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Abstract. Various economic, social, and environmental costs and benefits in illegal unconventional tin mining in Bangka Island have not been mapped clearly. The objective of this study is to obtain information on the economic, social, and environmental costs and benefits incurred by these mining activities expressed in monetary terms. The researcher conducted a field research in three mine villages and interviewed the miners, village government apparatus, and community leaders to map the impacts in the area. The benefits are the income and the growth of sales business, while the incurred costs include the flow of cash towards investors outside the village and the cost of river revitalization, land reclamation, watershed rehabilitation, and flood emergency response. Limited disclosure of data by the mining community and the lack of data available have yielded little cost benefit calculation. Net Present Value (NPV) approach was used to measure net social impact by assessing the profitability of mining, its benefits for the mining community, and the losses incurred by cost of investors and land reclamation. The results of calculation were positive, suggesting that unconventional mining had a significant economic impact at the local level. However, there needs to be further cost analysis of broader environmental damages.

1. Introduction

The rising of people's illegal tin mining in Bangka Belitung has lasted nearly 20 years since the transfer of tin mining management authority from the central government to the regional government [1]. This illegal tin mining is known as Unconventional Mining (UM), although sometimes the equipment used has the equivalent mining capacity of a large scale mining [2]. The 2016 Central Bureau of Statistics (CBS) census showed that there were 73,939 mining and quarrying labors. This number was dominated by tin mining sector, which contributed to the decrease in the open unemployment rate [3].

These mining activities have caused landscape changes in the form of pits and embankments and low soil fertility [4]. In addition, artisanal small-scale mining activities can damage the forest ecosystem, river sedimentation, land destruction and can be felt when the mine is closed such as unemployment, and degraded mining sites that limit certain economic activities [5,6]. These activities are carried out by local miners through small businesses, individuals and groups characterized by low mechanization and capital and high labor intensity [7].

On the other hand, UM activities has become the main source of income and a survival strategy for the miners when agricultural commodity prices decline in international markets [8,9]. A study [10] reported that the income obtained from UM activities contributed to the community's monthly family income by approximately 90 percent, which is the rough average percentage yielded in a case study of

three villages namely Lubuk Kelik (93.4 percent), Silip Village (95.1 percent), and Bencah Village (89.1 percent).

This contradiction led to the conclusion that a cost benefit analysis of UM activities is crucial as a basis for consideration for the government in making policies. As such, the present writer took the step to analyze more deeply the net benefits of unconventional mining for communities that have been depending on this sector for their livelihood.

2. Research methodology

This case study was conducted in Delas Village, Bencah Village, and Nyelanding Village, which were selected on the basis of three criteria. First, the community's involvement in tin mining activities has lasted since early in 2000, taking the proportion of roughly 30 percent. Second, in terms of hydrology, these three villages are included in Kepoh watershed where the community performs mining activities as well as using the river water for drinking, bathing, and washing. Third, the data publicized by CBS on the number of UM in these villages is available to be utilized. The research took place from June 2018 to November 2018 [11].

The data used in this study were primary and secondary data. The primary data was obtained through field searches and interviews that were analyzed to map the social, economic, and environmental impacts. The informants were sampled purposively from the mining communities in the three villages: mine owners, mine workers, and tin buyers; village apparatus: heads of the villages and hamlets; and the affected community around the mining area: farmers, traders, and housewives. Meanwhile, the secondary data were obtained from literature research, CBS data on the number of UM, food stalls, and the data on land damages provided by the Department of Environment.

For analysis, this study used the quantitative approach of cost benefit analysis that models the net social impact of mining activities in monetary units [12]. The equation for calculating Net Social Impact of Mine is as follows:

Mine Profitability (A) + External benefits to stakeholders (B) – External costs to society (C) (1)

where:

A = Net present value of revenues – net present value of internal costs

B = Sum of net present value of direct, inderect and induced positive economic, social and environmental impacts (positive externalities)

C = Sum of net present value of direct, indirect and induced negative economic, social and environmental impacts (negative externalities)

Several prior studies [12,13] reported that the direct benefits of mining activities were income for mine workers, tax revenue, employment opportunities, and an induced benefit, namely the growth of sales business. The negative impacts reported were environmental impacts such as vegetation clearance, rock/soil removal, river mining, the increasingly rare activities of refilling mined pits, the use of toxic materials, wild animal hunts, and the establishment of settlements. As a result, the incurred costs include those of land reclamation, medical services, watershed rehabilitation, and clean water supply.

3. Result and discussion

3.1. Mapping the impact of illegal unconventional mining

The data showed that the economic benefits of illegal unconventional mining were income for the actors involved, the emergence of stalls and restaurants providing foods for mine workers, and the presence of special shops selling mining equipment and supplies. There are capital injections for tin buyers and mining equipment suppliers by investors from outside the villages.

