secondary swamp forests were also converted into open land which covers an area of 57.07 ha, leaving only 212.70 ha of such forests in PT IJS in 2019. By the same year, the company had expanded its palm oil plantation area to 10,010.77 ha.

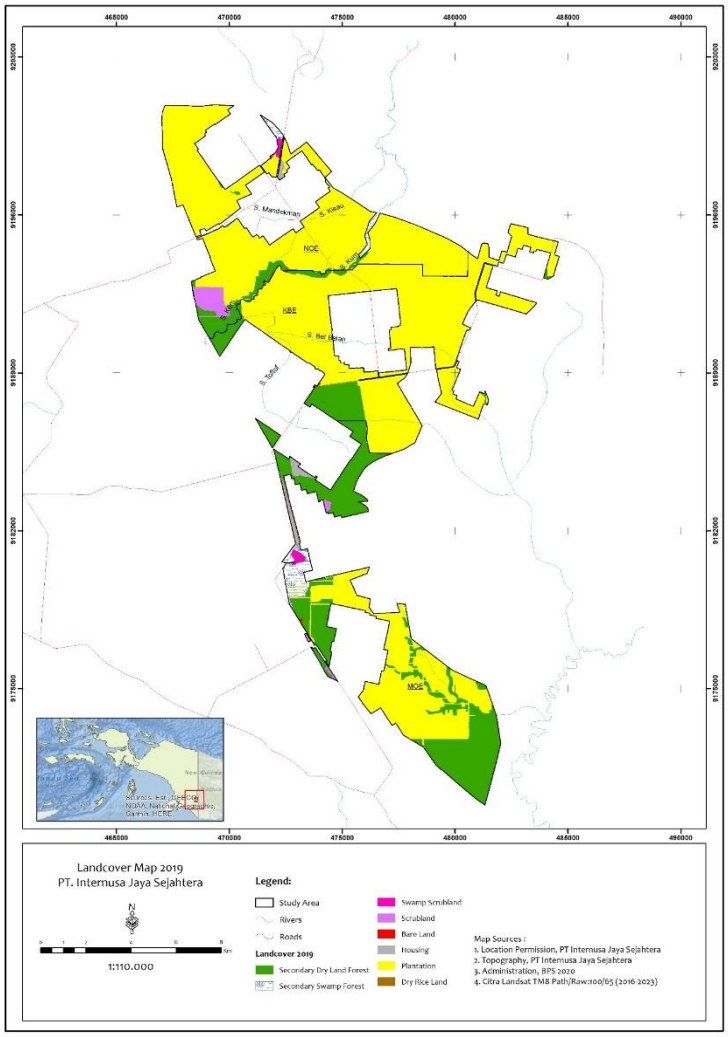


Figure 7. *Map of Land cover within PT IJS concession in 2019*

Figure 7 indicates that the northern part of NOE (Novak) has already been planted, while the remaining areas, previously covered by secondary dry land forest, have been converted into palm oil plantation. The uncultivated open land in this estate have naturally regenerated into scrubland. The southern part of MOE (Maro), previously classified a ssecondary dry land forest in 2018, has now been converted into palm oil plantation as of 2019.

As shown in Table 7, the secondary forest area in the company decreased from 2,697.00 ha to 1,694.10 ha in 2020. This reason for this is the conversion of secondary forest (997.39 ha) and land preparation (5.51 ha) into open land for the development of palm oil plantation. Additionally, a total of 148.83 ha of secondary swamp forest was also converted into palm oil plantation, leaving a remaining area around 63.87 ha in 2020. In the same year, palm oil plantation covered an area of 11,321.38 ha.

Table 8. Land cover within PT IJS concesion in 2018-2019

	Land cover	2020								Area (Ha)
		Scrubland	Swamp Scrubland	Secondary Dry Land Forest	Secondary Swamp Forest	Open Land	Settlement	Plantation	Cropland	
2019	Scrubland	181.33								181.33
	Swamp Scrubland		41.47					3.09		44.56
	Secondary Dry Land Forest			1,694.10		5.51		997.39		2,697.00
	Secondary Swamp Forest				63.87			148.83		212.70
	Open Land							161.31		6.58
	Settlement						116.44			116.43
	Plantation							10,010.77		10,165.50
	Cropland								6.55	6.55
Grand Total		**181.33**	**41.47**	**1,694.10**	**63.87**	**5.51**	**116.44**	**11,321.38**	**6.55**	**13,430.65**

Figure 8 shows that both Kumbe and Novak Estates are already dominated with oil palm. Similarly, there is a growing presence of palm oil plantations in Estate Maro, while the remaining secondary forests are concentrated along riverbanks, and secondary swamp forests have been cleared for expansion.

