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Spatial Analysis of the Land Object of Agrarian Reform Redistribution Priorities for Supporting Low Carbon Development

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Abstract: This study analyzes the spatial classification of redistribution priorities for Land Objects of Agrarian Reform (TORA) in Non-productive Convertible Production Forest (HPK Non-Productive) covering 14,310.42 hectares in Sintang Regency, West Kalimantan. The land was verified through the Inventory of Land Tenure, Ownership, Use, and Utilization (IP4T) in 2021 and proposed for forest release in 2022. The results of the study show the persistence of Dayak cultural traditions and reveal three key irregularities: landholdings exceeding the 5 ha TORA ceiling, multiple landholdings by single subjects, and the conversion of land to oil palm. Using a mixed-methods approach combining quantitative, qualitative, and spatial analysis with ArcGIS, the study identified three redistribution priorities: (1) fully eligible parcels (≈1.9%), (2) parcels under 5 ha requiring subject verification (≈26%), and (3) parcels over 5 ha, including forest-use and oil palm areas, requiring stricter screening and conflict resolution (≈71%). The LCDI-based analysis estimates 988,800 tC (3.63 million tCO_2e), with rubber plantations contributing >80%. The study recommends an inclusive TORA scheme that accommodates Dayak customary values by allocating communal forests (*hutan ulayat, tana ulen, tana jaka*) within each village. This supports forest cover preservation while aligning with the FOLU Net Sink policy, the Low Carbon Development Initiative (LCDI), and the oil palm moratorium, thereby reinforcing sustainable agrarian reform in forest boundary regions.

Keywords: Forest Boundary, Incremental Agrarian Arrangement, Low Carbon Development, Non-Productive HPK, TORA Redistribution.

INTRODUCTION

The transformation of environmental policy and sustainable development in Indonesia underscores the importance of integrating agrarian reform with climate change mitigation. The 2022 Nationally Determined Contributions (NDC) highlight that the Forestry and Other Land Use (FOLU) sector is expected to contribute 25.4% to national emission reductions, while the agricultural sector plays a role through improved land governance and fertilizer management (Bappenas, 2022). This aligns with the Low Carbon Development Initiative (LCDI) framework developed by the Ministry of National Development Planning/Bappenas to ensure that national development remains consistent with greenhouse gas emission reduction targets (Bappenas, 2021).

Within agrarian policy, the Land Objects of Agrarian Reform (TORA) serve as a key instrument to promote equitable land distribution and enhance community welfare, particularly within Indonesia's agricultural development strategy (Aldillah, 2020). Presidential Regulation No. 86 of 2018, updated by Presidential Regulation No. 62 of 2023 on the Acceleration of Agrarian Reform, stipulates that TORA can be sourced from forest release, including Non-productive Convertible Production Forest (HPK-Nonproductive).This study focuses on TORA in Sintang Regency, West Kalimantan, based on the Decree of the Minister of Environment and Forestry No. SK.608/MENLHK/SETJEN/PLA.2/12/2018, which designates HPK-Nonproductive as a TORA source. The designated land covers 14,310.42 hectares across ten villages in two districts: Ketungau Hulu and Ketungau Tengah.

In practice, most TORA land is already used for community agriculture and plantations, dominated by rubber, pepper, oil palm, and shifting cultivation. At the same time, Dayak customary spatial arrangements remain strongly upheld, including categories such as *tana' jakah* (sacred forest), *tana' ulen* (reserved/protected forest), and cultivation land open for farming (Samsoedin, Wijaya & Sukiman, 2010)..

To date, research on TORA has largely focused on land distribution, social justice, and community empowerment (Wiradi, 2020; Sitorus, 2016). Meanwhile, studies on Dayak communities often highlight land management based on indigenous knowledge (Samsoedin et al., 2010; Sardjono, 1990). However, no study has specifically integrated TORA redistribution priority analysis with the LCDI framework, particularly by calculating carbon stock potential while aligning with communal land-use systems of indigenous communities. Addressing this research gap is crucial, as TORA redistribution in Sintang Regency not only concerns equitable land distribution but also directly affects carbon emission reduction, natural resource governance, and the recognition of indigenous rights.

Accordingly, this study aims to: (1) analyze existing land use conditions within the HPK-Nonproductive TORA area in Sintang Regency; (2) determine redistribution priorities based on existing land use; and (3) assess the linkages between TORA redistribution planning and the principles of the Low Carbon Development Initiative (LCDI) through carbon stock analysis of land cover and the reinforcement of inclusive spatial arrangements rooted in Dayak indigenous knowledge.

METHODS

This study uses a descriptive quantitative approach combined with spatial analysis. The descriptive quantitative method is applied to analyze IP4T data to identify the area of each land parcel, classify parcel sizes based on the maximum 5-hectare TORA quota, determine the number of parcels controlled per subject, assess land use types, and evaluate

other spatial aspects relevant to prioritizing land redistribution, specifically in the context of the TORA object located in HPK Non Productive areas of Sintang Regency. The LCDI (Low Carbon Development Indonesia) analysis also uses a descriptive quantitative method based on IP4T data.

Meanwhile, a GIS-based spatial analysis method using ArcGIS software is applied to map existing land use patterns, analyze parcel areas, classify parcel sizes based on the 5-hectare quota, determine TORA redistribution priority categories, and visualize each spatial analysis result related to the TORA object located in HPK Non Productive areas of Sintang Regency. The selection of these two analytical approaches is tailored to the characteristics of the dataset, which consists of IP4T survey data (Inventarisasi Penguasaan, Pemilikan, Penggunaan, dan Pemanfaatan Tanah) and parcel-based spatial maps obtained from field surveys and compiled in shapefile (.shp) format.

The IP4T survey based on existing conditions identified a total of 3,378 land parcels under control, covering a total area of 15,873 hectares. In contrast, the delineated map of the TORA object in HPK Non Productive areas of Sintang Regency, as stipulated in the Ministry of Environment and Forestry (MoEF) decree on TORA allocation (SK TORA), covers an area of 14,310.42 hectares. Both datasets are crucial to be consistently analyzed. The IP4T Existing data represents field-verified facts obtained through direct survey, whereas the IP4T SK TORA data refers to IP4T data that has been adjusted to match the allocated area delineated in the official TORA reservation decree.

Data Collection

This research is based on a pilot project for TORA proposals through the release of HPK Non Productive as a TORA land source in five regencies across four provinces, one of which is Sintang Regency, West Kalimantan Province. The project is part of the Agrarian Reform Acceleration Program (PPRA) under the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN). Data used in this study were obtained from both primary and secondary sources.

