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A green scenario for sustainable landscape planning: the case study in Sintang Regency, West Kalimantan Province

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Abstract. Sintang Regency is one of the 12 regencies and two cities in West Kalimantan Province, Indonesia. The total area of this regency is approximately 2.2 million hectares (ha) with 59% of the area designated as state forest area which provides high biodiversity and environmental services for adjoining communities. Through multi-stakeholder scenario planning, the government of Sintang Regency committed to protect and preserve forest resources for long-term landscape planning and sustainable utilization. Scenario planning yielded two possible outcomes in 2030 called “green” and “business as usual” (BAU) scenarios. Under the green scenario, future development without deforestation and land permits complied with spatial planning while under the BAU scenario, future conditions will be the result of past conditions without interventions. This study aimed to analyze land-use change in the regency over the past ten years. By applying the Terrset Land Change Modeller (LCM) algorithm, this study predicted the land use and carbon stock change of both scenarios in 2030. Three steps to apply the LCM are by analyzing the changes based on past history, modeling the transition potential and predicting the changes. Time series data of land cover data from 2006 to 2016 were used for this analysis. The results indicated that a green scenario prevents to stop deforestation about 117,136 ha (more than 5%) compared to the BAU scenario. Furthermore, the green scenario prevents the emission of 5 million tons of carbon (tC) for the regency indicating that the multi-stakeholder scenario planning process can be an effective strategy to preserve land and forest resources and promote sustainable development planning. The green scenario requires to prevent deforestation and limit the expansion of plantation areas, which are only allowed inside the current cultivation license and permit areas.

Keywords: Land use projection, Sintang Regency, Sustainable landscape planning

1. Introduction

Sintang Regency is the third-largest regency area in West Kalimantan Province, bordered with Sarawak, Malaysia. Most of the landscape has hilly terrains, where there is Bukit Baka Bukit Raya national park situated in the southeast part of the Regency. Considering the biodiversity richness and the important function of the national park, the southern part of the Regency supposed to be the last frontier of conservation forest in West Kalimantan Province [1].

Sintang Regency is one of the regencies in Indonesia that has the initiative to achieve sustainable development goals through sustainable landscape management planning. The sustainable planning

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aims to ensure the optimization of land-use allocation distribution in certain land area. This aims to provide a more sustainable system in one county that be useful for future life of humans and nature. Sustainable landscape planning should include three aspects – allocating the land for conservation, protection, and utilization of land and natural resources [2]. There is a horizontal and vertical approach to design sustainable landscape planning. The horizontal approach analyzes the potential usefulness of ecological knowledge across current planning themes, sectors or applications including water resources, mineral resources, conservation, urban (and suburban), or transportation planning. The vertical approach refers to each phase of the planning process, common to every planning theme [3].

Sintang Regency has a good leader in understanding that future life is determined by current sustainable landscape planning. This political will had been translated into the Regency vision of a “Green” Regency, known as “*Sintang Lestari (SL)*”, aim to achieve the prosperous and harmonious Regency supported by a sustainably managed natural resource base and well-designed infrastructure [4]. This commitment is a strong basis to turn the Regency’s vision into the real condition, as the commitment from the leader is considered as one of the pre-conditions for success in landscape approach management [5].

One of the important issues identified in the Sintang Regency is the rapid conversion of land use and land cover (LULC), in particular, forest to other land use. Forest conversion in Sintang Regency has happened for several reasons: forest fire, conversion to plantations, and shifting cultivation [6]. Land use illustrates both biophysical and socio-economic elements within the landscape [7]. Analysis of land use and land cover change has become important to understand the landscape dynamics and the ongoing processes within the landscapes, which can support the government in decision-making processes. Understanding of historical land-use change can also provide a strong basis to project future land use, in order to understand the impact of current planning practices and to design government intervention in the landscape.

The aim of the study is to provide an overview of the current and historical land use, and the impact of SL scenario policy intervention in planning, on the projected land use. A comparison with the “Business as Usual” (BAU) condition is made to provide a brief overview of both cases in Sintang Regency landscape. It is expected that the result of this study will be able to guide the related government and planners in designing the intervention within the landscape.

2. Study Area

The area of interest for this study is the Sintang Regency, consisting of 14 sub-districts and covering a total area of 2.2 million hectares. The topographic condition of the Regency is mostly hilly (62.74%) with elevation ranging from 8 to 2,040 meters above sea level (figure 1).

