Environmental impact control of coal mining activities in Kandangan Lama, South Kalimantan through calculating post-mining costs

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Abstract. Land clearing during mining activities can harm the environment, one of which is a change in the landscape that results in erosion, flooding, and climate change. This study aimed to determine the total cost of the post-coal mining plan and identify its components to control environmental impacts and climate change in Kandangan Lama, South Kalimantan. The method used to calculate the total cost of the post-mining plan is based on the Decree of the Ministry of Energy and Mineral Resources Republic of Indonesia with the number 1827 K/30/MEM/2018. The data sampling technique used purposive sampling through observation, interviews, and document study. The results showed that the post-mining area in this study was 3.46 ha. Direct cost, namely IDR 1,064,459,474.00, consists of land use, revegetation, demolition, restoration, social, cultural, economic development, maintenance, and monitoring. Also, the indirect cost is IDR 310,822,166.00, which consists of mobilization and demobilization costs, post-mining plan, contract administration and profits, and supervision costs. Thus, the total cost of the post-mining plan for the 3.46 ha was IDR 1,444,045,722.00. These costs are commensurate with the restoration of environmental conditions to control climate change to maintain environmental stability.

1. Introduction
South Kalimantan is one of the provinces in Indonesia which has large coal reserves. Data in 2013 stated that South Kalimantan has coal reserves of 162,952,196 tons, so mineral and coal mining activities are the primary sources of this Regional Original Revenue. The coal reserves under management are scattered in several districts. One of the sediment locations is in Kandangan Lama Village, Tanah Laut Regency [1]. Part of the area in the village has become a Mining Business Permit Area (WIUP) during the production operation stage, but coal production operations have not yet been carried out. This condition illustrates that the natural resources in the village are still not utilized, making it easier to obtain complete and accurate data.

Land clearing in mining activities can negatively impact the environment, which changes the landscape that results in erosion, flooding, and climate change [2]. The most fundamental impact of mining activities is the emergence of ex-mining facilities and an ex-mine opening that will harm the environment without proper handling. One way to handle negative impacts from mining activities is by
carrying out planned reclamation and post-mining activities. Reclamation and post-mining are inseparable parts of mining activities, so mining, in this case, is not only an activity of digging, loading, transporting, but also having to return the land according to its allotment [3].

The government's efforts to anticipate negative impacts on the abiotic, biotic, and social, economic, and cultural impacts of mining activities are implemented into regulations requiring Mining Business Permit (IUP) holders to compile and submit plans for reclamation and post-mining activities. This obligation is based on the Law of the Republic of Indonesia Number 3 of 2020 [4] concerning Mineral and Coal Mining Article 99. The format of the preparation of the plan following the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia with Number 1827K/30/MEM/2018 [5]. The calculation of the post-mining plan costs can be used to reference the estimated cost of restoring environmental conditions such as the initial environmental baseline so that climate change due to mining activities can be suppressed.

Several studies have been conducted related to post-mining activities. Munir and Setyowati [6] have conducted post-mining land reclamation studies in Jambi, Bangka and South Kalimantan. The study results found that the reclamation carried out in Jambi, Bangka, and South Kalimantan was less effective due to the absence of active participation by the community and technological errors adopted in the implementation of reclamation. Another research conducted by Srimulyati et al. [7] analysed the socio-economic community after the coal mine closure in Sawahlunto, West Sumatra. The study results showed that there were social and economic concerns about the closure of coal mines. However, this concern does not need to occur because a small proportion of the people of Sawahlunto City work as employees in coal mining, meaning that the direct influence of coal mining on the community's economy is not too considerable.

However, no information was obtained from the application of the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia with Number 1827 K/30/MEM/2018 in calculating the planned post-mining activities including in Kandangan Lama, South Kalimantan. This is the first study in Kandangan Lama, South Kalimantan, and provides further information on the calculation of post-mining planning costs by referring to the application of the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia with Number 1827 K/30/MEM/2018. Thus, this study aimed to determine the total cost of the post-coal mining plan and identify its components to control environmental impacts and climate change in Kandangan Lama, South Kalimantan.

2. Materials and methods
This research is quantitative descriptive. Primary data used in this study were obtained from direct observation and interviews using the purposive sampling technique. Secondary data used in this study were obtained from document studies, which included data from related parties and agencies such as the local village administration, the Department of Energy and Mineral Resources of South Kalimantan Province, and the Environmental Service of Tanah Laut Regency, South Kalimantan.

