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Potential Analysis of Natural Stone Mining Activities in Mount Kuda on Environmental Quality as SDGs-Based Science Teaching Material

Dede Cahyati Sahrir[1,4*], Margareta Rahayuningsih[2], Aditya Marianti[3]

[1]Doctoral of Science Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Semarang, Indonesia 50229

[2]Biology Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Semarang, Indonesia 50229

[3]Biology Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Semarang, Indonesia 50229

[4]Biology Education Study Program, FITK, UIN Siber Syekh Nurjati Cirebon, Cirebon, Indonesia 45132

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*Corresponding author:
Dede Cahyati Sahrir
Universitas Negeri Semarang
E-mail: dcsahrir@students.unnes.ac.id

Abstract

The Gunung Kuda mining area in the Cipanas Village area, Dukupuntang District, Kuningan Regency has the potential for natural resources as a type of C excavation mine with a limestone soil texture where the results are partly used as raw materials for cement, natural stone and ceramics. Data collection techniques were carried out using open interviews, field observations and literature reviews. The results obtained show that Mount Kuda mining activities have positive and negative impacts. The positive impact felt by the surrounding community is as a center of livelihood to stabilize the economy. However, there are also negative impacts in the form of decreasing the quality of the surrounding environment, such as the river in the Gunung Kuda mining area which is classified as moderately polluted, namely with a value of Plj 10.39; air pollution in the form of dust resulting from the breakdown of rocks; as well as reduced vegetation in mining areas. Efforts made by the management and surrounding communities to balance the environment in the mining area are by replanting trees that have been reduced due to the mining process with trees that are considered to have benefits such as mango trees, durian trees and sengon trees. The results of the analysis of the impact of Mount Kuda mining on environmental quality are suitable as a study in SDGs-based contextual science learning resources.

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INTRODUCTION

Natural resources are very important to meet human needs in all areas. Management and utilization of natural resources is influenced by the

dependence between humans and natural resources. Increasing use of existing natural resources is correlated with increasing needs. More exploitative use of natural resources can have ecological impacts that endanger environmental balance (Zavina et al., 2019). In managing natural resources, it is important to prioritize sustainability and national benefits (Andriyani et al., 2021; A. J. Pratama et al., 2023; Sumawdiayani, 2021).

Natural resources that are not managed appropriately can increase environmental degradation. Humans' lack of understanding of the environment leads to wrong behavior that causes environmental crises (Miranto, 2017; Sumawdiayani, 2021). Bad environmental influences are caused by excessive exploitation of nature. Mining of sand, gravel, river rock and landfill is often carried out without paying attention to its environmental impact (Gautama et al., 2021; Kuspriyanto, 2016; Zavina et al., 2019). Uncontrolled or excessive use of natural resources can cause damage or decline in environmental quality, which can be influenced by the quality of the population or society (Ilyasa et al., 2020; Mustikawati, 2015).

Cexcavation mining is one of the most popular forms of natural resource management. Mining is one way to explore and utilize potential natural resources in the most profitable way for society (Fansuri & Deshariyanto, 2018). Cipanas Village has natural resource potential for type C excavation mining with a limestone soil texture, namely Mount Kuda. Since 2004, Mount Kuda in Cipanas Village, Dukupuntang District, Cirebon Regency, West Java, has been used as a mining location. Mount Kuda has been one of the C excavation locations where the results are partly used as raw materials for cement, natural stone and ceramics. The mining area in Cipanas Village is managed by the people who live nearby. Mining activities carried out can have positive and negative impacts. Mining activities can have a negative impact on the environment, such as incomplete reclamation of ex-mining land, air pollution in the form of dust and noise, a decrease in the number of local flora and fauna, and the emergence of unrest in the surrounding community. In excavation C mining in Cipanas Village, it is known that the land after mining has not been allocated for reclamation costs or environmental management (Nuraeni et al., 2015).