Primary data were collected through social safeguard assessments and field surveys using structured interviews with 10 respondents per village in the project locations. Data collection was conducted from October 25 to November 1, 2021. Enumerators were recruited and trained to administer survey forms, with technical assistance provided during fieldwork. Additionally, a technical coordination meeting and focus group discussion (FGD) were held at the provincial capital on November 10–11, 2021, involving inputs from provincial, district, sub-district, and village-level government institutions (*Organisasi Perangkat Daerah*/OPD). Secondary data were obtained from land tenure identification activities P4T, conducted between May and July 2021. This survey was implemented by a third party through a project subcontract.

Technically, the researcher utilized Microsoft Excel and ArcGIS as analytical tools to process IP4T data in determining land use planning schemes based on slope, elevation, and land capability. The analysis also examined the suitability of land use based on Cultivated Land Region (WTU) classification by reviewing existing land use and utilization, as well as assessing the economic potential in the newly emerging growth areas along the border region of Sungai Kelik, Sintang Regency. This served as the foundation for recommending directions for Access Arrangement (*Penataan Akses*) development.

RESULTS AND DISCUSSION

The current condition of land parcels within the HPK Nonproductive TORA objects in Sintang Regency indicates that not all areas under tenure are yet eligible for redistribution. Therefore, further identification is required to establish a prioritization sequence that can support the Agrarian Reform Task Force (GTRA), particularly the Land Office of Sintang Regency.

Establishing this prioritization still requires several spatial analyses, including mapping the area of parcels that meet the criteria for TORA, as stipulated in Article 27 paragraph (2) of Presidential Regulation No. 62 of 2023, which states: "Redistribution objects shall be allocated to Agrarian Reform subjects in accordance with the availability of TORA, with a maximum area of 5 (five) hectares." Accordingly, this section necessitates a spatial analysis of parcel sizes based on IP4T data for non-productive HPK TORA in Sintang Regency.

The next consideration relates to land use, particularly regarding areas classified as forest or oil palm plantations. Referring to current government policies, the existence of land parcels identified through IP4T within non-productive Convertible Production Forests (HPK) in Sintang Regency, which still exhibit forest cover or natural vegetation, must be approached with caution in the redistribution process. According to Presidential Regulation No. 98 of 2021 on Carbon Economic Value, forest cover holds significant importance as a carbon sink and storage area, contributing to Indonesia's greenhouse gas (GHG) emission reduction targets.

Aligned with this, the FOLU Net Sink 2030 policy from the Ministry of Environment and Forestry (MoEF) designates the forestry and land use sector as a key contributor in achieving net-zero emissions through forest protection and enhancement (MoEF, 2021). Additionally, the Social Forestry program provides a legal alternative for communities to manage forest areas sustainably without converting their status to Other Land Use (APL) through land redistribution (MoEF, 2022). Therefore, land parcels that still retain forest cover should not be prioritized for redistribution; rather, they should be directed toward forest management schemes that support national climate change mitigation and sustainable natural resource management policies.

Regarding oil palm plantations, reference is still made to the moratorium on new oil palm plantation permits as stipulated in Presidential Instruction No. 8 of 2018. Although the formal validity of this moratorium has expired, its substantive enforcement remains in place. This is reflected in various official government statements published in the media, including national news agency ANTARA, which reaffirms that the moratorium continues to serve as a guiding framework for the governance and regulation of the national oil palm sector (ANTARA, 2024).

Spatial Analysis Classification Area Eligible TORA

Spatial data processing was carried out using the baseline dataset from the 2021 IP4T TORA in HPK Non Productive areas of Sintang Regency. Spatial analysis was conducted using ArcGIS, utilizing various data processing tools available in the attribute table. The parcels were filtered based on size, grouping them into parcels of less than 5 hectares and those exceeding 5 hectares. Subsequently, the attribute data from the SHP map was extracted/exported into a database and Excel file. Further data analysis was performed using pivot tables in Excel, and the results were visualized in spatial analysis maps. The outcomes of the spatial analysis on parcel size classifications according to the TORA threshold are presented in the tables shown in Figure 1.

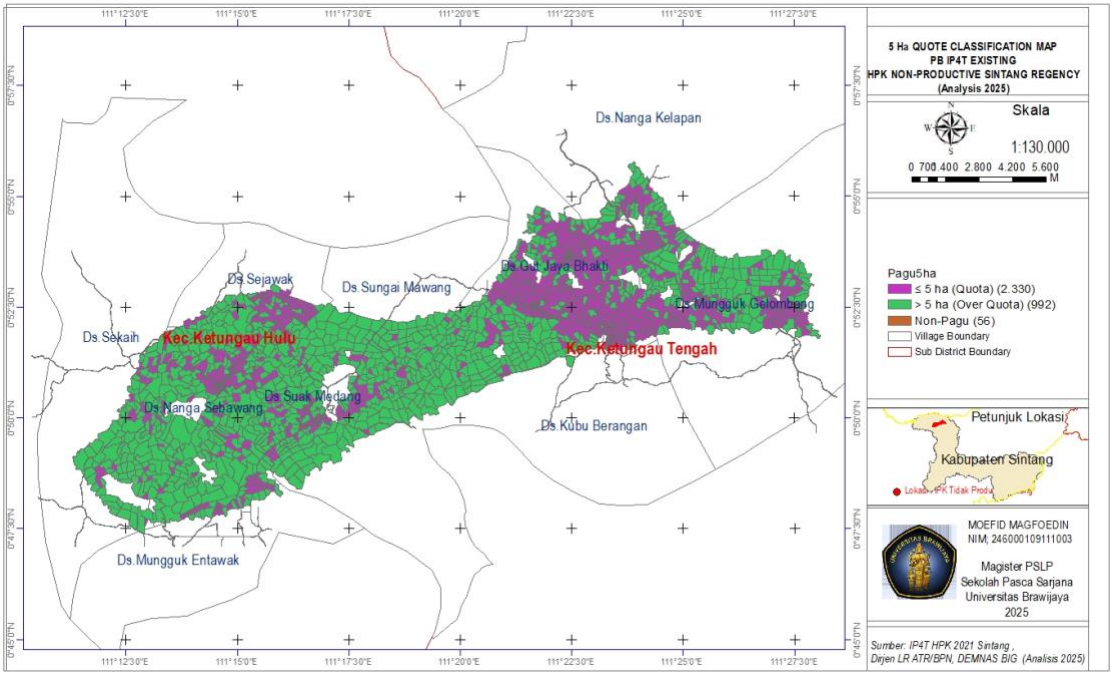

Figure 1. Spatial Distribution of TORA-Eligible PB Parcels from IP4T Existing Dataset
Source: Analysis Result, 2025