The components calculated to obtain the total cost of the post-mining plan refer to the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia with Number 1827 K/30/MEM/2018 [5]. The total cost of the post-mining plan consists of direct costs and indirect costs. The components of direct costs include costs for ex-mining sites, processing and/or refining facilities, supporting facilities, social, cultural, and economic development, maintenance, and monitoring. Market prices are used to determine the price of each component [8]. In addition, the indirect cost components include:

a. Cost of mobilization and demobilization of equipment (2.5%), with the calculation of Total direct costs x 2.5%

b. Post-mining plan cost (2-10%), with the calculation: Total direct costs x percentage according to Englemen's Heavy Construction Cost File graph

c. Post-mining administration costs and profits (3-14%), with the following calculations: Total direct costs x percentage according to Englemen's Heavy Construction Cost File graph
3. Results and discussion

3.1. Ownership and use of land
Kandangan Lama is a village in Panyipatan District, Tanah Laut Regency, South Kalimantan (Figure 1), with an area of 1.6715 ha and 2,456 people based on 2019 village government data. The primary source of income for the villagers is obtained from agriculture, plantations (oil palm and rubber), livestock, and forest products.

![Research location](image)

Figure 1. Research location.

The regional land use map shows that the IUP Production Operation area in Kandangan Lama village is an area of KBTTP (Fixed Plant Cultivation Area) and KBHPT (Permanent Production Forest Cultivation Area), while based on the Decree of the Menhutubun Number: 435/Menhutubun-Kpts/2009 it is known that most of the Production Operation IUP area is included in the Area for Other Use (APL) and a little in the eastern area is production forest (HP).
From the pre-construction stage to the post-mining stage in Kandangan Lama village, coal mining activity plans are in other areas of use. Based on the Feasibility Study document, activities at the post-mining stage focus on restoring disturbed land areas due to the construction of mining facilities, both primary and supporting facilities. The amount of disturbed land area for these mining facilities can be seen in detail in table 1.

### Table 1. The area of the post-mining plan.

| Mining Facilities          | Location  | Area (ha) |
|---------------------------|-----------|-----------|
| Main Facilities:          |           |           |
| a. Mine road              | In the IUP| 0.50      |
| a. Settling Pond          | In the IUP| 0.2       |
| b. Stockpile              | In the IUP| 0.50      |
| f. Waste Dump             | In the IUP| 1         |
| Supporting Facilities:    |           |           |
| a. Office building and Mess| In the IUP| 0.50      |
| b. Warehouse and workshop | In the IUP| 0.36      |
| c. Nursery                | In the IUP| 0.2       |
| d. Fuel Tank              | In the IUP| 0.20      |
| The total area of the mining facility | | 3.46 |

3.2. **Direct costs**

Based on the research results, several activities are categorized as direct costs of post-mining plans. Reclamation or land use activities are activities for land arrangement before revegetation activities are carried out. In this study, reclamation activities were carried out on an area of 3.46 ha of disturbed land. Land structuring activities include structuring the landfill overburden (OB) surface, spreading topsoil and controlling erosion, and managing runaway water drainage.

The revegetation activity was carried out after the land reclamation was completed in an area of 3.46 ha of disturbed land. The revegetation activities include the process of analyzing soil quality, fertilizing, procuring seeds, planting, and finally, plant maintenance. The specified plant spacing was 4 x 4 m consisting of pioneer plants and embedded plants based on the document study.

Demolition activities of mining facilities located in disturbed land areas, both permanent and semi-permanent, will be carried out before reclamation and revegetation activities. The cost for demolition is obtained from the local market price contracted out per unit of work. Recovery activities or remediation focused on disturbed land areas found in ex-mining site facilities, and this is because, in these facilities, it is estimated that there is much-spilt waste during mining activities.

### Table 2. Direct costs of post-mining plans.

| No. | Description                           | Evaluation (IDR) |
|-----|---------------------------------------|------------------|
| 1.  | Cost of Land use                      | 190,726,254.00   |
| 2.  | Cost of Revegetation                 | 143,733,219.00   |
| 3.  | Cost of Demolition                   | 180,000,000.00   |
| 4.  | Cost of Recovery/Remediation         | 200,000,000.00   |
| 5.  | Development of social, cultural, and economic | 200,000,000.00 |
| 6.  | Maintenance                           | 75,000,000.00    |
| 7.  | Monitoring                            | 75,000,000.00    |
| Total|                                       | 1,064,459,474.00 |

Costs for social, cultural, and economic development were determined based on the community development program's variable cost in the feasibility study document. The amount of environmental costs for social, cultural, and economic development were determined based on the community development program's variable cost in the feasibility study document. The amount of environmental
maintenance and monitoring costs is adjusted to the cost in the feasibility study document for this activity. The total direct cost of the post-mining plan with a disturbed land area of 3.46 ha according to the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia with Number 1827K/30/MEM/2018, the details can be seen in Table 2.

