**EVALUATION STUDY OF RECLAMATION SUCCESS ON FORMER COAL MINE LAND**

**OF PT. KOMUNITAS BANGUN BERSAMA**

**BATUAH VILLAGE, LOA JANAN DISTRICT, KUTAI KARTANEGARA REGENCY**

**ABSTRACT**

Environmental management of ex-coal mining land needs to be carried out through reclamation activities. Revegetation is an effort to repair and restore damaged vegetation through planting and plant maintenance activities. In this regard, it is necessary to assess the achievement of the reclamation activities that have been carried out as an effort to review the return of ex-coal mining land to its original habitat so that restoration of ex-coal mining land can be effective and efficiently implemented in the field. The purpose of the study was to determine the percentage of plant life and the level of success in reclaiming ex-coal mining land at PT. Komunitas Bangun Bersama. The study was conducted from September to November 2024 on the reclaimed land of PT. Komunitas Bangun Bersama, Pit Arjuna and Kresna, in Batuah Village, Loa Janan District, Kutai Kartanegara Regency, East Kalimantan Province. The data collected consisted of: (1) primary data obtained directly from observations, interviews, and observations of plants in the field such as height, stem diameter, plants that are still alive, and plants that have died; and (2) secondary data obtained from company documents, literature/libraries, and relevant journals. The results of the study showed that the percentage of plant life was Sengon Laut (*Paraserianthes falcataria*) and Sengon Buto (*Enterolobium cyclocarpum*) with a percentage of life reaching 96 - 97%, followed by Trembesi (*Samanea saman*) of 78.52%, Johar (*Cassia siamea*) of 75%, Gamal (*Gliricidia sepium*) of 67.86%; and the lowest growth percentage in Mahogany *(Swietenia mahagoni)* plants of 29.01%. Revegetation in Pit Kresna and Pit Arjuna showed a good level of reclamation success, especially by using Sengon Laut, Sengon Batu, and Trembesi plants.

Keywords: Evaluation of Success, Revegetation, Former Coal Mining Land

1. **INTRODUCTION**

Indonesia is one of the countries rich in natural resources such as oil and natural gas, copper, gold, and others. Indonesia's natural wealth of energy and mineral resources, especially coal, encourages investment in the coal mining sector. According to [1,2], in Indonesia coal mining is generally carried out using the open pit mining method. This mining method is carried out by opening or clearing the vegetation covering the land and then removing the topsoil and overburden layers, followed by coal extraction. This method can cause the surface of the land to be exposed and increase the risk of erosion accompanied by sedimentation. Furthermore, [3] stated that the impacts caused by coal mining include changes in the landscape, threats to biodiversity, decreased water quality, and decreased soil fertility levels influenced by soil quality. To overcome this negative impact, the government has set an obligation for mining business permit holders to reclaim mining land by applicable regulations.

Reclamation activities are activities carried out throughout the mining business stages to organize, restore, and repair so that they can function again according to their designation. Reclamation activities are expected to generate added value for the environment and create much better conditions. Mining reclamation is the process of restoring and rehabilitating ex-mining land so that it can be reused or returned to its natural condition after mining activities are completed or stopped. The main purpose of mine reclamation is to reduce the negative impacts on the environment due to mining and restore the land so that it can function again for various purposes such as agriculture, forestry, recreation, or nature conservation. Another purpose of reclamation is to improve and restore the composition of the types and structures of the surrounding ecosystem community [4].

One of the main challenges in reclamation is how to meet sustainability standards, including soil fertility and restoration of damaged ecosystems [5]. This activity is a priority in overcoming the problem of land degradation, due to intensive mining activities such as Indonesia [6]. This study explores the effectiveness of reclamation techniques and the challenges faced, with a focus on the reclamation success criteria applied in Indonesia [5].

Revegetation techniques using adaptive plant species are important to ensure the success of reclamation. The selected plants must have characteristics such as the ability to grow quickly, produce easily decomposed litter, and be symbiotic with soil microbes [7]. This revegetation technique is a key step in recreating canopy cover lost due to mining activities [8]. Biodiversity restoration is also an important part of the post-mining land reclamation process. The biodiversity in question includes the diversity of flora, fauna, and ecology. Monitoring and evaluation of the arrangement and restoration process greatly influences the success of the post-coal mining land reclamation program [3]. Reclamation is considered successful if it has met the established reclamation success criteria. In this case, for revegetation activities, it is necessary to pay attention to the types of plants selected and the growing requirements of plants with land conditions, so that the reclamation success criteria can be achieved [7].

