Assessment towards mine closure within IPPKH (Permit of Using Forest Area): Study case of a coal mining Licence at Taba Penanjung, Central Bengkulu, Indonesia

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Abstract. Mine closure is an inevitable event within the mining business; however, post-mining land use is always intended for further beneficial use for further development, mostly to reach a landscape that sustain and give further benefit after the mining operation has finished. One of the mining licence schemes is the permit of using forest area (IPPKH). One of the mining companies at Central Bengkulu has experienced phasing out production towards mine closure. The query is how the mining-affected area can be reclaimed and rehabilitated to become a healthy forest ecosystem. This study aimed to assess the closure criteria based on mine closure regulations. Data were collected from stages of operation according to assessment of mine closure, particularly from rehabilitation sites. The results indicate that rehabilitation sites showed significant re-vegetation of mining-affected areas (dumping area and in-pit backfilling area) and progression to become forested areas, as depicted by structural development of re-forested sites. The overall score is within the suitable range of "good post-mine closure" but require examination and supervision if after mining, the areas are expected to have economic value.

1 Introduction

Mine closure is an inevitable event within the mining business; however, post-mining land use is intended for further beneficial use for development. A fundamental premise of mined land rehabilitation is that the site preparation and re-vegetation of mined sites will reinitiate physical, geochemical, ecological and other ecosystem processes that result in a progression towards a more natural, similar to undisturbed landscape [1]. Bengkulu province is rich in coal reserves and has already allotted 28 Mining Licences or "*Izin Usaha Pertambangan*/IUP" [2]. Despite the importance of mining to the regional economy, mining activities in Bengkulu caused serious environmental and ecological problems. One case of Mining Licence is in the form of Permit of Using Forest Area or "*Izin Pinjam Pakai kawasan Hutan* (IPPKH)," meaning that the government gives a permit to use forest area for other

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forest uses such as coal mining. Environment and Forestry Ministry (Permen no. P.50/MenLHK/Setjen/Kum.1/6/2016) regulate the procedure and obligation concerning Permit for Using Forest Area (IPPKH). One of them is to return the affected areas due to mining operation to be back to the forest ecosystem. Do rehabilitated areas or communities return to their former state after mining disturbance? Do rehabilitated sites progress toward self-sustaining ecosystems? And if they do, how long it takes to reach the self-sustaining condition? These questions are critical for the evaluation of any rehabilitated mined land, especially as mine operators wish to relinquish the areas to the appropriate authority at the earliest opportunity. So far, no studies answering those questions in Bengkulu have been done, even though some progress on rehabilitated mine sites have been conducted [3,4].

The objectives of the research were first to assess the rehabilitation site using GIS and classify it into several land uses, and second to review the progress of forested area within IPPKH area from 2016 to 2021.

2 Materials and method

This study was carried out at PT. Bukit Sunur Mining area, Kota Niur Village, Taba Penanjung, Central Bengkulu (see Fig.1). The area was delineated from google earth images using GIS version 10. Land uses were classified under the term of PP No 26 the year 2020 to assess the progress of rehabilitation of mined land. The analysis based on imagery interpretation and confirmed by ground check in the field.

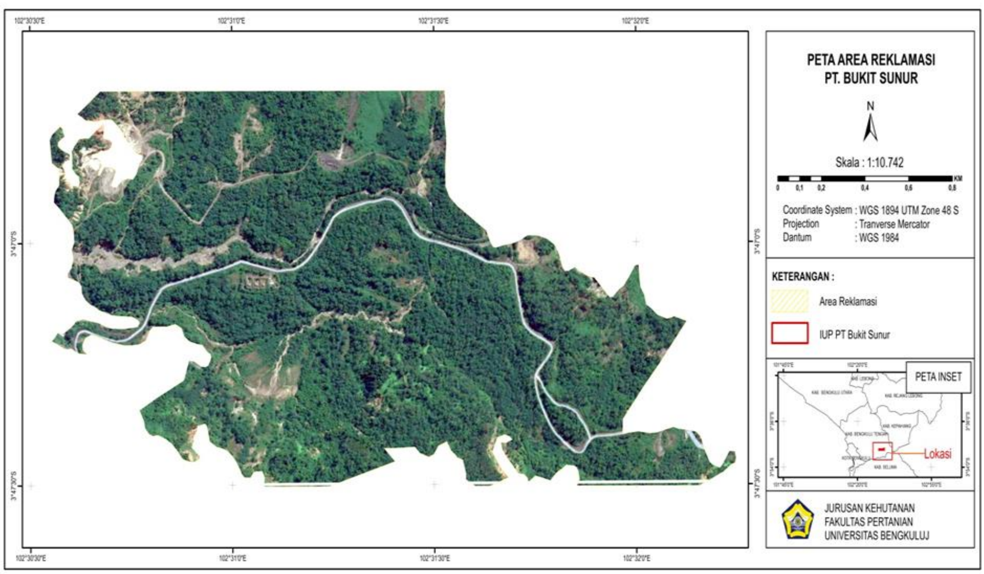

Fig.1. Study site on IPPKH area of PT. Bukit Sunur.