3.3. Indirect costs
Indirect costs are based on a modified graph from "Englemen's Heavy Construction Cost File." This graph explains the total of direct costs converted into an agreed dollar exchange rate so that the percentage amount has been determined in the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia with Number 1827K/30/MEM/2018.

The cost of mobilization and demobilization of equipment is 2.5% of direct costs, or based on the calculation in this study, the cost of mobilization and demobilization is calculated as 2.5% x IDR 1,064,459,474.00 is IDR 26,611,487.00.

Post-mining plan costs in indirect costs are costs incurred by mining managers to re-verify the disturbed area used for mining activity facilities. Based on the Englemen's Heavy Construction Cost File graph as shown in Figure 2, the percentage of post-mining plan costs is 8.2%. If the direct cost of the post-mining plan is IDR 1,064,459,474.00 and the current dollar to rupiah exchange rate (March 2021) is IDR 14,519.00, then the cost of the reclamation plan is IDR 1,064,459,474.00 x 8.2% = IDR 87,285,677.00.

Administrative costs and contractor profits are costs incurred by mining managers for contractor services that will carry out post-mining plans. Based on Englemen's Heavy Construction Cost File graph as shown in Figure 3, the percentage of administrative costs and contractor profits is 12.5%. If the direct cost of the post-mining plan is IDR 1,064,459,474.00 and the current dollar to rupiah exchange rate (March 2021) is IDR 14,519.00 then the cost of the reclamation plan is IDR 1,064,459,474.00 x 8.2% = IDR 133,057,434.00.

Supervision costs are costs that will be incurred by mining managers for monitoring activities on post-mining activities. Based on the Englemen's Heavy Construction Cost File graph as shown in Figure 4, the percentage of supervision costs is 6.0%. If the direct cost of the post-mining plan is IDR 1,064,459,474.00 and the current dollar to rupiah exchange rate (March 2021) is IDR 14,519.00, then the cost of the reclamation plan is IDR 1,064,459,474.00 x 8.2% = IDR 63,867,568.00.
The total Indirect cost with a disturbed land area of 3.46 ha according to the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia with Number 1827K/30/MEM/2018, the details can be seen in Table 3.

### Table 3. Indirect costs.

| No. | Description                                      | Presentage | Evaluation (IDR)  |
|-----|--------------------------------------------------|------------|-------------------|
| 1   | Cost of mobilization and demobilization (2.5%)    | 2.50%      | 26,611,487.00     |
| 2   | Cost of post-mining plan (2% -10%)                | 8.20%      | 87,285,677.00     |
| 3   | Cost of administration and contractor profits (3% -14%) | 12.50% | 133,057,434.00   |
| 4   | Cost of supervision (2% -7%)                      | 6%         | 63,867,568.00     |
|     | **Total**                                        | **310,822,166.00** |                 |

3.4. **Total post-mining plan costs**

Post-mining plan costs are calculated based on direct costs plus indirect costs and an additional 5% escalation cost from the sum of direct costs with indirect costs to anticipate price increases when the activity is to be carried out. From the above calculations, it can be seen that the cost of the post-mining plan with a disturbed land area of 3.46 ha in Kandangan Lama Village is as follows in Table 4.

### Table 4. The total cost.

| No. | Description                | Evaluation (IDR)  |
|-----|----------------------------|-------------------|
| 1   | Direct costs               | 1,064,459,474.00  |
| 2   | Indirect costs             | 310,822,166.00    |
|     | **Sub Total (1 + 2) before escalation** | **1,375,281,640.00** |
|     | Escalation Cost (5%)       | 68,764,082.00     |
|     | **Total (after escalation)**| **1,444,045,722.00** |
4. Conclusion
Based on the results of this study, it can be concluded that the direct costs and indirect costs of the post-mining plan in the disturbed area of 3.46 ha, respectively: IDR 1,064,459,474.00; IDR 310,822,166.00. In addition, the 5% escalation cost is IDR 68,764,082.00, so the total cost of the post-mining plan that the manager must incur is IDR 1,444,045,722.00. These costs are commensurate with the restoration of environmental conditions to control climate change to maintain environmental stability.

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