 The purpose of the study was to determine the percentage of plant life and the success rate of reclamation of ex-coal mining land at PT. Komunitas Bangun Bersama.

**2. RESEARCH METHOD**

**2.1. Time and Location**

The study was conducted from September to November 2024 on the reclaimed land of PT. Komunitas Bangun Bersama, Pit Arjuna and Kresna, in Batuah Village, Loa Janan District, Kutai Kartanegara Regency, East Kalimantan Province.

**2.2. Research Activities**

The stages of research activities are as follows: (1) preparation, (2) field observation, (3) determination of sampling areas using the stratified sampling method, creation of 8 50 m x 50 m sample plots, (4) observation of living and dead plants, (5) data analysis, and (6) reporting.

**2.3. Data Collection**

The data collected consists of: (1) primary data obtained directly from observations, interviews, and observations of plants in the field such as height, stem diameter, living plants, and plants that have died; and (2) secondary data obtained from company documents, literature/libraries, and relevant journals.

**2.4. Data Analysis**

1. The percentage of plant survival is calculated from the number of living plants at the time of the field research divided by the total number of plants at the beginning of planting.

2. The percentage of plant mortality is calculated from the number of plants that died during the field research divided by the total number of plants at the beginning of planting.

The results of the percentage of plant growth according to [8], are categorized as presented in Table 1.

Table 1. Category of Plant Growth Percentage

|  |  |  |
| --- | --- | --- |
| **No** | Plant growth percentage (%) | **Category** |
| 1.2.3.4.5. | > 90 %80 - 89 %70 - 79 %60 - 69 %< 60 % | Sangat baikBaikSedangKurangSangat Kurang |

Source: Regulation of the Minister of Forestry Number 60 of 2009 [8]

**3. RESULTS AND DISCUSSION**

**3.1. Company Overview**

PT Komunitas Bangun Bersama (PT. KBB) is a company engaged in coal mining and has been established since 2006. In 2007 the company received the first Exploration Mining Authorization, and in 2008 received the second stage Exploitation Mining Authorization issued by the Regent of Kutai Kartanegara Regency.

Furthermore, by the new regulations related to mineral and coal mining business activities, in 2010 the company received adjustments related to the mining permits that had been previously obtained. Furthermore, in 2014 the company received an operational permit through the Decree of the Regent of Kutai Kartanegara No.540/001/IUP-OP/MB-PBAT/I/2014 dated January 10, 2014, concerning the Approval of the Production Operation Mining Business Permit. In 2023, the company received the second IUP Extension Decree from the Ministry of Investment/Head of the Investment Coordinating Board of the Republic of Indonesia No. 11/1/IUP/PMDN/2023 and is valid until January 10, 2034.

Administratively, the Mining Business Permit area of ​​PT. Komunitas Bangun Bersama is located in Batuah Village and Tani Bhakti Village, Loa Janan District, Kutai Kartanegara Regency, East Kalimantan Province with an area of ​​1,903 hectares. The location of the research plot is in the Kresna Pit and Arjuna Pit with topographic conditions in the form of a wide plain with a slope of 2-3o, having a soil pH ranging from 3-4 with Ultisols soil type. The reclaimed land in the Kresna Pit is ex-mining land dominated by sengon laut plants, while in the Arjuna Pit, the type of plant dominated is sengon laut.

**3.2. General Overview of Reclamation Plants and Planting**

Sengon is a legume plant that is often used in reclamation projects because it grows quickly and can improve soil fertility through nitrogen fixation. Sengon requires soil with a pH of 5-6, although it can still grow in soil with a slightly lower pH (4-5), but with proper soil treatment.

Trembesi, often known as Rain Tree is a plant that can grow in various types of soil, but prefers soil conditions with a neutral pH (5.5–7.5). Trembesi can survive in more acidic soil but requires treatment to improve soil quality for optimal growth.

Johar is a plant that is known to have tolerance to various soil conditions but grows better in soil with a slightly lower pH (4-6).