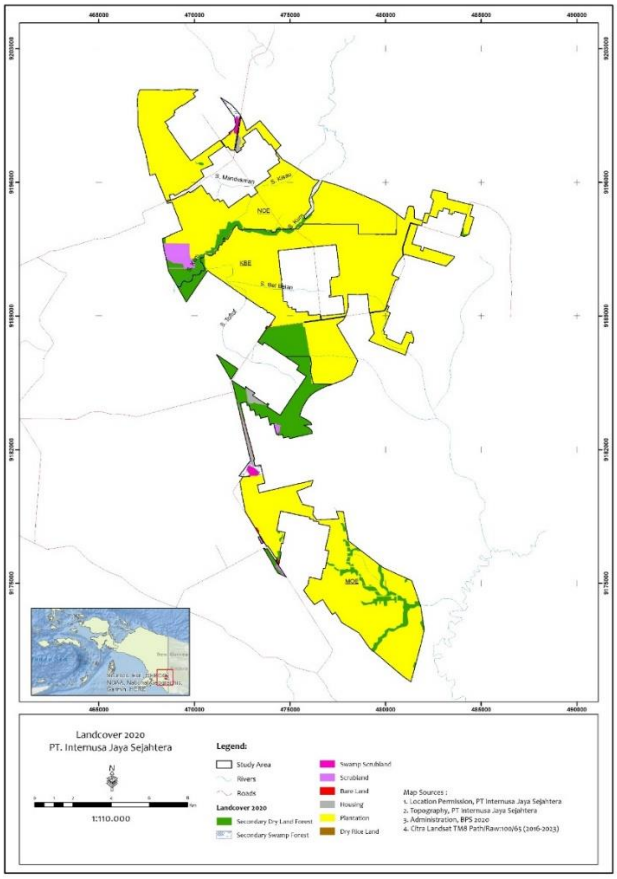


Figure 8. Map of Land cover within PT IJS in 2020

In 2021, no conversion of secondary swamp forest was found, and around 63.87 ha forest areas within PT IJS remained. In the secondary forest areas, 16.60 ha of lands were converted into palm oil plantation. In addition, timbers with a certain diameter were also extracted within the company's area, leading to land conversion into a scrub area of 19.39 ha.

Table 9. Land cover within PT IJS concession in 2020-2021

	Landcover	2021							Area (ha)
		Scrubland	Swamp Scrubland	Secondary Dry Land Forest	Secondary Swamp Forest	Settlement	Plantation	Cropland	
2020	Scrubland	181.33							181.33
	Swamp Scrubland		41.47						41.47
	Secondary Dry Land Forest	19.39		1,658.12			16.60		1,694.10
	Secondary Swamp Forest				63.87				63.87
	Open Land							5.51	5.51
	Settlement					116.43			116.43
	Plantation						11,321.38		11,321.38
	Cropland							6.55	6.55
Grand Total		**200.72**	**41.47**	**1,658.12**	**63.87**	**116.44**	**11,337.98**	**12.06**	**13,430.65**