Efforts to fulfill the right to a good and healthy environment are carried out through environmental management efforts as mandated by Law Number 32 of 2009 concerning Environmental Protection and Management. The government and all elements of society are obliged to protect and manage the environment in implementing sustainable development, so that the Indonesian environment remains a resource and support for the Indonesian people and other living creatures (Maydrawati, Tri Rusti, 2016; Megaartha, 2021). Gunung Kuda Mining already has an Amdal permit in the Cirebon Regency Regional Government Regulation in paragraph 5 concerning mining designated areas in article 46 page 48 and article 37 in letter e, namely in the form of a mineral and rock mining designated area with an area of approximately 601 hectares. One of them is in Dukupuntang District covering an area of approximately 122 hectares.

The problem in practice, especially in Cipanas Village, Dukupuntang District, Cirebon Regency, is that there is a business activity that utilizes natural resources in the form of Mount Kapur, namely Mount Horse in the mineral and rock mining area which is used by the community or business actors to produce natural stone. Almost on every road in the area there are natural stone mining business activities. The natural stone mining business activities carried out by mining business actors not only have positive impacts but also have negative impacts such as pollution or environmental destruction.

One of the wastes produced from natural stone mining business activities is liquid waste. Based on previous research, liquid waste from the remaining natural stone mining business activities has so far been directly dumped into the Cimanggu and Jamblang rivers. As a result, river water becomes polluted with a cloudy and thick gray color like cement. The polluted river water then flows into the farmers' irrigation canals, so that the rice fields are affected, causing the farmers' rice productivity to fall.

Several studies related to mining activities in other locations include excavation C mining activities in Parangloe District, Gowa Regency, affecting infrastructure, environmental quality and institutions, but not affecting facilities. (M. R. Pratama & Surur, 2021). Then at sand mining on the banks of the Brantas river, Ngunut District, Tulungagung Regency, the community said that sand mining had a negative impact on the surrounding environment. They also say that sand mining helps the economy of the surrounding community (Kuspriyanto, 2016). Meanwhile, research that has been carried out at the Gunung

Kuda mining location is evaluating the impact of Gunung Kuda mining activities (Monica et al., 2021).

There has not been much research that has turned the results of environmental quality analysis in mining areas into a specific learning resource. The presence of research that utilizes the surrounding environment in the form of analysis of the impact of Mount Kuda mining activities on environmental quality as a learning resource is expected to be able to enrich students' competencies. The research questions include: (1) What is the impact of mining activities in Mount Kuda on environmental quality in terms of river pollution levels, air pollution and vegetation diversity?; and (2) What is the potential of the results of the impact analysis of Mount Kuda mining activities on environmental quality as a source of SDGs-based science learning on the environmental pillar?

METHOD

The location of this research was carried out in Mining Excavation C, Cipanas Village, Dukupuntang District, Cirebon Regency, West Java Province. Data sources from this research include primary data and secondary data. Primary data in this research is data resulting from interviews with key informants. The key informants in this research were 1 mining manager in the Gunung Kuda area, 4 communities around the mining area, 1 village official, and 1 resource person from the Cirebon Regency Environmental Service. The data obtained is in the form of a general description of the environmental impacts of mining on Mount Kuda. Furthermore, primary data was also obtained from field observations in the form of observations of physical and chemical parameters. The data obtained were in the form of monitoring reports from the Cirebon Regency Environmental Service, results of literature studies, and other supporting data related to the research. The location of this research is presented in Figure 1.

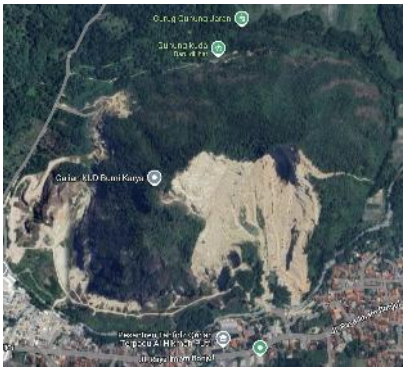

Figure 1. Location Map of Gunung Kuda, Cipanas Village, Dukupuntang District, Cirebon Regency, West Java Province.