Gamal is a type of leguminoceae plant that is famous for land rehabilitation because of its ability to improve soil quality through nitrogen fixation. This plant is more resistant to acidic soil and can even grow at a lower soil pH (4–5).

Mahogany is a plant that requires better soil conditions, with a soil pH of 5.5-6.5. This plant requires fertile and nutrient-rich soil and can grow better in soil that has been properly cultivated.

The planting stages are as follows: (1) land preparation, (2) lime application, (3) chicken manure application, (4) planting, (5) NPK fertilizer application, and (6) plant maintenance.

Planting time at the Arjuna Pit location is between February 2023 and April 2023, while planting time at the Kresna Pit location is between January 2024 and May 2024.

**3.3. Soil Texture and Chemical Properties at the Research Site**

Based on the results of the analysis of the chemical properties of the soil at the research site, it shows that the soil texture at the Kresna Pit is Sandy Clay, and at the Arjuna Pit is Clay Loam, the soil reaction is classified as very acidic with a pH (3.53 - 4.37), the electrical conductivity is classified as very low (0.144 mS/cm - 0.391 mS/cm) this value is below the threshold, namely <4.0 mS/cm, the content of C-organic, Cation Exchange Capacity, and Base Saturation is classified as low, so that the soil fertility status is classified as very low to low. To overcome this, PT. Komunitas Bangun Bersama has carried out liming. This aims to improve soil fertility and increase soil pH. In addition, manure and NPK fertilizers are also provided.

**3.4. Plant Conditions in the Research Plot**

**3.4.1. Plant Conditions in the Kresna Pit**

The land area in the Kresna Pit is 12.72 hectares, in 2024 8,000 plants have been planted with a planting distance of 4 m x 4 m. The types planted are sengon buto (*Enterolobium cyclocarpum*), sengon laut (*Paraserianthes falcataria*), Trembesi (*Samanea saman*) and Johar (*Cassia siamea*). Now the plants have an average diameter of <5 cm and an average plant height of <80. The results of observations of plant conditions in the Kresna Pit are presented in Table 2.

Table 2. Plant Conditions in the Kresna Pit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Plots | Type of Plant  | Number of Plants  | Plants That Are Still Alive  | Plants That Are Dead |
| 1 | Sengon Laut | 64 | 60 | 4 |
| Sengon Buto | 52 | 52 | 0 |
| Trembesi | 36 | 28 | 8 |
| Johar | 5 | 5 | 0 |
| 2 | Sengon Laut | 66 | 66 | 0 |
| Sengon Buto | 56 | 56 | 0 |
| Trembesi | 38 | 34 | 4 |
| Johar | 0 | 0 | 0 |
| 3 | Sengon Laut | 66 | 66 | 0 |
| Sengon Buto | 48 | 47 | 1 |
| Trembesi | 36 | 27 | 9 |
| Johar | 7 | 4 | 3 |
| 4 | Sengon Laut | 66 | 60 | 6 |
| Sengon Buto | 66 | 61 | 5 |
| Trembesi | 25 | 17 | 8 |
| Johar | 0 | 0 | 0 |

Source: Processed Primary Data

**3.2.2. Plant Conditions in the Arjuna Pit**

The land area in the Arjuna Pit is 4.20 hectares, in 2023 2,625 plants have been planted with a planting distance of 4 m x 4 m. The types planted are sengon laut (*Paraserianthes falcataria*), Mahogany (*Swietenia mahagoni*), and Gamal (*Gliricidia sepium*). Now the plants have an average diameter of + 12.34 cm and an average plant height of + 3.20 meters. The results of observations of plant conditions in the Arjuna Pit are presented in Table 3.

Table 3. Plant Conditions in the Arjuna Pit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Plots | Type of Plant  | Number of Plants  | Plants That Are Still Alive  | Plants That Are Dead |
| 1 | Sengon Laut | 68 | 66 | 2 |
| Mahoni | 56 | 10 | 46 |
| Gamal | 33 | 19 | 14 |
| 2 | Sengon Laut | 70 | 68 | 2 |
| Mahoni | 12 | 5 | 7 |
| Gamal | 67 | 51 | 16 |
| 3 | Sengon Laut | 74 | 71 | 3 |
| Mahoni | 28 | 8 | 20 |
| Gamal | 55 | 42 | 13 |
| 4 | Sengon Laut | 78 | 77 | 1 |
| Mahoni | 66 | 24 | 42 |
| Gamal | 13 | 2 | 11 |

Source: Processed Primary Data

Furthermore, based on the data in Tables 2 and 3, the recapitulation of the condition of plants in the Kresna Pit and Arjuna Pit is presented in Table 4.