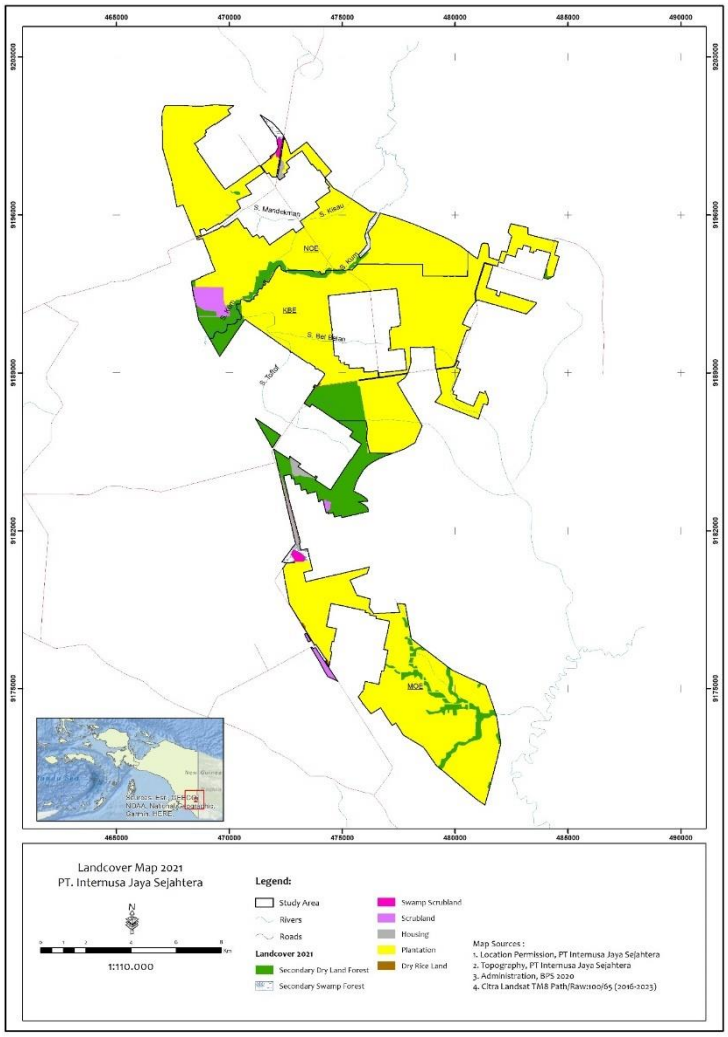


Figure 9. Map of Land cover within PT IJS concession in 2021

Table 9 shows that secondary forests decreased in 2022 due to conversion into open land (54.54 ha) and palm oil plantation (7.20 ha). Scrubland (205.46 ha) resulting from the conversion of secondary forests in the previous year continues to regenerate, and no additional palm oil plantations are developed on this area.

Table 10. Land cover within PT IJS concession in 2021-2022

	Landcover	2022								Area (ha)
		Scrubland	Swamp Scrubland	Secondary Dry Land Forest	Secondary Swamp Forest	Open Land	Settlement	Plantation	Cropland	
2021	Scrubland	205.46								205.46
	Swamp Scrubland		41.47							41.47
	Secondary Dry Land Forest			1,591.63		54.54		7.20		1,653.37
	Secondary Swamp Forest				63.87					63.87
	Settlement						116.43			116.43
	Plantation							11,337.98		11,337.98
	Cropland								12.06	12.06
Grand Total		**205.46**	**41.47**	**1,591.63**	**63.87**	**54.54**	**116.43**	**11,345.18**	**12.06**	**13,430.65**

In MOE (Maro) Estate, secondary forests on the riverbank was cleared (see Figure 10), while other estates conditions are relatively unchanged.

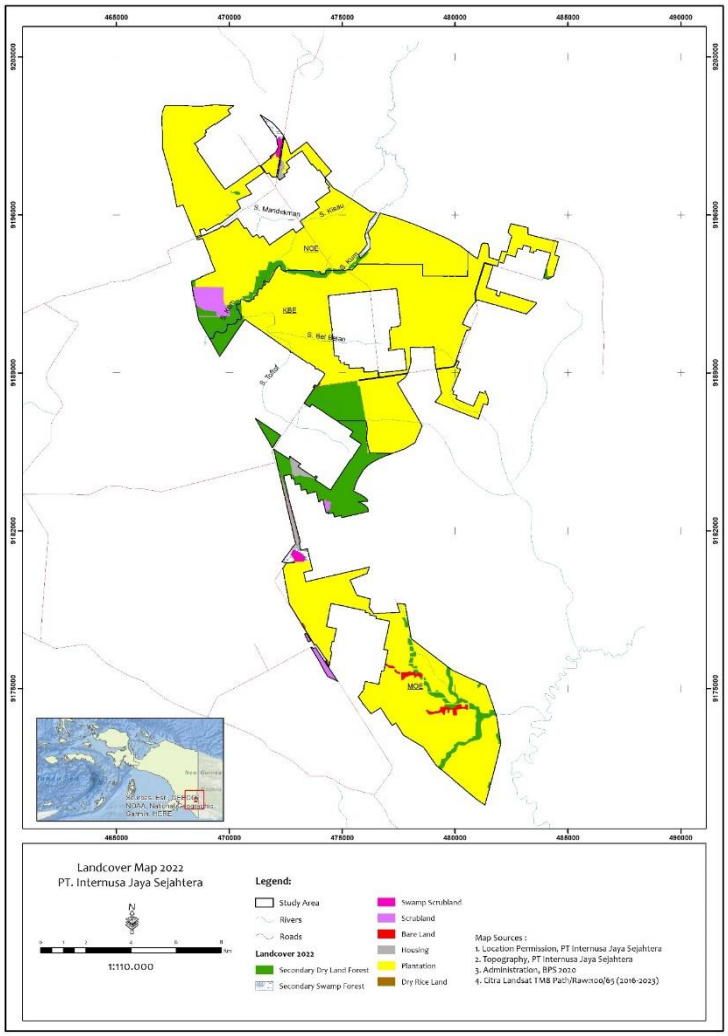


Figure 10. Map of Land cover within PT IJS concession in 2022

The final phase of land cover change analysis was carried out in April 2023. As detailed in Table 10, the area of secondary swamp forest remains unchanged at 63.87 ha. However, local communities cleared 19.61 ha of the area to establish a route for transporting fresh fruit bunches, facilitating independent smallholders. As of April 2023, PT IJS palm oil plantation area has reached 11,345.18 ha.