During the last five years, economic structure in Sintang Regency is still dominated by land-based sectors (e.g., agriculture and mining), trading, tourism, and industry. Agriculture is the largest sector by contribution to the Regency’s income (22.21%), followed by trading (17.43%), and construction (15.04%) [7]. In contrary to the Regency’s ecological richness and economic condition, Sintang Regency is the fourth highest poverty rate in West Kalimantan Province [8]. A challenge from this condition is how to optimize land use allocation with suitable commodities to minimize land degradation and at the same time, provide optimum income for the community. Due to these reasons, land use planning is an important element in Sintang Regency.

3. Methods

3.1. Design the SL scenario

The design and development of the SL scenario were made in close coordination with related stakeholders in Sintang Regency. Coordination was done through in-depth discussion and a series of focus group discussions (FGDs) in the Regency. In-depth discussions were held with the Regency’s key people, including the head of Regency/*Bupati*, head of regional planning agency, forestry and agriculture services and key NGOs working in the Regency. FGDs with wider audiences were held to

obtain more inputs on SL key indicators and were held two times with related institutions in the Regency.

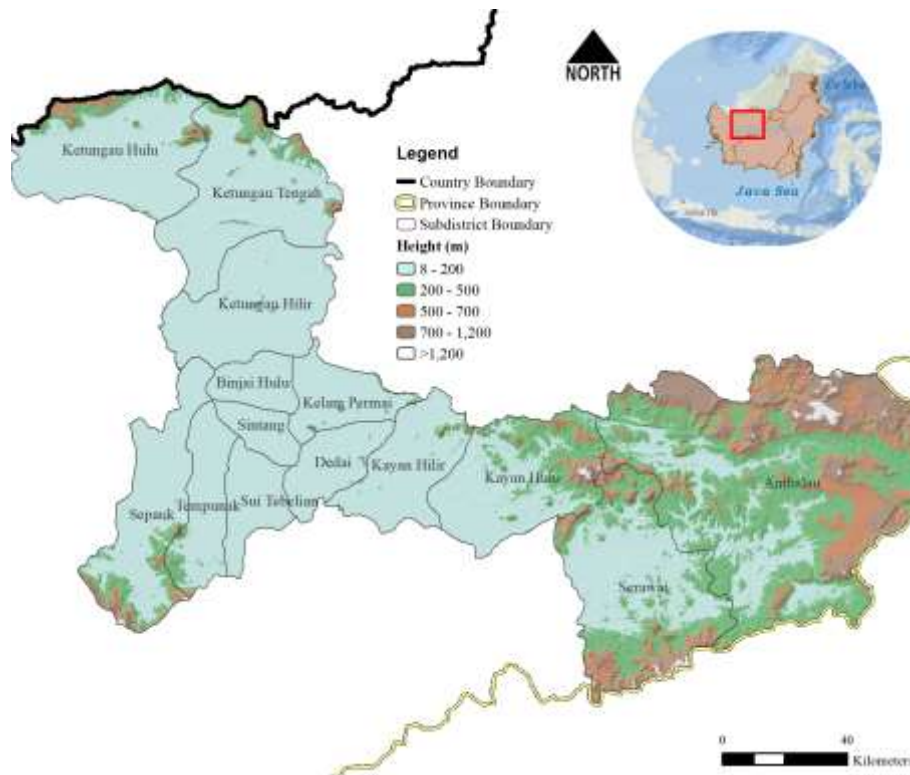


Figure 1. Topographic condition of the study area

3.2. Historical land use and land cover

Land use and land cover dynamics were assessed using a spatial analyst tool in ArcGIS version 10.5. Land cover data used in this study derived from the Ministry of Environment and Forestry (MOEF) years 2006 and 2016. Land cover data year 2006 used as a baseline year of the study, while the year 2016 was used as the most recent condition in the Regency.