Furthermore, the data collection method was carried out by interviews, observation and documentation. The interview technique used in this research is an unstructured interview technique or also called an in-depth interview. Unstructured interviews are used so that the information obtained is more in-depth and also so that the interview process is flexible and open (Sugiyono, 2012). Interviews were conducted to obtain data in the form of information regarding the environmental impacts it causes. Furthermore, observations were carried out to assess the environmental impact on the river, air and vegetation around the mine. The documentation is in the form of documentation studies and document analysis from the Cirebon Regency DLH as well as literature studies on relevant topics. The data analysis method used in this research is descriptive qualitative analysis by describing, describing and comparing data with the actual situation in the field so that a conclusion can be drawn. The research aligns with the environmental pillar of SDGs, particularly with a focus on several key goals, namely SDG 6 (Clean Water and Sanitation), SDG 13 (Clean Water and Sanitation) and SDG 16 (Life on Land).

RESULT AND DISCUSSION

The Cirebon region has a diversity of potential minerals with quite large reserves (Sulaksana, 2006). The use of excavation C is permitted by the local government. This management is considered to be able to increase PAD, improve the economy and create jobs for people inside and outside mining. As managers, industry is expected to be able to manage natural resources well and effectively. Based on the results of interviews with the management of Mount Kuda natural stone mining, it was stated that Quarry C mining is in the form of a cooperative which has obtained a Borrow-to-Use Forest Area Permit for stone mining activities (C quarry) in the Gunung Kuda block, including the administrative area of the

Cipanas village government, Dukupuntang sub-district, Cirebon district, covering an area 10 (ten) hectares, through a loan-to-use forest area procedure with a compensation ratio of 1:2. The land compensation area provided by a cooperative, namely Kopontren Al-Azhariyah, covers an area of 20 hectares which comes from owned land, located in Bantaragung Village, Sindangwangi District, Majalengka Regency, which is located bordering the Ciremai mountain forest area.

Based on the results of interviews, the community explained that one of the problems caused by mining activities was that trucks carrying excavation products caused road damage, dust and noise. To reduce the negative impact on local communities, the local government has carried out sweeping and issued warnings to excavation businesses and truck drivers. However, it cannot be denied that this sector is the one that provides the most jobs to the community.

The environment always has issues that can be classified into two parts. First, environmental problems that arise as a result of various natural phenomena themselves, for example earthquakes, eruptions, eclipses and so on. Second, environmental problems as a result of human intervention. Changes caused by nature which then become existing symptoms cause various impacts on the inhabitants, but most of the impacts arising from these changes are resolved by nature itself, namely by maintaining balance. One of human efforts to care for the environment is to limit human behavior in every activity so that a balance is established between humans and nature that is always maintained and preserved.

Some development potentials require attention to environmental conditions as a place for human interaction with other living and non-living creatures. The decline in environmental quality, depletion of natural resource supplies and the emergence of various environmental problems can be caused by humans' lack of knowledge about the environment, resulting in environmental damage. In order to overcome environmental problems in order to achieve environmental conservation, environmental pollution was identified as a result of mining activities in the Mount Kuda block in the Cirebon Regency area.

Based on the results of interviews with the Cirebon Regency Environmental Service, we obtained some information, namely that Cirebon Regency has a natural stone industry which is spread across 4 sub-districts in Cirebon Regency, one of which is Cipanas Village. Talking about pollution, if you look at a lot of pollution, such as water pollution, land pollution and air pollution, which results in a decline in environmental quality, even though there is a positive side behind it, such as economic growth and job opportunities. The environmental quality index in Cirebon district is 54.39 in the Medium category.

Regarding water pollution in Cirebon district, there is light pollution, moderate pollution and heavy pollution according to water quality index data. By calculating the pollution index, it gets a PLJ value of 7.33. Based on this value, the status of the Cirebon district river is in the moderately polluted category. Based on the results of direct observations regarding the condition of the river in the Mount Kuda block mining area using physical parameters, data were obtained which can be seen in Table 1.