The environmental impacts included landscape changes and riverbed siltation and turbidity, which triggered floods in Delas Village. The social impacts were the conflicts over lands between miners and between miners and oil palm farmers due to land grabbing. In addition, protests were carried out by the

housewives of Nyelanding Village against mining in or around the river, which caused the water used for bathing and washing to become muddy.

3.2. Net social impact of ilegal unconventional mining

3.2.1. Mining profitability (A)

Mining Profitability is the difference between the net present value of revenue and the net present value of cost incurred. Revenues are measured by calculating sales of tin sand mined by mine owners while costs are measured by calculating the cost of investment, fuel, spare parts, and labor wages. It should be noted that this study did not include mining sites that were settled at one place due to the nature of unconventional tin mining activities which frequently move from one place to another. However, based on the interview results, although the mining activities did not stay at one place, the miners did not move too far from their previous mining sites. The details of income received and costs borne by the mine owners can be seen in Table 1.

Table 1. Proceeds from sales of tin sand and costs incurred in UM in Nyelanding Village, Delas Village, and Bencah Village in 2018

Item	Total sales and costs (IDR/month)	Total sales and costs (IDR/year)
Average sales of tin sand by small-scale tin mine owners	IDR 104,120,000.00	IDR 1,249,440,000.00
Average sales of tin sand by large-scale tin mine owners	IDR 442,600,000.00	IDR 5,311,200,000.00
Average costs borne by small-scale mine owners which includes:	IDR 33,080,000.00	IDR 396,960,000.00
– Labor cost	IDR 28,540,000.00	IDR 342,480,000.00
– Fuel cost	IDR 1,640,000.00	IDR 19,680,000.00
– Mining equipment and supplies renewal	IDR 2,900,000.00	IDR 34,800,000.00
Costs borne by large-scale mine owners which include:	IDR 177,600,000.00	IDR 2,131,200,000.00
– Labor cost	IDR 154,000,000.00	IDR 1,848,000,000.00
– Fuel cost	IDR 7,600,000.00	IDR 91,200,000.00
– Mining equipment renewal	IDR 16,000,000.00	IDR 192,000,000.00

Based on the data information, mine owners with investments ranging from IDR 10,000,000.00 - IDR 20,000,000.00 are categorized as small-scale mine owners, while those with investments more than IDR 50,000,000.00 are categorized as large-scale mine owners. As for tin buyers, those with buying capacity of 500 kg/week are categorized as small-scale tin buyers while those with buying capacity of 5.000 kg/week are categorized as large-scale tin buyers. There were a total of 335 mining units in the three villages: 35 units in Nyelanding Village, 200 units in Bencah Village [12], and around 100 units in Delas Village. Based on the data provided by the mining equipment suppliers, 20 percent of the demands came from large scale mining business while the 80 percent came from small-scale mining business.

Based on the data, the equation for mining profitability of the mines (A) in these three locations is as follows:

$$A = (268 \times \text{IDR } 1{,}249{,}400{,}000.00) + (67 \times \text{IDR } 5{,}311{,}200{,}000.00) - (268 \times \text{IDR } 396{,}960{,}000.00) - (67 \times \text{IDR } 2{,}131{,}200{,}000.00)$$

$$A = \text{IDR } 690{,}700{,}320{,}000.00 - \text{IDR } 249{,}175{,}680{,}000.00$$

A = IDR 441,524,640.00 per year

3.2.2. Positive Externalities (B)

Positive impacts consist of direct benefits, indirect benefits, and induced benefits. Mining communities that are directly affected economically are mine workers, tin lobbyists, mine owners, and tin buyers [8]. Each mine owner employs 4 workers with a 70 percent- 30 percent profit sharing scheme for the mine owner and mine workers respectively. During the period in which this research took place, the average prices of tin sand ranged between IDR 100,000.00 and IDR 117,000.00 for Sn 1.2 kg and 1.3 kg.

Table 2. Direct and indirect benefits of illegal unconventional tin mining activities in Delas Village, Bencah Village, and Nyelanding Village in 2018

Item	Average income (IDR/year)	Total net income in the 3 observed villages (IDR/year)
A. Direct beneficiaries		
1. Large-scale mine owners	IDR 336,600,000.00	IDR 22,552,200,000.00
2. Small-scale mine owners	IDR 121,200,000.00	IDR 32,481,600,000.00
3. Mine workers hired by large-scale mine owners	IDR 90,000,000.00	IDR 14,490,000,000.00
4. Mine workers hired by small-scale mine owners	IDR 33,600,000.00	IDR 21,638,400,000.00
5. Large-scale tin buyers	IDR 4,980,000,000.00	IDR 11,952,000,000
6. Small-scale tin buyers	IDR 498,000,000.00	IDR 5,976,000,000.00
7. Workers hired by large-scale tin buyers	IDR 34,800,000.00	IDR 2,923,200,000.00
8. Workers hired by small-scale tin buyers	IDR 24,000,000.00	IDR 4,363,200,000.00
Total direct benefits		IDR 113,453,400,000.00
B. Indirect beneficiaries		
1. Providers of mining equipment and supplies	IDR 460,200,000.00	IDR 736,320,000.00
2. Food stall owners	IDR 40,200,000.00	IDR 522,600,000.00
3. Grocery shop sellers	IDR 12,600,000.00	IDR 1,625,400,000.00
Total indirect benefits		IDR 2,884,320,000.00