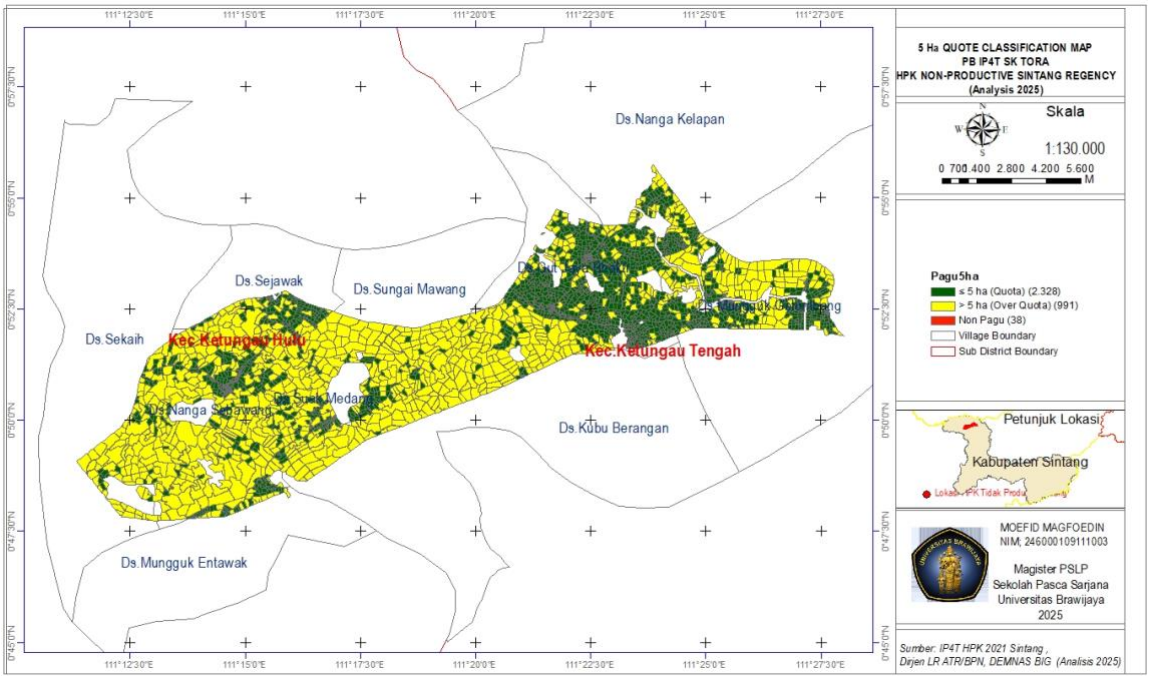

Figure 2. Spatial Distribution of TORA-Eligible PB Parcels from PB IP4T SK TORA Dataset
Source: Analysis Result, 2025

Table.1, The classification of land parcel sizes based on the threshold defined by agrarian reform policy reveals that, while the majority of parcels fall under the ≤ 5 ha (Quota) category in terms of count, the accumulated land area is predominantly concentrated in the > 5 ha (Over Quota) category. This pattern is consistently observed in both the IP4T Existing dataset and the IP4T SK TORA dataset.

Table 1. Classification of TORA Eligible Area

Classification Area	Existing		SK TORA	
	Parcel	Area (Ha)	Parcel	Area (Ha)
> 5 ha (Over Quota)	992	11.153,60	991	9.958,23
≤ 5 ha (Quota)	2330	4.459,69	2.328	4.244,02
Non Pagu	56	259,41	38	97,18
Total	3.378	15.873	3.357	14.299

Classification Area	Existing		SK TORA	
	Parcel (%)	Area (%)	Parcel (%)	Area (%)
> 5 ha (Over Quota)	29,37%	70,27%	29,52%	69,64%
≤ 5 ha (Quota)	68,98%	28,10%	69,35%	29,68%
Non Pagu	1,66%	1,63%	1,13%	0,68%
Total	100%	100%	100%	100%

Source: Author Analysis, 2025.

In the IP4T Existing dataset, a total of 2,330 parcels (68.98%) fall into the ≤ 5 ha (Quota) category, whereas 992 parcels (29.37%) are classified as > 5 ha (Over Quota). However, in terms of total area, the Over Quota parcels dominate, covering 11,153.60 ha (70.27%), which is substantially larger than the Quota parcels at only 4,459.69 ha (28.10%). Meanwhile, the Non Pagu category accounts for 56 parcels (1.66%) totaling 259.41 ha (1.63%).

A similar pattern is found in the IP4T SK TORA dataset, where 2,328 parcels (69.35%) are in the ≤ 5 ha (Quota) category and 991 parcels (29.52%) are > 5 ha (Over Quota). However, the Over Quota parcels still dominate in terms of area, with 9,958.23 ha (69.64%), compared to Quota parcels with only 4,244.02 ha (29.68%). The Non Pagu category in the SK TORA data includes only 38 parcels (1.13%) with a total area of 97.18 ha (0.68%).Figure.1 presents the spatial distribution of land parcels according to the TORA quota classification, based on the PB IP4T Existing dataset, than Figure.2 for PB IP4T SK TORA. These findings indicate that, despite the majority of parcels being administratively compliant with the 5-hectare quota threshold, the cumulative landholding in the > 5 ha (Over Quota) category remains significant and spatially dominant. This reality should be carefully considered in determining land redistribution policies within the TORA framework. The presented data serve as a critical factor in establishing priority classification criteria for redistribution in the TORA HPK Non Productive area of Sintang Regency.

Detailed Spatial Analysis of Existing Land Use

This analysis aims to identify the detailed pattern of current land use, particularly agricultural use. It is essential to obtain information regarding the types of crop commodities cultivated on the land parcels under control. Identifying the types of agricultural crops in the existing condition provides a strategic foundation for assessing the potential of agricultural economic value.

The resulting data will serve as a critical baseline for preparing the proposal for releasing areas designated as TORA within the HPK Non Productive zone of Sintang Regency. Additionally, this information plays a significant role during the implementation stages of asset structuring and access structuring within the agrarian reform process. Moreover, the types of crops used in land utilization may represent limiting factors. For instance, oil palm (sawit) commodities remain subject to the national moratorium, which is still in effect. Similarly, land parcels covered by forest or sparse forest vegetation must take into account the constraints imposed by the FOLU Net Sink policy—a key commitment in Indonesia's emission reduction agenda in the forestry and land use sector. Consequently, these two conditions are crucial considerations in determining the Priority Redistribution Category for this study.

Table.2 presents a more detailed distribution of land use, particularly for agricultural purposes, across both PB IP4T Existing and PB IP4T SK TORA parcels. In the analysis

concerning the prioritization of redistribution, the identification focuses on land use types that serve as limiting factors. Tables.2 show that there are PB IP4T Existing parcels classified as *secondary forest* and *primary forest*, with areas of 1,031.70 ha and 210.49 ha respectively, accounting for 6.50% and 1.33% of the total. Meanwhile, land used for oil palm plantations occupies 249.92 ha or 1.57% of the PB IP4T Existing area.