3 Result and discussion

3.1 Within IUP areas

The delineation of google earth imagery in April 2016 was shown in Fig. 2 and in March 2021 in Fig. 3 respectfully.

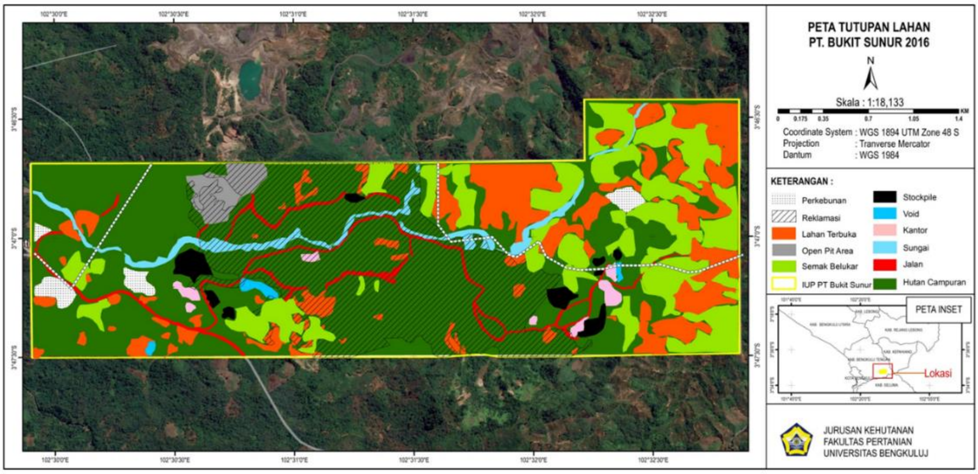

Fig. 2. Land cover of IUP PT BS 2016.

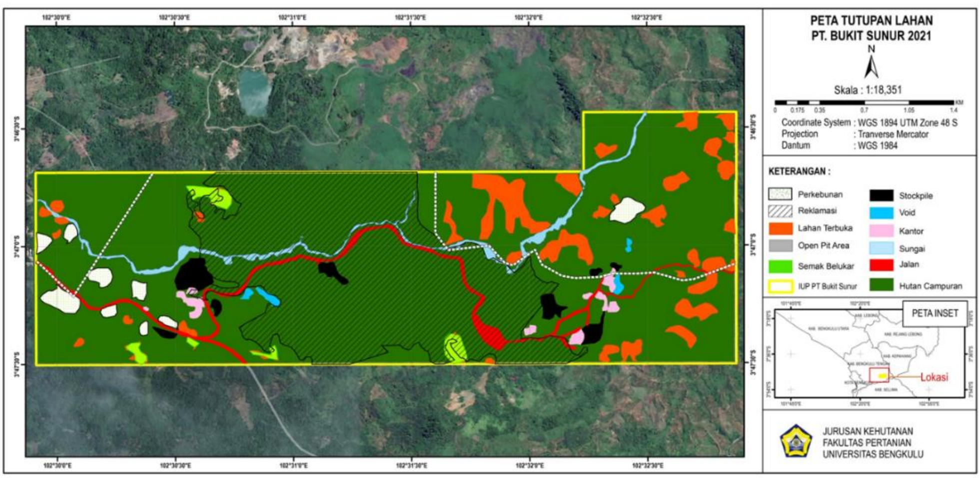

Fig. 3. Land cover of IPU PT BS 2021.

Table 1. Comparison of land cover type between 2016 and 2021.

No	Land cover	2016		2021	
		(Ha)	(%)	(Ha)	(%)
1	Road	18.22	2.06	20.3	2.29
2	Forest	518.71	58.61	644.6	72.83
3	Crop Estate	12.77	1.44	16.3	1.85
4	Shrubby cover	146.53	16.56	146.5	16.55
5	River	21.20	2.40	15.9	1.79
6	Open area	167.62	18.94	41.5	4.69
TOTAL		885.05	100	885.05	100

3.2 Within IPPKH areas

The changing of land cover from 2016 to 2021 within IPPKH area is depicted at Fig. 4 and Fig. 5, respectively.