The process of washing and drying tin sand is done in order to increase tin content to an average of 70 percent. Small-scale tin buyers usually hire 1 worker, while large-scale tin buyers hire at least 7 workers, with an average IDR 1,000.00 wage per kilogram of tin sand. Tin sand is sold at IDR 185,000.00 to IDR 200,000.00 per kilogram. Indirectly benefited groups include shop owners selling mining equipment, grocery shop owners, and food stall owners that provide food for the mining workers. Based on the data obtained from the 3 villages, there were 8 mining equipment providers, 129 grocery shops, and 13 food stalls available.

Details of direct and indirect benefits can be observed in Table 2. It should be noted that investors from outside the village were involved in providing capital for tin buyers and mining equipment suppliers. Even after paying the investors their share, large-scale tin buyers are able to get hundreds of millions of rupiahs for their weekly net profit, while small-scale tin buyers get tens of millions of rupiah per week. Even so, there were cases in which mine owners borrow money from tin buyers to buy mining equipment or have a buy-now-pay-later purchase deal with the shop owners.

The induced beneficiaries group consists of grocery shop, food and beverage stalls, night markets, and carpentry services. The amount of economic benefit obtained by the induced group is measured by

South Bangka Regency's per capita consumption, which was IDR 1,155,676.00/month. There were 1,356 households relying on tin mining in the 3 observed villages, with an average of 3 dependents per family. The result of calculation for the induced benefits is as follow:

NPV of induced impact =1,356 x 3 × IDR 1,155,676.00/month × 12 months
= IDR 56,415,479,616.00 per year

Based on the calculation of direct, indirect, and induced benefits, we can calculate the value of positive externalities (B), i.e. =

B = IDR 113,453,400,000.00 + IDR 2,884,320,000.00 + IDR 56,415,479,616.00
= DR 172,753,199,616.00 per year

3.2.3. Negative externalities (C)

The observed negative impacts include the loss suffered by farmers, damage to the landscape, silting rivers, floods, and the money paid to investors from outside the village. However, in this calculation, taking into account the availability of accessible data, the measured negative impacts included the cost of reclamation and the mining money circulating outside the village.

According to the calculation of Geographic Information System (GIS), the total area of land with critical and very critical categories is 4954.69 ha, with 687.5 ha in Delas Village, 1,740.6 ha in Nyelanding Village, and 2,526.6 ha in Bencah Village. The reclamation cost per hectare is IDR 44.92 million (referring to the amount of reclamation guarantees issued by PT. Timah Tbk, which was IDR 222,557,732,856.44 for 2,027 ha of land). Meanwhile, illegal tin mining in the 3 villages were blooming in 2004, and the activities were still ongoing at the time of the study in 2018. Thus, the reclamation cost was:

Reclamation cost =4,954.69 ha × IDR 44.920.00 ha/14
= IDR 15,897,476,771 per year

The amount of money circulating outside the village was found by calculating the capital provided by outside investors for local tin buyers and mining equipment suppliers. Interviews revealed that 80 percent of the gross income received by tin buyers and mining equipment suppliers was paid to investors.

Money cirulating outside of the village =(80% × IDR 89,640,000,000.00)+(80% ×IDR 460,200,000.00×8)
= IDR 72,080,160,000.00 per year

Negative externalities value (C)= IDR 15,897,476,771.00 + IDR 72,080,160,000.00
= IDR 87,977,636,771.00 per year

The net social impact of unconventional mining for mining communities in the research sites is calculated based on the calculation results for mining profitability, positive externalities, and negative externalities as follows:

Net social impact of mining (A+B+C) = IDR 85,217,087,485.00 per year

4. Conclusion

The study results obtained from the three sites show that the benefits of unconventional mining activities are significantly felt by the mining community, especially tin buyers and mine owners. However, the involvement of outside investors remained a concern for the community. These investors are providing the capital support for the purchase of tin sand and the provision of mining equipment. As such, they are the party that enjoyed the most benefit from the activity, reducing the potential benefit enjoyed by the villages. However, economic stimuli arising from unconventional mining activities have also triggered horizontal conflicts related to mining lands between miners. Land grabbing committed by mine owners against farmers is also a disconcerting issue. In addition, massive damages have occurred due to mining activities that led to landscape changes and river damages. The damages have caused losses to

the community, since it triggered annual flooding in Delas Village and caused river water for bathing and washing to become turbid and no longer usable.

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