For the PB IP4T SK TORA parcels, *secondary forest* use covers 981.56 ha (6.86%), *primary forest* use reaches 201.61 ha (1.41%), and oil palm plantations cover 200.29 ha (1.40%). These land use types—particularly forest cover and oil palm—are considered significant limiting factors in determining redistribution priorities within the HPK Non-Productive areas of Sintang Regency.

Table 1. Detail Land Use TORA HPK Non Productive Sintang Regency

Detail Land Use	PB SK TORA		PB Exsisting	
	Parcel	Area (ha)	Parcel	Area (ha)
Catholic Church	5	2,62	5	2,92
Protestant Church	1	0,03	1	0,03
Secondary Forest	142	981,56	142	1.031,70
Primary Forest	19	201,61	19	210,49
Collector Road	28	75,80	37	207,64
Local Road	7	9,43	15	31,20
Scattered Settlement	436	39,75	436	44,95
Mixed Garden	220	868,25	221	960,94
Rubber Plantation	2.397	11.725,47	2.398	12.926,15
Pepper Plantation	20	148,65	20	150,97
Oil Palm Plantation	51	200,29	52	249,92
Special Cemetery	1	4,47	1	4,47
Public Cemetery	2	7,77	2	7,77
Sports Field	1	1,02	1	1,02
Early Childhood Education (PAUD)	1	0,14	1	0,14
Village Government Office	2	0,40	2	0,39
Primary School	2	1,67	2	1,67
Junior High School	1	1,38	1	2,71
Integrated Health Post (Posyandu)	2	0,04	2	0,04
Vegetables	1	0,16	1	0,16
Small River	3	11,93	4	20,59
Vacant Land	5	2,25	5	2,25
Temporary Open Land (Land Clearing)	10	14,73	10	14,72
Total	**3.357**	**14.299,43**	**3.378**	**15.872,84**

Source: Spatial Analysis PB IP4T, 2025

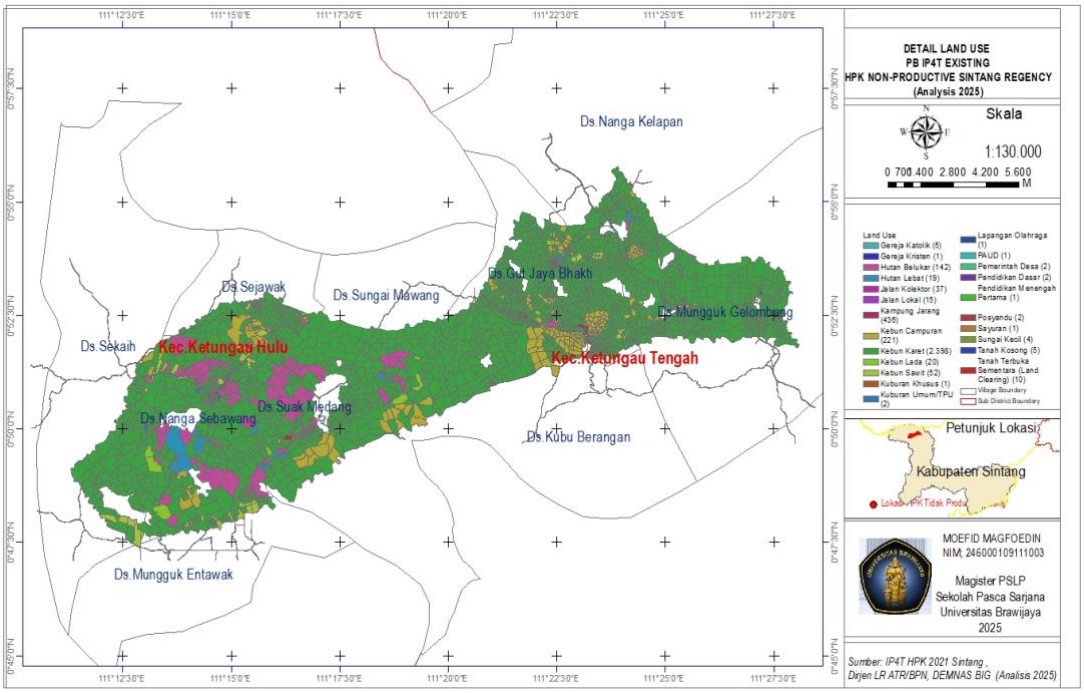

Figure 3. Detail Land Use Map PB IP4T Existing

Figure.3 illustrates the detailed spatial distribution of land use across each land parcel within the TORA HPK Non-Productive area in Sintang Regency, based on the identified land use data presented in Table 2. This visualization effectively represents the spatial analysis conducted on both PB IP4T Existing and PB IP4T SK TORA data.

Analysis of Land Parcel Ownership Classification

The typical profile of TORA HPK Non-Productive areas in Sintang Regency, as previously discussed, originates from forest areas predominantly inhabited by the Dayak ethnic groups of Kalimantan, who are traditionally known for practicing shifting cultivation. Consequently, the potential for landholders to control more than one parcel is not uncommon.

Spatial analysis of the IP4T data for TORA HPK Non-Productive in Sintang Regency reveals the occurrence of multiple land parcel ownership by individual subjects, as shown in Table 3. According to the data, there are 532 subjects who control only one parcel, with a total area of 2,678.04 hectares. Meanwhile, 256 subjects hold two parcels each, with a cumulative area of 2,449.40 hectares.

Furthermore, there are 150 subjects who control three parcels, accounting for a still-substantial total area of 2,033.65 hectares. For ownership of four to ten parcels, the number of subjects ranges from 10 to 76, with a high aggregate area. Ownership of eleven to forty-

two parcels is held by 1 to 7 subjects, respectively.