3.3. Land use and land cover projection modeling

Projection of land use and land cover was made using the Land Change Modeller (LCM) module algorithm in Terrset software. The LCM consists of several steps to model the land use: change analysis, transition potential modeling, and change prediction. Change analysis was performed using the comparison of 2006 and 2016 land cover data, which provided an analysis of historical LULC change in the Regency. Once the historical changes were identified, the transition potential of each change was modeled. Transition potential classes were assembled into a set of sub-models and drivers of each sub-models were defined by the users [9]. During the process of defining sub-models, knowledge on local conditions of the landscape is important. Information and verification on drivers triggering the LULC change was obtained from key stakeholders in the Regency during the consultation process. Change prediction is the last step in the modeling done for BAU and SL scenarios. The BAU scenario models the LULC change in the future based on the historical process, while the SL scenario implements limiting factors (constraints) to block changes in deforestation and plantation sub-models from occurring. Constraints were defined based on SL indicators that can be spatialized. Land use projection was made up to the year 2030 based on the regency's spatial plan implementation period. In general, the workflow of the LULC projection model shown in Figure 2.

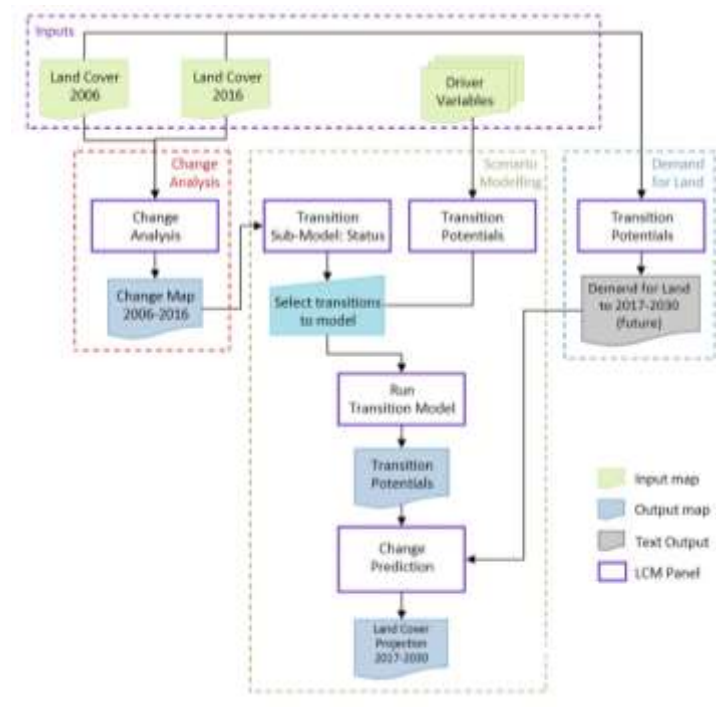


Figure 2. Flowchart of the LULC projection model

4. Results

4.1. Design of the SL scenario

Selected indicators were developed based on the output from the FGD of SL definition with related stakeholders (table 1). These indicators were selected based on their ability to be presented as spatial data, other indicators that could not be presented spatially were not selected. Selected indicators were then translated into the model and used as constraints for the deforestation and plantation sub-models. This means that no deforestation will occur under SL scenario and new plantation will only be possible under designated concession areas.

Table 1. Indicators for SL scenario model.

Indicator/constraint	Description for Model	Application in Model
Zero deforestation		
Sustainable use of natural resources without damaging the environment	Forest cover based on land cover 2016	Zero deforestation
Forest is protected to maintain the water quality of rivers	should be protected and conversion is not allowed.	(applies to both primary and secondary forest)
Protected Forest is free from illegal farming and illegal logging		
Compliance with Spatial Plan and <i>Kajian Lingkungan Hidup Strategis</i> (KLHS) - Strategic Environmental Assessment (SEA)	The cultivation area is restricted. No cultivation allowed outside current concession areas.	Plantation limitation

4.2. Current and historical LULC

Dominant land use in Sintang Regency in the year 2016 is dryland agriculture (44%), followed by secondary forest (23%), primary forest (18%), and plantation (6%). Areas with primary forest cover are mostly located in the eastern part of the regency (figure 3). This area is relatively hilly, and part of it lies within Bukit Baka-Bukit Raya National Park. There are also patches of primary and secondary forests in the northern and southern parts of the regency. The central part of the regency is mostly non-forested, dominated by dryland agriculture and plantation. Built-up areas (residential and public facilities) are also located in the central part of the regency, in particular along the Kapuas River.