Table 1. Physical and chemical parameters of water pollution in the Cipanas Village River, Dukupuntang District, Cirebon Regency

No	Physical Factors	Description
1	River water temperature	320C
2	pH	5,64
3	Colors	Brownish gray
4	Turbidity	18 cm
5	Smell	River water has a quite strong odort

The results of observations carried out on March 1 2023 in Table 4.2 show that there are several that exceed the environmental quality standards (BML) and there are several that meet the quality standards based on the observed temperature value of 32°C, this temperature condition is still in accordance with the criteria for class II water quality standards. . The pH value of the river shows 5.64, which is acidic, this value is below the quality standard value. The next observation regarding the level of turbidity of the Jamblang River was that after measuring it with sechi diks, a value of 18 cm was obtained, this value exceeded the water quality standards. The color of the water is grayish brown and has a quite strong odor. This condition is as seen in Figure 2.

Figure 2. River in the Mount Kuda Mining Area

Previous studies show that liquid waste produced from Mount Kuda's natural stone mining operations has been directly discharged into the Cimanggu and Jamblang rivers. (Fauzia & Siska, 2022). As a result, river water becomes polluted with a very dark, murky gray color, similar to the color of cement. Liquid waste from the natural stone industry usually consists of fine powder and mud produced

from cutting stone which is then flowed continuously into waterways or river bodies and then mixed with river water. (Santika, 2021). The solids contained in natural stone waste then settle to the bottom of rivers, which can reduce water and soil quality. To support efforts to manage river water quality, river water management and monitoring must be carried out regularly and periodically (Hernandi et al., 2021).

This was further strengthened by data from monitoring results from the Cirebon district environmental service on the Jamblang River. Data was taken from the Jamblang River because liquid waste produced from natural stone mining operations has so far been directly discharged into the Cimanggu and Jamblang Rivers. (Fauzia & Siska, 2022).

Table 2. Data from Monitoring of Water Pollution Levels in the Jamblang River, Cirebon Regency

No	Factor	Environmental Quality Standards	Description
Physique			
1	River water temperature	300C	28,10C
2	Total Dissolved Solids (TDS)	2000 mg/L	324 mg/L
3	Total Suspended Solids	100 mg/L	217 mg/L
Chemistry			
4	pH	6-9	8,18
5	BOD	12 mg/L	14,1 mg/L
6	COD	80 mg/L	49,1 mg/L
7	Nitrate	20 mg/L	2,8 mg/L
8	Lead	0,5 mg/L	0,29 mg/L
9	Amonia	0,5 mg/L	0,646 mg/L
10	Mercury	0,0005 mg/L	0,0016 mg/L
11	Nickel	0,1 mg/L	0,64 mg/L
Biology			
12	Fecal Coliform	2000 mg/L	3100 mg/L
13	Total Coliform	10000 mg/L	24000 mg/L

Based on the results of monitoring by the Environmental Service based on table 2, it can be seen that pollutant components exceed quality standards, including physical factors, namely total suspended solids of 217 mg/L. Meanwhile, in terms of chemical factors, the BOD value shows 14.1 mg/L, the ammonia content is 0.646 mg/L, the mercury content is 0.0016 mg/L, and the nickel content is 0.64 mg/L, exceeding quality standards. Furthermore, from biological factors, the results of the analysis of the Fecal Coliform content in river water were 3100 mg/L and total Coliform in river water was 24000 mg/L, both of which exceeded environmental quality standards.

Based on the results of the analysis using the pollutant index method by comparing the results of the PPRI quality standard analysis No. 22 of 2021 Class II. The guidelines used in the calculation are Minister of Environment Decree No. 115 of 2001 concerning guidelines for water quality status, the Jamblang River is classified as heavily polluted, namely with a Plj value of 10.39, while the monitoring results for rivers in Cirebon district after averaging the water pollution index are classified as moderate with a Plj value of 7.33.

Observations of physical parameters on air quality in the Gunung Kuda natural stone mining area were also carried out with the results which can be seen in table 3.