Table 2. Analysis Number of Parcel Ownership per Subject

No	Parcel Ownership Count Classification	Number of Land Tenure Subjects		Number of Household Members	Area (ha)		Remarks
1	1	532	43,89%	1.538	2.320,97	16,23%	
2	2	257	21,20%	797	2.217,66	15,51%	
3	3	151	12,46%	618	1.776,86	12,43%	
4	4	75	6,19%	315	1.137,92	7,96%	
5	5	39	3,22%	161	803,38	5,62%	
6	6	44	3,63%	260	1.180,41	8,25%	
7	7	32	2,64%	205	945,17	6,61%	
8	8	30	2,48%	193	1.218,27	8,52%	
9	9	10	0,83%	53	375,44	2,63%	
10	10	16	1,32%	131	732,15	5,12%	
11	11	3	0,25%	18	204,66	1,43%	
12	12	3	0,25%	18	308,08	2,15%	
13	13	7	0,58%	22	326,71	2,28%	
14	14	3	0,25%	14	70,12	0,49%	
15	15	3	0,25%	15	69,54	0,49%	
16	16	2	0,17%	10	223,56	1,56%	
17	17	3	0,25%	18	123,19	0,86%	
18	22	1	0,08%	4	182,51	1,28%	No Name*
19	33	1	0,08%	0	82,83	0,58%	Pemkab Sintang
Total		1.212	100%	4.390	14.299,43	100%	

Source : Spatial Analysis, 2025

Table.3 also presents the number of land tenure subjects occupying the TORA HPK Non-Productive area in Sintang Regency, based on the IP4T Existing survey data, which amounts to 1,213 subjects, with a total household population of 4,393 persons. This dataset will be valuable for further analysis on the potential eligibility of land tenure subjects as TORA recipients in this area.

As shown in Table.3, from the perspective of proportion (%), subjects who control only one parcel represent the highest share by subject count at 43.86%, although their land area proportion is relatively low, at 16.87%. These parcels and subjects are considered as having the most immediate potential for redistribution and asset legalization, provided that the parcel size complies with TORA requirements (i.e., not exceeding the maximum threshold of 5 hectares).

In contrast, subjects who control more than one parcel collectively account for over 80% of the total land area, indicating that these cases require further screening, particularly regarding parcel size and compliance with eligibility criteria as TORA recipients, as well as

other regulatory requirements.

In the category of subjects classified as controlling more than one parcel, the existing conditions in the Area of Interest (AoI) reveal a range of potential challenges, which can be identified through several contextual factors:

- The area includes 10 village administrations that are officially recognized by the state but are situated within the HPK Non-Productive forest zone in Sintang Regency. This situation creates governance complexities, as administrative villages overlapping with forest zones often face legal and institutional ambiguities in land rights recognition and redistribution (MoEF, 2018; World Bank, 2019).
- The indigenous population consists of the Dayak ethnic group, whose cultural and social identity is deeply rooted in forest landscapes and surrounding environments. Previous studies highlight that Dayak communities' livelihoods and identities are strongly tied to forest resources, shaping their perceptions of land tenure and governance (Dove, 1985; Li, 2007; Sellato, 2001).
- The community practices a traditional shifting cultivation system, characterized by rotational collective labor. This cultural norm is a key driver of multi-parcel land tenure, which accounts for over 83% of the total land area. Similar findings have been documented in other parts of Kalimantan, where swidden agriculture results in fragmented landholding patterns and complex claims to forestlands (Cramb, 2011; Padoch & Peluso, 1996).
- The region is located in a border area with Malaysia, and the local population takes pride in their role in maintaining Indonesia's sovereignty along the national frontier. Borderland studies note that communities living in peripheral areas often construct strong national identity narratives while simultaneously engaging in transboundary interactions, producing unique governance challenges (Eilenberg, 2012; Horstmann, 2014).
- The expansion of oil palm concession areas (HGU) surrounding the AoI has created strong incentives for land occupation and conversion to oil palm, which poses risks of opportunistic land claims by external actors for personal gain. Scholars have shown that oil palm expansion in Indonesia often drives contestation over land, generating overlapping claims and adverse incorporation of local communities (Li, 2014; McCarthy, 2010; Colchester & Chao, 2011).

Additionally, there are 81 parcels totaling 369.62 hectares identified as being under the control of village governments, the Sintang Regency Government, and community groups. Details are provided in Table 4. Most of these parcels are designated for village, district, or provincial roads, as well as public service areas, and some remain as plantation land or forested land.

Table 4. Name of Community Group and Institutions Land Occupation (PB IP4T Existing)

No	Name of Community Group	Total Parcel	Family Member	Area
519	Community Group of Nanga Sebawang Village	1	0	26,91
520	Community Group of Sedangu Hamlet	3	0	26,96
820	The government of Kubu Berangan Village	1	0	5,02
821	Mungguk Entawak	6	0	9,96
822	The government of Mungguk Gelombang	5	0	10,54
823	The government of Nanga Kelapan Village	3	0	5,24
824	The government of Nanga Sebawang Village	13	0	39,50
825	The government of Suak Medang Village	2	0	4,46
826	The government of Sintang Regency Village	42	0	215,99
827	Central Government of Indonesia	4	0	20,58
1058	Customary land	1	4	4,47
	Total			

Source: Spatial Analysis, 2025

This data has implications for determining TORA Redistribution Priorities, as these government-held parcels, when grouped under generic land-use classifications, may be overlooked in Priority Group 1 and thus excluded from asset legalization eligibility.

Determining TORA Redistribution Priorities

Based on the spatial analysis of eligible TORA parcel areas, detailed land use analysis, WTU spatial analysis, and classification of parcel holdings by subject, these combined findings serve as the basis for formulating and determining the TORA Redistribution Priorities for HPK Non-Productive areas in Sintang Regency.

The criteria for prioritizing TORA redistribution in HPK Non-Productive areas of Sintang Regency are defined based on the following parameters:

Priority 1

Parcels categorized under this group are recommended for top-priority redistribution and asset legalization due to their land use characteristics, which fulfill basic needs, support public services, and provide broader benefits to the community. The following criteria are used to define Priority 1:

- Parcels used for settlements, service land (tanah jasa), roads, or water bodies.

- Parcels held under the names of community groups, customary landholders, village governments, sub-district governments, district governments, provincial governments, or the national government.
- Classified under Non-WTU category in the WTU classification.
- Parcel size within SK 5 ha threshold (i.e., within the 5-hectare ceiling; non-quota, non-redistribution restriction).

Priority 2

Parcels under this category are those that still legally and spatially meet the 5-hectare allocation criteria, fall within WTU 1C or WTU 1D classifications, are not located on areas with dense or sparse forest cover, are not used for oil palm plantations, and demonstrate potential for productive economic use. The following criteria define Priority 2:

- Parcels classified within the Wilayah Tanah Usaha (WTU) categories of WTU 1C or WTU 1D.
- Parcel size complies with the 5-hectare ceiling in accordance with TORA provisions.
- Land is used or has potential for economic purposes.
- The existing land use classification does not include dense forest or sparse forest cover.
- The parcel is not currently used for oil palm plantation.

Parcels meeting Priority 2 criteria are still subject to further screening or investigation, particularly regarding the number of land parcels controlled by each subject, as discussed in the subsection on Analysis of Parcel Holding Classification.

