**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 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 secondary data obtained from company documents, literature/libraries, and relevant journals. The results of the study showed that that percentage of living plants is white albizia (*Paraserianthes falcataria*) of 96.18 – 97.24%, monkey soap (*Enterolobium cyclocarpum*) of 97.30%, rain tree (*Samanea saman*) of 78.52%, cassia siamea of 75%, Mexican lilac (*Gliricidia sepium*) of 67.86%; and mahogany *(Swietenia mahagoni)* plants of 29.01%; and revegetation using white albizia, monkey soap and rain tree plants in Pit Kresna and Pit Arjuna showed a good level of reclamation success.

Keywords: albizia , Reclamation**,**  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. In Indonesia coal mining is generally carried out using the open-pit mining method [1, 2]. 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. 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 [3]. Many studies elucidated that the ecologies constituting both macro and micro are under severe destruction in and around active and abandoned coalfields. The landscape is the first entity in the coalfield to be altered during the coal excavation, specifically in the case of open-cast coal mines. It is well established through many endeavors, that the alteration of the original landscape obliterates the entire ecosystem flourished on it [4]. Results indicate that several samples exceed safe thresholds for TDS, nitrate, and iron, posing health risks primarily due to agricultural runoff and geological sources [5]. 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 [6].

One of the main challenges in reclamation is how to meet sustainability standards, including soil fertility and restoration of damaged ecosystems [7]. This activity is a priority in overcoming the problem of land degradation, due to intensive mining activities such as Indonesia [8]. This study explores the effectiveness of reclamation techniques and the challenges faced, with a focus on the reclamation success criteria applied in Indonesia [7].

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 [9]. This revegetation technique is a key step in recreating canopy cover lost due to mining activities [10]. 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 [9].

 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: preparation, field observation, determination of sampling areas using the stratified sampling method, create a research plot measuring 50 m x 50 m, consisting of 8 plots, observation of living and dead plants, data analysis, and reporting.

**2.3. Data Collection**

The data collected consists of: 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 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 [11], 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 % | Very goodGoodModeratePoorVery Poor |

Source: Regulation of the Minister of Forestry Number 60 of 2009 [11]

**3. RESULTS AND DISCUSSION**

**3.1. Company Overview**

Based on the statement of the Company's Management and Documents of PT Komunitas Bangun Bersama (PT. KBB), the company is a company engaged in the coal mining sector and has been established since 2006. In 2007, the company received its first Exploration Mining Authorization, and in 2008, it 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 white albizia plants, while in the Arjuna Pit, the type of plant dominated is white albizia.

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

White albizia (*Paraserianthes falcataria*) and monkey soap (*Enterolobium cyclocarpum*) is a legume plant that is often used in reclamation projects because it grows quickly and can improve soil fertility through nitrogen fixation. According to [12], white albizia and monkey soap plants can grow and develop on any soil, be it dry land, yard land, or even on newly opened forest land. From observations in the field, plants can grow well on regosol, alluvial, and latosol soils. The soil has a sandy clay texture and dusty clay with a soil pH of 6-7.

Rain tree (*Samanea saman*) is a native plant originating from tropical America such as Mexico, Peru, and Brazil but has been proven to grow in various tropical and subtropical areas. The optimum growth of rain trees is in conditions of evenly distributed rain throughout the year. Rain tree can grow on various types of soil with a soil pH of 6.0--7.4, and requires good drainage but is still tolerant to waterlogged soil for a short time [13].

Johar (*Cassia siamea*) is a native flora that is widely found in Southeast Asia. Its distribution extends to Central America, West Africa, East Africa, and South Africa. Johar is indeed a plant that is suitable for growing in tropical areas. This tree cannot grow in cold climates. Lowlands are the most suitable areas for this tree to grow, with rainfall between 500 - 2800 mm/year and temperatures between 20 ° C - 31 ° C. In Indonesia, johar trees are often found in Sumatra and Java. Johar trees are chosen as greening plants, shade plants, and ornamental plants for roadside gardens [14].

Mexican lilac (*Gliricidia sepium*) is a type of leguminoceae plant that is famous for land rehabilitation because of its ability to improve soil quality through nitrogen fixation. Mexican lilac an grow well on various types of soil in areas with annual daytime temperatures in the range of 12-44 °C, average annual rainfall in the range of 600-3,500 mm, soil acidity (pH) in the range of 5.5-6.2, but tolerant to 4.5-8. [15].