Table 4. Percentage of Plant Life in the Arjuna Pit and Kresna Pit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pits | Type of Plants | Number of Plants | Number of Living Plants and Percentage of Living | Number of Dead Plants and Percentage of Dead |
| Kresna | Sengon Laut | 262 | 252 (96,18) | 10 (3,82%) |
| Sengon Buto | 222 | 216 (97,30%) | 6 (2,70%) |
| Trembesi | 135 | 106 (78,52%) | 29 (21,48%) |
| Johar | 12 | 9 (75,00%) | 3 (25,00%) |
| Arjuna | Sengon laut | 290 | 282 (97,24%) | 8 (2,76%) |
| Mahoni | 162 | 47 (29,01%) | 115 (70,09%) |
| Gamal | 168 | 114 (67,86%) | 54 (32,14%) |

Based on the data in Table 4, it shows that in the Kresna Pit, 631 plants have been planted, consisting of 262 sengon laut plants, 222 sengon buto plants; 135 trembesi plants, and 12 johar plants. The sengon laut plants that are still alive are 252 plants (96.18%) and 10 plants have died (3.82%); The sengon buto plants that are still alive are 216 plants (97.30%) and 6 plants have died (2.70%); The trembesi plants are still alive are 106 plants (78.52%) and 29 plants have died (21.48%); and the johar plants are still alive are 9 plants (75.00%) and 3 plants have died (3.00%). Based on the data in Table 4, it shows that in Pit Arjuna, 620 plants have been planted, consisting of 290 sengon laut plants, 162 mahogany plants, and 168 gamal plants. The sengon laut plants that are still alive are 282 plants (97.24%) and the dead plants are 8 plants (2.76%); The mahogany plants that are still alive are 47 plants (29.01%) and the dead plants are 115 plants (70.09%); and the gamal plants are still alive are 114 plants (67.86%) and the dead plants are 54 plants (32.14%).

In general, the results of the study showed that the types of plants that can grow very well and healthily for revegetation are sengon laut (Paraserianthes falcataria) and sengon buto (Enterolobium cyclocarpum) with a survival percentage of 96-97%, followed by trembesi (Samanea saman) at 78.52%, johar at 75%, gamal (Gliricidia sepium) at 67.86%; and the lowest growth percentage in mahogany plants at 29.01%. Based on the criteria for the percentage of plant growth, sengon laut and sengon buto plants are classified as very good; trembesi plants are classified as good; gamal and johar plants are classified as moderate, and mahogany plants are classified as less good. The results of this study are in accordance with the research report [9], that the percentage of growth of ex-coal mining land at PT Kitadin Site Embalut Kutai Kertanegara Kaltim Regency in 2010, 2011 and 2012 were 88.0%, 77.7%, and 83.6% respectively. Reclamation and revegetation activities are considered good based on indicators of the success rate of the percentage of life and growth of both tree diameter and height, the growth of sengon buto (*Enterolobium cyclocarpum*) plants is more dominant than trembesi (*Samanea saman*) and johar (*Senna siamea*). Furthermore, it was reported by [10] that there were 4 (four) types of main plants in the reclamation and revegetation areas on the former coal mining land of PT. Amanah Anugerah Adi Mulia at the Riam Adungan Site, Tanah Laut Regency that were studied, namely gmelina (*Gmelina arborea*), sengon laut (*Paraserianthes falcataria*), trembesi (*Samanea saman*) and sengon buto (*Enterolobium cyclocarpum*). The highest percentage of plant growth and health values ​​occurred in sengon laut, followed by gmelina, trambesi, and sengon butu. Furthermore, it was reported by [11] that revegetation on former coal mining land in Tanah Bumbu Regency, South Kalimantan Province with pioneer plants, namely sengon laut, and trembesi, while the types of local insert plants were 40% of the pioneer plants in the form of fruits, namely jackfruit, rambutan, and petai, so that revegetation was declared unsuccessful because the percentage of plant growth was <60%.