Table 11. Land cover within PT IJS in 2022-2023

	Land Cover	2023								Area (ha)
		Scrubland	Swamp Scrubland	Secondary Dry Land Forest	Secondary Swamp Forest	Open Land	Settlement	Plantation	Cropland	
2022	Scrubland	205.46								205.46
	Swamp Scrubland		41.47							41.47
	Secondary Dry Land Forest			1,572.02		19.61				1,591.63
	Secondary Swamp Forest				63.87					63.87
	Open Land					54.54				54.54
	Settlement						116.43			116.43
	Plantation							11,345.18		11,345.18
	Cropland								12.06	12.06
Grand Total		**205.46**	**41.47**	**1,572.02**	**63.87**	**74.15**	**116.43**	**11,345.18**	**12.06**	**13,430.65**

Figure 11 illustrates the clearance of secondary forests in MOE (Maro) Estate, with no evidence of planting in the areas where land clearing occurred in 2022.

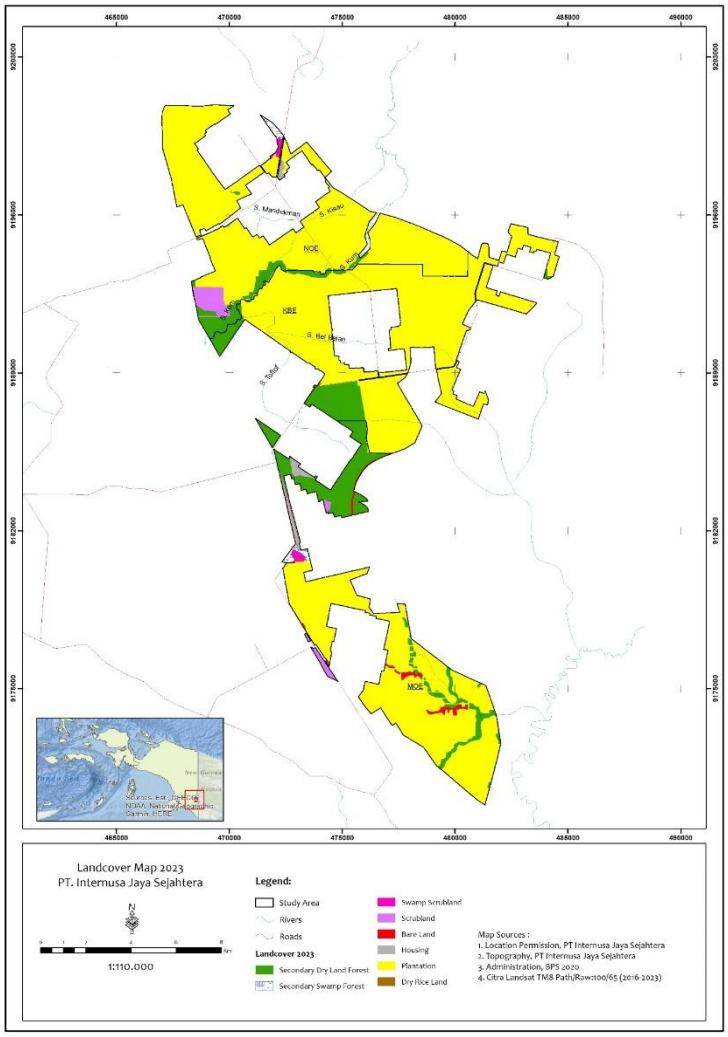


Figure 11. Map of Land cover within PT IJS concession in 2023

5. Land Cover Change from Forest into Palm Oil Plantation

Table 12. Total remaining forest area within PT IJS, South Papua in 2016 and 2023

Land Cover	Year	
	January 2016 (ha)	April 2023 (ha)
Secondary Dry Land Forest	10,397.64	1,572.02
Secondary Swamp Forest	269.77	63.87
Grand Total	**10,667.41**	**1,635.89**

Furthermore, the analysis includes the comparison between forest areas that were present in 2016 and those remain in 2023. PT IJS forest cover includes Secondary Dry Land Forest and Secondary Swamp Forest. Referring to Table 11, the total area of forest cover in

2016 was 10,667.41 ha, representing around 79.42% of the total concession area. Conversely, the forest area decreased to 1,653.89 ha in 2023, equivalent to 12.18% of the total concession area (Table 15).