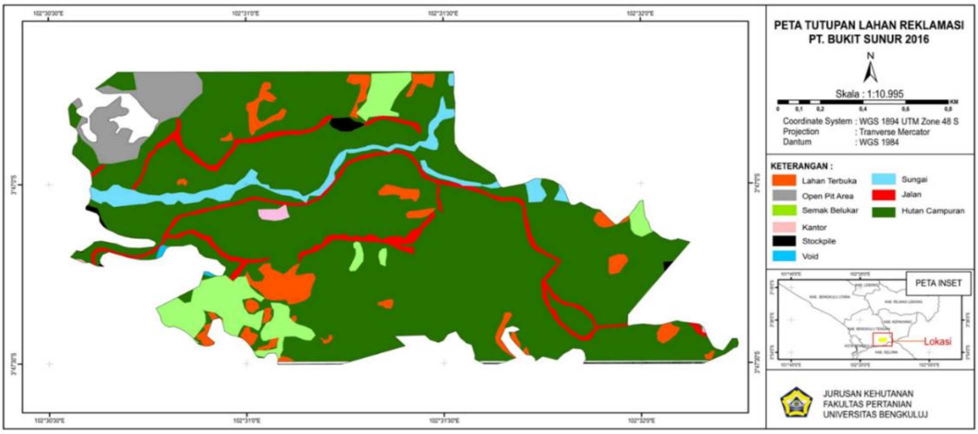

Fig. 4. Land cover within IPPKH 2016.

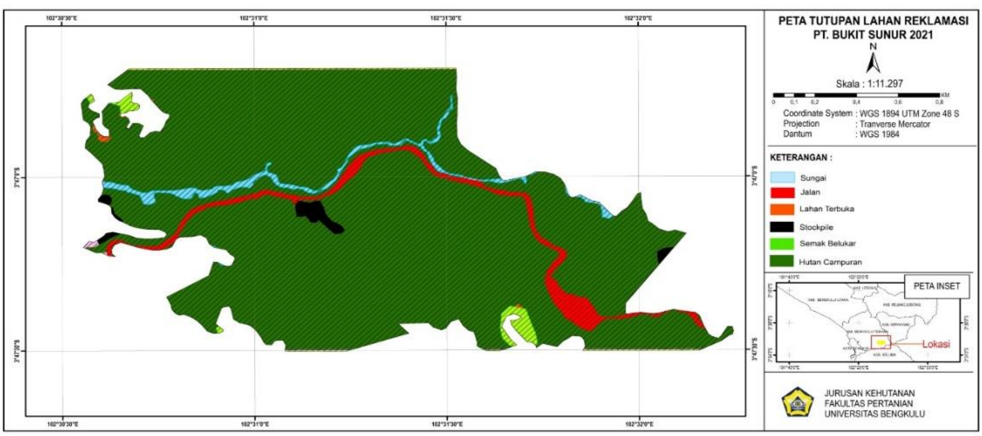

Fig. 5. Land cover within IPPKH 2021

The land cover changed toward more forested area with IPPKH areas (Table 2).

Table 2. Land cover within IPPKH areas.

No	Land cover	2016		2021		
		(Ha)	(%)	(Ha)	(%)	Change
1	Roads	30.17	10.7	13.2	4.7	-6.0
2	Forest	90.57	32.3	232.17	82.8	+ 50.5
3	Open Area	102.83	36.7	15.3	5.4	-31.3
4	Shrubby cover	30.2	10.77	7.3	2.6	-8.17
5	River	16.2	5.78	12.2	4.3	-1.48
TOTAL		280.17	100	280.17	100	

Significant changes were shown in forested area, with more than 50% forested area adding and progressing toward a forested ecosystem. Most assessments of rehabilitation success have focused on the restoration of vegetation characteristics [5,6]. However, if the goal of mined site rehabilitation is to return an ecosystem's self-sufficiency and resilience in the face of perturbation [7], it is essential to measure more than just vegetation attributes [8]. It is obvious that not all characteristics of rehabilitated mined sites can be measured. Therefore, it is scientifically important to find robust indicators that summarize the characteristics of systems and are practical to apply. Bellairs [9] identified three stages in the determination of success criteria of rehabilitated mined sites: (1) determine what must be accomplished for rehabilitation to be successful; (2) determine structural, compositional, and functional processes that are required to meet success criteria; and (3) determine how to assess whether those processes are taking place or are likely to occur.

Even though the forested area at the IPPKH is more than 80 %, following mining, the following land use must still be investigated: what is the long-term and appropriate use of landscape after mining? Based on 30 years of experience in forest ecosystem development in eastern Germany's post-mining landscape [10] indicated that many "missing links" must be discovered to establish general conclusions about on the ecological development of the disturbed landscape. As a result, in Indonesian cases [11], more need to be investigated in term of mine closure legislation, as an ecosystem development [3] and as the sustainability of post-mining landscape management [12].

4 Conclusion

As mining licenses near the end of their mine life or are exhausted, proper legislation and criteria for mine closure are required.

It can be concluded from the closure of one mining license within IPPKH in Taba Penanjung, Central Bengkulu:

- The changing land cover into a forested area (82.3%) indicates proper planning and implementation of good mine closure approach (>80%).
- Actions are required for further development and management of the post-mining area, as well as additional stringent legislations to govern mine closure plan and its implementation.

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