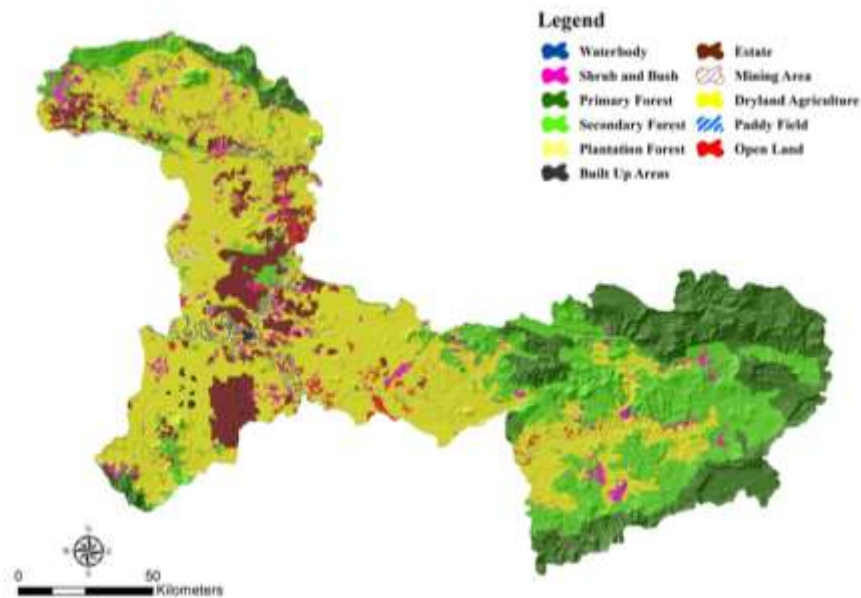


Figure 3. LULC of Sintang Regency year 2016

LULC change analysis shows significant change during the period of 2006 to 2016 as the loss of secondary forest (87,680 ha), followed by shrub (12,874 ha), and primary forest (7,289 ha). Meanwhile, the largest increases during the same period were in estate crops (87,539 ha), open land (16,159 ha), and dryland agriculture (8,589 ha). Further analysis on the loss of secondary forest change found that most of the secondary forest were converted into plantations (35%), followed by shrub (32%) and dryland agriculture (29%). Meanwhile, contributor classes to the increase of estate crop area are dryland agriculture (53%), secondary forest (35%), and shrub (6%). Generally, the total change area in Sintang Regency from 2006 to 2016 is 226,311 ha or 10% of the total Regency area (figure 4).

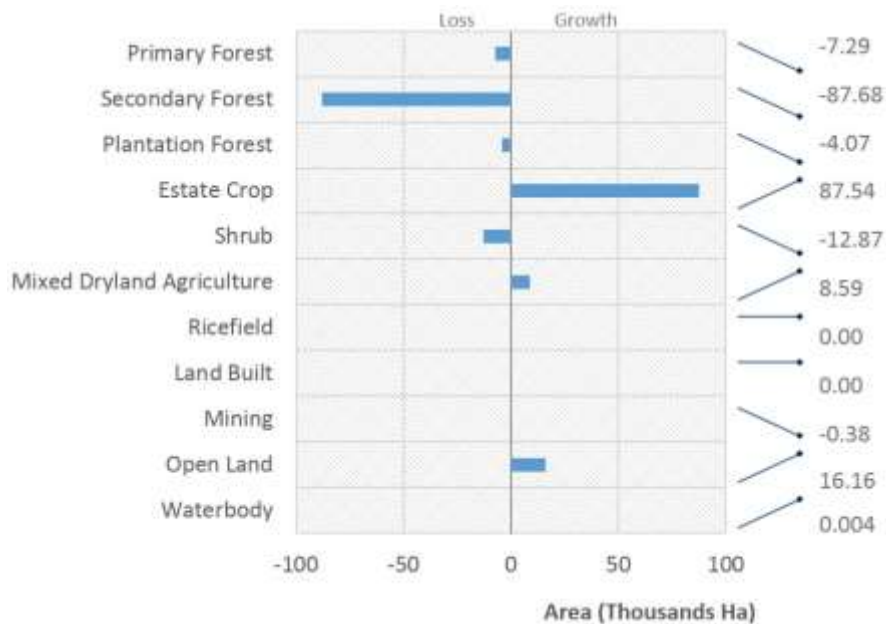


Figure 4. Historical LULC change in Sintang Regency (2006 – 2016).

4.3. Land use and land cover projection modeling

The land projection model for the BAU scenario shows that secondary forest decreases will still continue. In 2030, secondary forest loss is contributing to the largest amount of deforestation in Sintang Regency (107,000 ha), followed by mixed dryland agriculture (34,000 ha), and primary forest areas (10,000 ha). On the other hand, plantation, shrub, and open land areas are expecting to be increased.