Table 13. Total forest area converted into non-forestry zone within PT IJS concession (South Papua) in 2016-2023

2016	Land Cover	2023 (ha)				Total (ha)
		Scrubland	Open Land	Plantation	Cropland	
	Secondary Dry Land Forest	178.87	74.15	8,567.09	5.51	8,825.62
	Secondary Swamp Forest			205.90		205.90
Grand Total		**178.87**	**74.15**	**8,772.99**	**5.51**	**9,031.52**

Based on Table 12, the total forest area (secondary dryland forest and secondary swamp forest) affected by palm oil plantation development from 2016 to 2023 is 9,031.52 ha, including scrubland (178.87 ha), open land (74.15 ha), plantation (8,772.99 ha), and cropland (5.51 ha).

VI. Conclusion

1. The total area of PT IJS plantation was 1,251.93 ha in 2016 and increased to 11,345.18 ha in 2023. Land expansion from 2016 to 2023 amounts to 10,093.25 ha.
2. In 2016, forest cover (secondary dryland forest and secondary swamp forest) within PT IJS concession was 10,667.41 ha, representing 79.42% of the total concession. However, in 2023 the area decreased to 1,653.89 ha or 12.18% of the total concession.
3. In relation to the conversion of forest cover into non-forest areas from 2016 to 2023, the liability value attributed to PT IJS amounts to **9,031.52** ha, corresponding to **67.24%** of its total concession area.

VII. Recommendation

The following recommendations are provided for PT IJS as a follow-up to this assessment.

1. Develop recovery plan (Remediation and Compensation) to address impacts caused by palm oil plantation development. Please refer to the RSPO Remediation and Compensation Procedure on Land Clearance without Prior HCV Assessment (attached).
2. Publish sustainability progress report regularly that includes the implementation and progress of NDPE commitment.
3. Strengthen PT IJS organisational structure for biodiversity conservation by forming a special division responsible for overseeing biodiversity within High Conservation Value (HCV) areas and the entire conservation area.
4. Develop compensation programmes for biodiversity
5. Ensure that compensatory biodiversity programmes are carefully planned and implemented to maximise conservation benefits and results in relation to the resources invested. This should be done by taking into account landscape context, regional conservation priorities, and relevant organisational framework or regulations.
6. Allocate programmes either inside or outside management units, or both, in addition to remediation (e.g., restoring riparian areas) as stated in RSPO P&C. Activities inside the management units may include, for example, restoration of natural vegetation in affected areas, and activities to eliminate the causes for biodiversity loss and degradation. These include restoration and prevention of high-risk activities in recently set-aside areas, and/or in additional areas earmarked for biodiversity conservation.
7. In many cases, effective conservation solutions for smallholders can include providing funding or participating in conservation projects on a per-hectare basis. These often involve collaboration with external experts, Non-Governmental Organisations (NGOs), or

conservation authorities. Activities in areas outside management units under smallholder control may include the following.

a. Participate in or support for habitat restoration, improve management and monitoring in protected areas, and take measures to protect rare, endangered, and threatened species (if necessary).
b. Provide direct monetary assistance for the implementation of conservation activities/programmes carried out by third party organisations, including biobanks. In the context of biodiversity conservation, biobank is a concept that involves allocating funds for conservation projects in specific areas, and certificates or other formal documentations are provided by the relevant authority for verification and monitoring.
c. Invest in capacity building for plantation internal management as well as empower local community. The programmes should be supported with sufficient resources, have clearly defined targets, timeline, and PIC, and designed to produce outcomes with the following characteristics:
    - Enriching – as an addition to conservation efforts planned or implemented by other stakeholders, and to any actions required by the applicable regulations and RSPO standards;
    - Sustainable – through safe and long-term tenure agreement with the authorities, land owners, or lease owners, and through effective monitoring, assessment, and evaluation that produce information on adaptive management;
    - Inclusive – by engaging affected stakeholders in project planning, decision making and implementation processes. This includes a fair and balanced distribution of responsibilities and rewards, and by respecting legal and customary regulation; and
    - Knowledge-based – based on sound scientifict and/or traditional knowledge that is widely disseminated and communicated to stakeholders and partners in a transparent and timely manner.

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