Mahogany (*Swietenia mahagoni*) plants are a type of plant that does not have specific soil type requirements, can survive in various types of soil that are free from puddles, and slightly acidic - alkaline soil reactions, arid or marginal, even though it does not rain for months mahogany is still able to survive. However, growth will be optimal in fertile soil, with deep solum good aeration, and a pH ranging from 6.5 - 7.5 [16].

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, a total of 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*). 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 | White albizia | 64 | 60 | 4 |
| Monkey soap | 52 | 52 | 0 |
| Rain tree | 36 | 28 | 8 |
| Johar | 5 | 5 | 0 |
| 2 | White albizia | 66 | 66 | 0 |
| Sengon Buto | 56 | 56 | 0 |
| Rain tree | 38 | 34 | 4 |
| Johar | 0 | 0 | 0 |
| 3 | White albizia | 66 | 66 | 0 |
| Monkey soap | 48 | 47 | 1 |
| Rain tree | 36 | 27 | 9 |
| Johar | 7 | 4 | 3 |
| 4 | White albizia | 66 | 60 | 6 |
| Monkey soap | 66 | 61 | 5 |
| Rain tree | 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, a total of 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 | Mexican lilac | 68 | 66 | 2 |
| Mahogany | 56 | 10 | 46 |
| Mexican lilac | 33 | 19 | 14 |
| 2 | White albizia | 70 | 68 | 2 |
| Mahogany | 12 | 5 | 7 |
| Mexican lilac | 67 | 51 | 16 |
| 3 | White albizia | 74 | 71 | 3 |
| Mahogany | 28 | 8 | 20 |
| Gamal | 55 | 42 | 13 |
| 4 | White albizia | 78 | 77 | 1 |
| Mahogany | 66 | 24 | 42 |
| Mexican lilac | 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 | White albizia | 262 | 252 (96,18%) | 10 (3,82%) |
| Monkey soap | 222 | 216 (97,30%) | 6 (2,70%) |
| Rain tree | 135 | 106 (78,52%) | 29 (21,48%) |
| Johar | 12 | 9 (75,00%) | 3 (25,00%) |
| Arjuna | White albizia | 290 | 282 (97,24%) | 8 (2,76%) |
| Mahogany | 162 | 47 (29,01%) | 115 (70,09%) |
| Mexican lilac | 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 white albizia plants, 222 monkey soap plants; 135 rain tree plants, and 12 johar plants. The white albizia plants that are still alive are 252 plants (96.18%) and 10 plants have died (3.82%); The monkey soap plants that are still alive are 216 plants (97.30%) and 6 plants have died (2.70%); The rain tree 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 white albizia plants, 162 mahogany plants, and 168 monkey soap plants. The white albizia 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 mexican lilac 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 white albizia (*Paraserianthes falcataria*) and monkey soap (*Enterolobium cyclocarpum*) with a survival percentage of 96-97%, followed by rain tree (*Samanea saman*) at 78.52%, johar at 75%, mexican lilac (*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, white albizia, and monkey soap plants are classified as very good; Rain tree plants are classified as good; Mexican lilac and johar plants are classified as moderate, and mahogany plants are classified as less good. The results of this study are by the research report 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 monkey soap (*Enterolobium cyclocarpum*) plants is more dominant than rain tree (*Samanea saman*) and johar (*Senna siamea*) [17]. Furthermore, it was reported 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 was studied, namely gmelina (*Gmelina arborea*), white albizia (*Paraserianthes falcataria*), rain tree (*Samanea saman*) and monkey soap (*Enterolobium cyclocarpum*). The highest percentage of plant growth and health values ​​occurred in white albizia, followed by gmelina, rain tree, and monkey soap [18]. Furthermore, it was reported that revegetation on former coal mining land in Tanah Bumbu Regency, South Kalimantan Province with pioneer plants, namely white albizia, and rain tree, 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% [19].

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 white albizia, monkey soap, and rain tree 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 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 [9].

**4. CONCLUSION**

Based on the research results and discussion, it is concluded that percentage of living plants is white albizia (*Paraserianthes falcataria*) of 96.18 – 97.24%, monkey soap (*Enterolobium cyclocarpum*) of 97.30%, rain tree (*Samanea saman*) of 78.52%, cassia siamea of 75%, mexican lilac (*Gliricidia sepium*) of 67.86%; and mahogany (*Swietenia mahagoni*) plants of 29.01%; and revegetation using white albizia, monkey soap and rain tree plants in Pit Kresna and Pit Arjuna showed a good level of reclamation success.

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.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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