Under the BAU scenario, most of the deforestation is projected to occur within the secondary forest area. This is assumed due to the accessibility factors since most of the secondary forest is located in flat, accessible locations compared to the primary forest area. LULC change projection under the SL scenario shows different trends in deforestation and plantation sub-models. Forested areas will remain the same as a result of implementing forest cover in the year 2016 as a constraint for the deforestation sub-model. The SL scenario also limits the expansion of plantation areas, which are only allowed inside current cultivation license and permit areas. This limiting factor reduces the expansion of plantation by more than 50% compared to the BAU Scenario. Moreover, the forested area is predicted to remain constant from 2016 to 2030 due to zero deforestation commitment.

Under the BAU scenario, forest cover has almost disappeared in the northwest, near the border with Malaysia, as a result of plantation development. In the southwest, forest cover changes into shrub and mixed dryland agriculture, leaving a small patch of forest cover. Deforestation is also found in the eastern part of the regency, which is the ecotone area between forest and non-forest areas. This condition does not conform to the Regency spatial plan, where the eastern part of the regency is allocated as a forestry development area. LULC comparison between the 2030 BAU scenario and the 2030 SL scenario is shown in **Figure 5**.

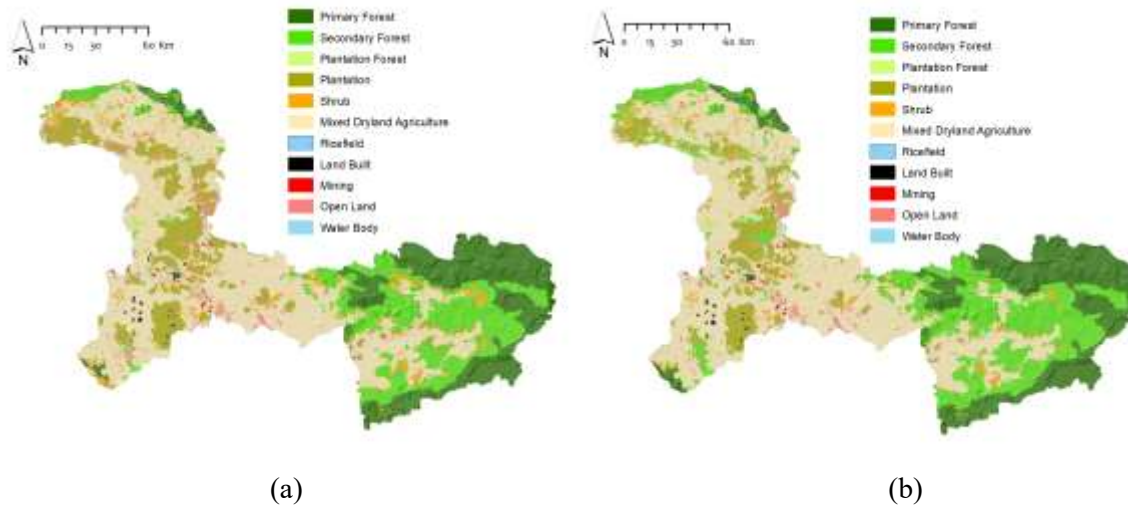


Figure 5. LULC projection result under BAU Scenario (a) and SL scenario (b) in Sintang Regency.

Moreover, emissions from both scenarios are also calculated. Emission measurement was done by comparing carbon stock for a certain period of time with carbon stocks from the following time frame [10]. The carbon stock calculation shows that the SL scenario will be able to preserve 5 million tons of carbon (tC) more than the BAU scenario. Under the BAU scenario, it is projected that Sintang Regency will result in a carbon stock loss of 3.8 million tC in 2030. A comparison of baseline carbon stock and projected carbon stock is presented in Figure 6.