Priority 3

This category includes land parcels that exceed the 5-hectare allocation ceiling, fall within the WTU 1C and WTU 1D classifications, are located in areas with dense or sparse forest cover, are utilized for oil palm plantations, and/or are under other forms of economic use. The following criteria are used to define Priority 3:

- The parcel is classified as Wilayah Tanah Usaha (WTU), specifically WTU 1C or WTU 1D.
- The parcel size exceeds the 5-hectare ceiling as stipulated under TORA regulations.
- The parcel is used for economic purposes.
- The existing land use classification includes dense forest cover or sparse forest cover.
- The parcel is currently used for oil palm plantation.

Parcels that fall under Priority 3 still require additional screening or further verification regarding the number of parcels held by each subject, as outlined in the subsection Analysis

of Parcel Holding Classification.

Results of Spatial Analysis Based on Priority Classification

The results of the spatial analysis for priority classification based on the above criteria are presented in Table.5. In the PB IP4T SK TORA dataset, the number of land parcels categorized under Priority 1 is 507 parcels (15.10%) with a total area of 247.56 hectares, representing 1.73% of the total Area of Interest (AoI). The majority of land parcels fall under Priority 2, totaling 1,744 parcels (51.95%) with a total area of 3,887.11 hectares or 27.18% of the AoI. For Priority 3, there are 1,106 parcels (32.95%) covering a total area of 10,164.76 hectares, which constitutes 71.09% of the total AoI area.

Table 5. Result of TORA Redistribution Priority in HPK Non-Productive Areas, Sintang Regency

Clasify of Priority	PB IP4T Existing				PB IP4T SK TORA			
	Parcel	(%)	Area (ha)	(%)	Parcel	(%)	Area (ha)	(%)
Priority 1	506	14,98	305,12	1,92%	507	15,10%	247,56	1,73
Priority 2	1.748	51,75	4.096,58	25,81%	1.744	51,95%	3.887,11	27,18
Priority 3	1.124	33,27	11.470,99	72,27%	1.106	32,95%	10.164.76	71,09
Total	3.378	100	15.872,69	100%	3.357	100%	14.299,43	100

Source: Spatial Analysis, 2025

In the PB IP4T Existing analysis, the data pattern is generally similar, with differences primarily in the number and size of parcels due to boundary adjustments made in accordance with the indicative allocation map of TORA under the decree of the Ministry of Forestry (SK Kemenhut). However, the data presented in Table.5 remain analytically significant. According to the PB IP4T Existing dataset, the total number of land parcels analyzed is 3,378, covering 15,872.69 hectares. These are classified into three priority groups.

- Priority 1 comprises 506 parcels (14.98%) with a total area of 305.12 hectares, accounting for only 1.92% of the total land area.
- Priority 2 has the highest number of parcels, totaling 1,748 parcels (51.75%) with an area of 4,096.58 hectares or 25.81% of the total.
- Priority 3 includes 1,124 parcels (33.27%), yet dominates in terms of land area, amounting to 11,470.99 hectares or 72.27% of the total.

This pattern reveals that although Priority 3 parcels are not the most numerous, they encompass the largest land area. This has significant implications for future TORA governance strategies and policy direction in Sintang Regency.

The PB IP4T Existing dataset reflects the current condition of IP4T land parcels within HPK Non Productive areas in Sintang Regency, where all identified parcels are still based on raw survey data. The proposed submission for the release of these TORA-designated areas to the Ministry of Environment and Forestry (KLHK) requires verification aligned with the delineation of the TORA reserve map, which serves as a reference for KLHK in accordance with Ministerial Decree of Environment and Forestry No. SK.608/MENLHK/SETJEN/ PLA.2/12/2018 dated 21 December 2018 concerning the reservation of non-productive convertible production forest areas as a source for TORA land objects. This verification is critical because the area of interest (AoI) must be officially proposed for release from HPK Non Productive designation into APL (Area for Other Land Use), in order to enable subsequent TORA redistribution.

Following spatial clipping of the PB IP4T Existing parcels based on the administrative boundaries defined in the SK TORA issued by the Ministry of Environment and Forestry, the refined dataset—PB IP4T SK TORA—is considered the ideal dataset for follow-up in the redistribution program. While there was a decrease in both the number and total area of land parcels—from 3,378 parcels (15,872.69 ha) to 3,357 parcels (14,299.43 ha)—the prioritization pattern remained consistent. Priority 2 continued to represent the largest group in terms of parcel count, while Priority 3 dominated in terms of total area. This consistency indicates that, despite the boundary adjustments in accordance with SK TORA, the structural distribution of TORA Redistribution Priorities remains largely intact.

The spatial distribution of land parcels according to their TORA Redistribution Priority classification is presented visually in the spatial analysis shown in Figure 4 below.

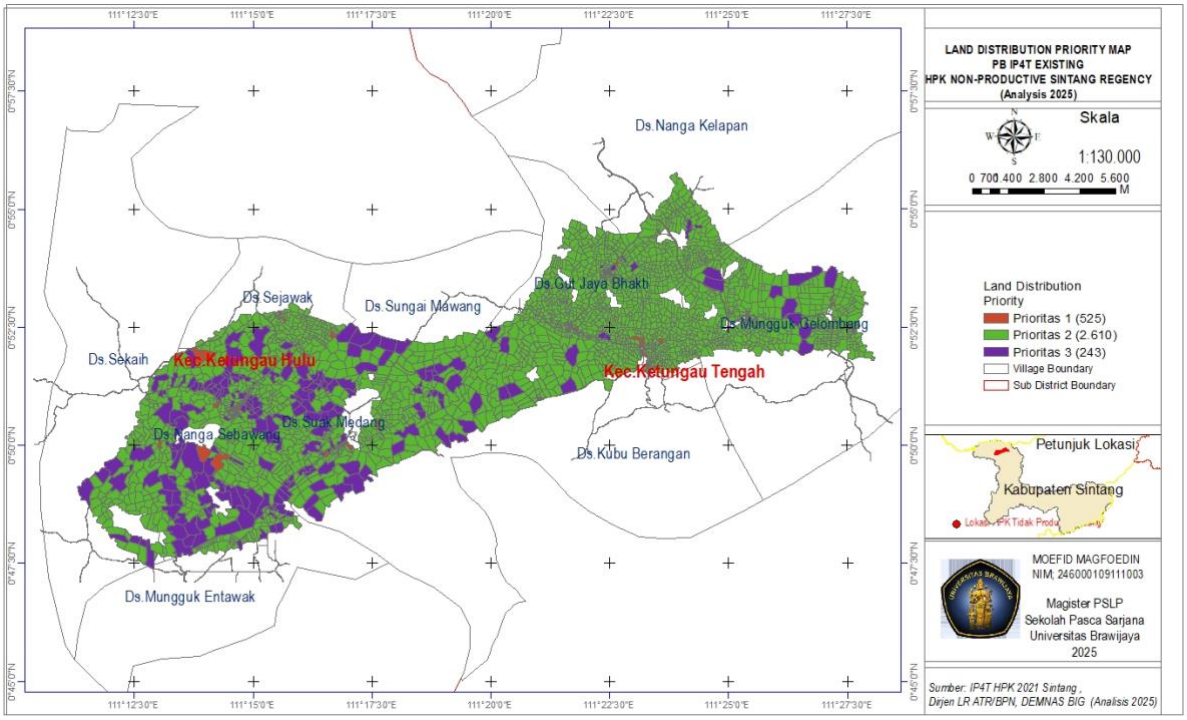

Figure 4. Priority Land Distribution Map of PB IP4T Existing in HPK Non-Productive Areas, Sintang Regency
Source: Spatial Analysis, 2025