Based on the results of the study, it shows that revegetation in Pit Kresna and Pit Arjuna, shows a good level of reclamation success, especially by using sengon laut, sengon batu, and trembesi plants. The success of revegetation on ex-coal mining land does not only depend on the selection of plant types but also environmental factors and plant management techniques applied in its implementation. As stated by [7] reclamation with revegetation is considered successful if it has met the established reclamation success criteria. In this case, for revegetation activities, it is necessary to pay attention to the types of plants selected and the growing requirements of plants with land conditions, so that the reclamation success criteria can be achieved.

**4. CONCLUSION**

Based on the results of the research and discussion, the following conclusions were drawn:

1. The percentage of plant life is sengon laut (Paraserianthes falcataria) and sengon buto (Enterolobium cyclocarpum) with a percentage of life reaching 96 - 97%, followed by trembesi (Samanea saman) of 78.52%, johar of 75%, gamal (Gliricidia sepium) of 67.86%; and the lowest growth percentage in mahogany plants of 29.01%.

2. Revegetation in Pit Kresna and Pit Arjuna showed a good level of reclamation success, especially by using sengon laut, sengon batu, and trembesi plants.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

REFERENCE

[1] A. Yamani. (2012). Study of Erosion Amount in Coal Mine Reclamation Area at Pt Arutmin Indonesia Kotabaru Regency. Jurnal Hutan Tropis. 13: 46-54.

[2] A. Rachman., S. Sutono., I. Irawan., I.W. Suastika. (2020). Soil Quality Indicators on Ex-Mining Land. Jurnal Sumberdaya Lanhan. 11: 1. https://doi.org/10.21082/jsdl.v11n1.2017.1-10.

[3] A. Wahyu Nugroho., I. Yassir. (2017). Policy for Assessing the Success of Post-Coal Mining Land Reclamation in Indonesia. Jurnal Analisa Kebijakan Kehutanan. 14: 121-136.

https://doi.org/10.20886/jakk.2017.14.2.121-136

[4] T. Mcdonald., G.D. Gann., J. Jonson., K.W. Dixon. (2016). International standards for the practice of ecological restoration - including principles and key concepts. Society for Ecological Restoration. 427-437.

[5] Amanah, F., & Yunanto, T. (2019). Mine reclamation period to successfully meet criteria in Indonesia. Mine Closure 2019, 1(1), 1303-1310. https://doi.org/10.36487/ACG\_rep/1915\_103\_Amanah

[6] Möller, A., Schütte, P., Saragi, A., Ichsan, N., & Franken, G. (2024). Pilot reclamation of a tin mining area using biochar on Bangka Island, Indonesia. Mine Closure 2024, 1(1): 473-478 https://doi.org/10.36487/ACG\_repo/2415\_34.

[7] Setyowati, Rr Diah Nugraheni, Nahawanda Ahsanu Amala, & Nila Nur Ursyiatur Aini. (2017). Study of Revegetation Plant Selection for Successful Reclamation of Former Mining Land. Al-Ard: Journal of Environmental Engineering, 3(1): 14-20. https://doi.org/10.29080/alard.v3i1.256.

[8[ Ministry of Forestry. (2009). Decree of the Minister of Forestry of the Republic of Indonesia Number 60 concerning Guidelines for Assessing the Success of Forest Reclamation. Jakarta.

[9] Budiana, I.G.E. (2017). Evaluation of the Level of Success of Revegetation of Former Coal Mining Land at PT Kitadin Site Embalut, Kutai Kartanegara Regency, East Kalimantan. Agrifor Journal. XVI (2):195–208.

[10] Azhar, B. Achmad, E. Rosadi, B. J. Priatmadi. (2023). Evaluation of the Success Level of Revegetation on Plant Growth and Health on Former Coal Mining Land of PT. Amanah Anugerah Adi Mulia at the Riam Adungan Site, Tanah Laut Regency. EnviroScienteae. 19 (1): 172-182.

[11] Gunawan, C., Badaruddin, Kissinger, H. Susanti. (2023). The success of Reclamation of Former Coal Mining Land, Case Study of Mining Business Permits in Tanah Bumbu Regency, South Kalimantan Province. EnviroScienteae. 19 (1): 76-87.