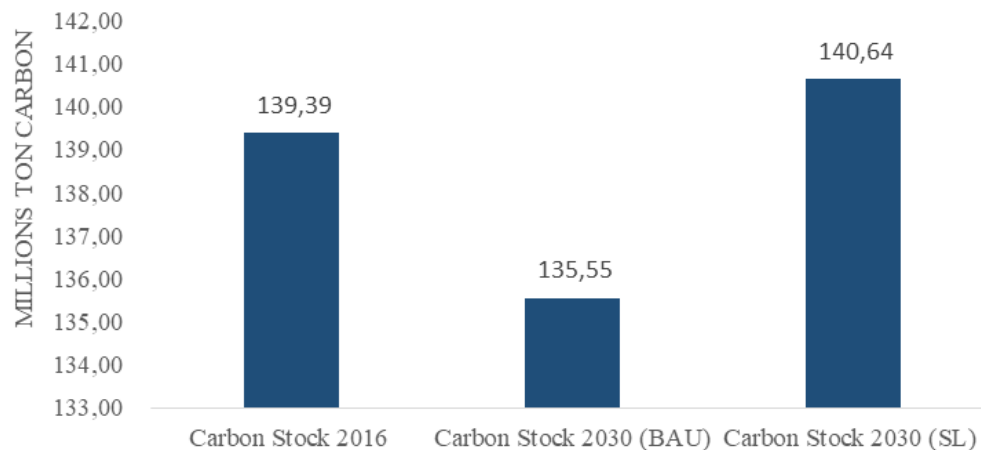


Figure 6. Baseline and projected carbon stock under BAU and SL scenario.

5. Discussion

In today's world, the harmony of economic development with environmental sustainability and social-cultural integrity is one of the biggest challenges in local and global development. Sustainable Development Goals (SDGs) are the result of the agreement of UN members to implement specific development patterns which include social, economic, environmental, legal, and governance development pillars. Correspondingly, the Government of Sintang Regency is committed to achieving the Development of Sustainable Landscapes by prioritizing the improvement of community welfare in a broad and sustainable manner that is balanced with efforts to preserve the sustainability of natural resources and environmental functions. The commitment of the government is evidenced by the strong determination delivered by the Regent Winarno on 10 April 2018. The Regent said that realizing a

green vision with support from all parties within the Sintang Regency. However, there were challenges to implementing the green vision especially in protecting and maintaining the remaining forest areas. Maintaining the integrity of the Forest Area (59 %) and APL area (41 %) to remain managed fairly, sustainably and sustainably and prosperity is the view of the Sustainable Development Goals (SDGs) in Sintang Regency through the implementation of a shared vision of Green Regency.

From the analysis, the past ten years of historical data of land cover shows that most deforestation in Sintang Regency had happened in the secondary forest. This happened as the economic structure of Sintang relies on land and natural resources. This study noted that of the three key sectors driving the economy of Sintang Regency, the one that has the highest dependence on natural resources and ecosystems, is agriculture. Included in this sector are forestry and plantations. Furthermore, agricultural systems are still largely rainfed, intensifying the mutual dependence with the ecosystem.

The deforestation has also happened in shrub and primary forest area, however, the deforestation rate was not as massive as in the secondary forest. The study found that the status of deforested land area had changed its functions and being converted to plantations, shrub, and dryland agriculture. At the same time, there was an increasing number of estate crops, especially in oil palm plantations. A rising number of plantations in Sintang were about the same as decreasing number of deforested areas in secondary forest. It means that the process of land change status from forest to plantation was begun by converting from secondary forest to plantations. This finding is supported by previous study that been done by Gunarso *et al.* [11] and Margono *et al.*[12]. Those studies noticed that most forest cover loss in Kalimantan happened due to converting the forest area to palm oil plantation. Therefore, it is critical to protect the remaining secondary forest in the Regency, in particular from the expansion of estate crops such as oil palm plantations. Based on the LULC projection modeling, the SL Scenario appears as a good approach in protecting the forest and limiting the expansion of the plantation in non-designated land use.

6. Conclusion

This study provides an overview of the current and past conditions of land-use changes in Sintang landscape from 2006 - 2016. It also analyzes the implication of green scenario intervention on future land-use change in 2030 and in comparison with BAU condition. It is found that under the green scenario, the Sintang Regency is able to stop the deforestation of 117,136 ha which will be occurred in the BAU condition in 2030. Besides, the green scenario has positive benefits to reduce the GHG emission of 5 million tons of carbon (tC) caused by deforestation in 2030. Under the green scenario, it is critical to protect the remaining secondary forest in the Regency, in particular from the expansion of estate crops particularly oil palm plantations. The green scenario was proven to be a good approach to protecting the forest and limiting the expansion of the plantation in non-designated land use. The participatory multi-stakeholder approach can be an effective planning strategy to ensure the involvement and responsibility of related stakeholders in sustainable landscape and development planning.

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