Analysis of the Low Carbon Development Initiative (LCDI)

The integration of LCDI in this study is not merely descriptive but serves to highlight the policy relevance of spatial TORA classification. By identifying which parcels within HPK Non-Productive areas retain significant forest cover, the spatial analysis supports the LCDI agenda in ensuring that land redistribution aligns with national low-carbon development targets. This demonstrates that spatial prioritization of TORA is not only a matter of agrarian justice but also a determinant in achieving Indonesia's NDC commitment. In this sense, LCDI is not positioned only as a policy backdrop, but also as an analytical lens through which the implications of spatial TORA classification for carbon mitigation and sustainable land use can be critically examined.

This analysis employs a simple approach using land area data by land cover type. The estimation of carbon stock and potential greenhouse gas (GHG) sequestration is conducted through the IPCC default value (*Tier 1*) method, which has been developed and applied in various national and international references. The primary objective is to provide a new perspective on land redistribution policies through TORA originating from the release of HPK Non Productive areas, making them adaptive to climate change and supportive of

low-carbon development. An essential strategy is to ensure the provision of forest areas in each target village, in alignment with the cultural traditions of the Dayak indigenous communities whose livelihoods are inseparable from forests. Preserving forest cover by allocating it for village forests or customary forests represents an adaptive and inclusive policy that supports *Low Carbon Development* and climate change mitigation, as emphasized in the LCDI framework.

This study employed a descriptive quantitative approach to estimate carbon stock and carbon sequestration potential in above-ground biomass (AGB). The estimation was based on land cover area data and carbon stock coefficient values per hectare, obtained from relevant scientific references and national reports (IPCC, 2006; MoEF, 2020; Bappenas, 2019). The data used in this study comprised:

1. Land cover area derived from the overlay of the TORA Sintang map.
2. Land cover types, including rubber plantations, dense forest, secondary forest, mixed-crop gardens, and oil palm plantations.
3. Default carbon stock values per hectare (ton C/ha) sourced from relevant national references.

The estimation of carbon stock per land cover type in this study follows the IPCC Tier-1 approach, which applies default carbon stock values (ton C/ha) derived from regional and national guidelines when site-specific field data are not available (IPCC, 2006; IPCC GPG-LULUCF, 2003). For the Indonesian tropical context, national guidelines and empirical studies are recommended as more representative sources of default values compared to using global averages alone (MoEF/KLHK guidance). Therefore, the selection of carbon stock values for each land cover type was based on the following literature.

Tropical primary forests generally store a high aboveground biomass (AGB) carbon stock. The default AGB values recommended by recent studies and the IPCC refinement guidelines indicate large carbon storage for primary and mature secondary forests (IPCC, 2006; IPCC, 2019 refinement). Consequently, for dense forest, this study adopts a conservative carbon stock value of 200 ton C/ha, which falls within the range commonly used in Southeast Asian studies and national accounting recommendations. This value reflects the high tree biomass stock in tropical primary forest ecosystems and supports the initial carbon stock estimation in the study area.

Shrubland and secondary forest vegetation typically have lower carbon stocks compared to primary forests, depending on age and regeneration stage. Literature examining AGB recovery rates in secondary forests shows substantially lower default values for young vegetation compared to mature forests (IPCC refined defaults). Accordingly, this study uses a conservative carbon stock value of 75 ton C/ha for the shrubland/secondary forest category, representing semi-structured vegetation or early regeneration conditions in many tropical areas. This value aligns with mid-range estimates

reported in regional studies for secondary vegetation.

Mixed gardens or agroforestry systems exhibit varying carbon stocks depending on tree composition, age, and the intensity of annual cropping. Agroforestry research and published inventories indicate mid-range carbon stock values for mixed gardens. For Tier-1 purposes and consistency with national literature, this study adopts a value of 60 ton C/ha for mixed gardens, reflecting a combination of productive trees with annual crops and a moderate vertical structure (World Agroforestry/ICRAF and regional studies).

Formula and Assumptions

Carbon stock (tC) per land cover class:

$$\mathbf{C}_{\text{total}} = \text{Area (ha)} \times \text{Default carbon stock (tC/ha)}$$

Conversion to CO_2e:

$$\mathbf{CO_2e} = \mathbf{C}_{\text{total}} \times \frac{44}{12} \approx \mathbf{C}_{\text{total}} \times 3.67$$

Table 6 presents a summary of default carbon stock values for various vegetation cover types along with their literature sources, serving as the basis for calculating carbon stocks and emission sequestration capacity. These values represent above-ground biomass (AGB) only, excluding below-ground biomass and soil carbon. The resulting estimates are conservative but remain consistent with the Tier-1 methodology (IPCC, 2006; MoEF, 2020).

Table 6. Default Carbon Stock Value Tier 1 and References

Land Cover Type	Tier-1 Default Value (tC/ha)	Main Reference (s)
Dense Forest	200	IPCC (2006): IPCC (2019 Refinement)
Secondary Forest/Shrubland	75	IPCC (2006), Rejou-Mechain et al (2019)
Mixed Garden/Agroforestry	60	ICRAF; MoEF (2020)
Rubber Plantation	62	Guillaume et al (2018); Rubber Plantation review
Oil Palm Plantation	41	Guillaume et al (2018)

Source: IPCC (2006); IPCC (2019 Refinement); Réjou-Méchain et al. (2019); ICRAF; MoEF (2020); Guillaume et al. (2018); Rubber plantation review

Table 7 indicates that the HPK Non-Productive TORA in Sintang Regency store a total of 3,952,370.32 tCO_2e, representing a significant carbon stock that can contribute to Indonesia's climate change mitigation targets under the Low Carbon Development Indonesia (LCDI) framework and the FOLU Net Sink target. The largest share of carbon

stock originates from rubber plantations, accounting for 801,421.30 tC (equivalent to 2,941,216.17 tCO_2e), followed by secondary forest/shrubland (77,377.50 tC or 283,975.43 tCO_2e) and mixed garden/agroforestry (57,656.40 tC or 211,598.99 tCO_2e). Although dense forest covers only 210.49 ha, it has the highest carbon density (200 tC/ha), storing 42,098.00 tC (154,499.66 tCO_2e). Meanwhile, oil palm plantations contribute 98,646.20 tC (361,080.07 tCO_2e) to the total carbon stock.

Table. 7. Carbon Stock Calculation

Land Cover	Area (ha)	Default (tC/ha)	Carbon Stock (tC)	Ce (t)
Secondary Forest/Shrub	1031,70	75	77.377,50	283.975,43
Dense forest	210,49	200	42.098,00	154.499,66
Mixed Garden/Agroforestry	960,94	60	57.656,40	211.598,99
Rubber Plantation	12.926,15	62	801.421,30	2.941.216,17
Oil Palm	249,92	41	10.246,72	37.605,46
Total	15.379,20		988.799,92	3.628.895,71

Source: Spatial Analysis, 2025

Redistribution of TORA in HPK-Nonproductive Areas

The relevance of these findings indicates that mitigating potential tenure and social issues in the redistribution of TORA in HPK-Nonproductive areas of Sintang must take into account both spatial and ethnographic dimensions of the Dayak community. A key challenge lies in the discrepancy between land area and beneficiaries. Based on IP4T results, the TORA object in HPK-V Sintang covers 15,378 ha but is only controlled by 1,212 subjects. With a maximum redistribution of 5 ha per subject (5 × 1,212 = 6,060 ha), the redistribution needs of the indigenous population can only be met by approximately 39.4%. This imbalance has the potential to trigger social tensions if not addressed through inclusive management schemes.

The socio-cultural characteristics of the Dayak Iban in Ketungau further emphasize the need for such an approach. Traditions and cultural practices in the ten villages remain deeply rooted, making it clear that agrarian restructuring cannot be separated from their socio-cultural values. An ethnography-based approach is therefore crucial to ensure the sustainability of TORA redistribution. In line with the findings of Samsoedin, Wijaya, and Sukiman (2010), the Dayak spatial system is organized into residential spaces (Leppo'/longhouse and individual houses), productive spaces (Uma', swidden fields; Pula/Linda, gardens; production forests), and sacred or conservation spaces (Tana' Ulen/ulayat forest). This spatial concept highlights that sustainable agrarian reform requires the provision of communal areas aligned with customary land use systems.

Within this framework, land parcels categorized as Priority 3—which generally consist of dense forest, secondary forest, mixed gardens, and oil palm plantations exceeding

allocation thresholds—require further screening to determine their suitability for allocation as productive or sacred areas. Such prioritization is important to ensure that redistribution policies are socially inclusive while safeguarding the ecological and cultural integrity of Dayak land use practices.

The integration of carbon stock calculations further reinforces the importance of this spatial–ethnographic approach. Analysis shows that the HPK-Nonproductive TORA area in Sintang contains a total carbon stock of 988,799.92 tC, equivalent to 3,628,895.71 tCO_2e. The largest contributions come from rubber plantations (801,421.30 tC / 2,941,216.17 tCO_2e), followed by secondary forests, dense forests, and mixed gardens, with oil palm contributing the least. When correlated with the Dayak spatial system, productive areas such as swidden fields and mixed gardens maintain moderate carbon stocks, while sacred and conservation forests (Tana' Ulen) and dense forests represent significant carbon reservoirs. This demonstrates that aligning TORA redistribution with the Dayak ethnographic spatial system not only secures communal livelihoods but also preserves high-carbon ecosystems critical for climate mitigation.

Consequently, ensuring land allocation that reflects both productive and conservation functions consistent with the Dayak spatial system allows TORA redistribution to simultaneously advance agrarian justice and contribute to national climate policy objectives such as the FOLU Net Sink 2030 and the Low Carbon Development Initiative (LCDI). By preserving forest cover and reinforcing community-based land management, inclusive TORA planning directly supports global climate change mitigation through carbon sequestration, making it a vital instrument that links social equity, cultural integrity, and ecological sustainability.

CONCLUSIONS

The spatial classification of TORA redistribution priorities in non-productive HPK in Sintang Regency reflects low-carbon development considerations. Priority 1 represents the smallest proportion, with 506 parcels (14.98%) covering 305.12 ha (1.92%), deemed eligible for redistribution followed by land rights allocation. Priority 2 constitutes the largest proportion in terms of parcel count, with 1,748 parcels (51.75%) covering 4,096.58 ha (25.81%). Priority 3 ranks second in parcel count with 1,124 parcels (33.27%), yet accounts for the largest total area, 11,470.99 ha (72.27%). This category faces multiple constraints, necessitating a specific scheme for asset arrangement, in compliance with the oil palm moratorium, LCDI policies, and the protection of natural resources, biodiversity, and Indigenous communities. The HPK Non-Productive TORA in Sintang Regency stores a total of 3,952,370.32 tCO_2e, representing a significant carbon stock that can contribute to Indonesia's climate change mitigation targets under the Low Carbon Development Indonesia (LCDI) framework and the FOLU Net Sink target.

RECOMMENDATIONS

The analysis of land parcels classified as Priority 3, combined with the results of carbon stock assessment, highlights the need for a redistribution scheme that simultaneously addresses agrarian justice, ethnographic sustainability, and climate policy commitments. The mismatch between available land and the needs of beneficiaries requires a redistribution model that not only provides access to farmland but also secures communal and sacred areas consistent with the Dayak Iban spatial system.

A dedicated TORA scheme in HPK Non-Productive areas of Sintang Regency should prioritize the establishment of *hutan desa* (village forests) and *hutan adat* (customary forests) in each of the ten Dayak Iban villages. This scheme must explicitly integrate ethnographic dimensions by safeguarding *ulayat* forests (*tana' ulen*) as conservation and sacred spaces, while allocating other parcels for productive purposes such as swidden fields (*uma'*) and gardens (*pula/linda*). Such arrangements ensure that agrarian restructuring is culturally grounded and socially inclusive.

At the same time, the integration of carbon stock analysis underscores that maintaining forest cover within redistributed land can generate substantial climate co-benefits. Preserving high-carbon ecosystems such as dense forests and secondary forests not only secures Dayak communal tenure rights but also contributes directly to Indonesia's FOLU Net Sink 2030 target, the Low Carbon Development Initiative (LCDI), and the palm oil plantation moratorium policy. Recognizing the Dayak Iban as both beneficiaries and guardians of forest landscapes ensures that redistribution outcomes advance agrarian reform, biodiversity conservation, water resource protection, and long-term carbon sequestration.

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