Table 3. Observation Results of Physical Parameters of Air Pollution

No	Physical Factors	Description
1	Air temperature	35,40C
2	Air humidity	51,7 RH
3	Smell	No odor
4	Dust	There is enough dust around the mining area that it can be seen on the trees and floors of residents' houses around the mining site

The results of observations made on March 1 2023 in table 3, the air temperature around the Gunung Kuda mining area is 35.4 °C. The higher the air temperature, the drier and lighter the particles will become, so that the particles become more reactive and last longer. The dust produced is quite disturbing to residents, especially during the dry season. The humidity measurement results of 51.7 RH do not meet the specified requirements. The burning smell from vehicle exhaust has increased due to cement factory activities. There is residual dust from mining activities which can disturb local residents because it causes suffocation and irritation. To complete the data, monitoring results from the environmental service can be seen in Table 4.

Table 4. Air Quality Monitoring Results from the Environmental Service

No	Location	SO2		NO2	
		Stage I	Stage II	Stage I	Stage II
1	Cipanas Village	4,72	5,3	10,09	27,93

The results of monitoring by the Environmental Service are in table 4. The air pollution index in stage I obtained NO2 4.72 µg/m in stage II the NO2 value

increased to 5.3 µg/m and SO2 in stage I 10.09 µg/m increased in stage II to 27.93 µg/m m of these results meet air pollution quality standards. TSP, NO2, SO2, CO, and P6 are ambient air pollution that can come from smoke from burning limestone. This can endanger human health, especially workers (Fevria, 2016). Rainwater can produce acid rain which is caused by the reaction of sulfur oxide gas (SO2 and SO3) with water vapor. This acid rain can damage structures, bridges and statues, causing plants to die or not be able to grow.

Based on observations of vegetation diversity, the dominant plant types around Mount Kuda hill are rubber trees, sengon trees, rubber trees, willow trees, chinese petai trees, sapodilla trees, mango trees, durian trees, cherry trees and banana trees.

Figure 3. Vegetation around Mount Kuda Mine

With the dredging of Mount Kuda Hill, it cannot be avoided that it will reduce the local flora, but the management and community are committed to replacing every lost tree with a new tree. For replanting, productive fruit-bearing trees are selected so they are considered to be more beneficial. Efforts made to maintain natural balance are also carried out by creating a Green Belt around mining areas using sengon plants (Albizia chinensis) to minimize the impact of noise and dust on settlements around mining areas (Monica et al., 2021). The tree canopy that functions as a greenbelt performs a function through the process of adsorption and absorption, which reduces the number of solid particles in the air. Solid particles will be absorbed (stick) to the surface of the leaves, especially rough and hairy leaves.

The main cause of environmental damage is the human factor. Changing human behavior that tends to damage the environment can be achieved through activities carried out by all fields of education, especially by educators at the tertiary level. Every educator must be trained to integrate environmental materials and concepts in their learning (Miranto, 2017). According to previous research (Fauzi & Hayati, 2023; Irwandi & Fajeriadi, 2020; Ismawaty, 2021; Ningsih et al., 2022; Sabran et al., 2016; Susilo, 2018; Widiastuti, 2017), The environment can be used as a direct learning resource because it has a relationship with human interactions and places of life. Thus, the environment can be used as a learning resource to support the learning process. Therefore, the results of the analysis of the impact of mining activities in Mount Kuda on environmental quality can be used as a resource for SDGs-based science learning. This concept is based on the understanding that natural resources must be managed sustainably, taking into account the interests of future generations. Apart from that, this concept also emphasizes the importance of sustainable economic development, while still paying attention to environmental and social sustainability.

The study primarily correlates with the environmental pillar of the Sustainable Development Goals (SDGs), addressing a number of interconnected objectives (Kementerian PPN/Bappenas, 2020). It focuses on SDG 6 (Clean Water and Sanitation) by investigating the degree of river contamination caused by mining waste, namely in the Cimanggu and Jamblang rivers. The findings emphasize the negative impact of mining activities on water quality, which is crucial for community health and agricultural output. The report also addresses SDG 13 (Climate Action) through an assessment of air quality, demonstrating how dust and emissions from mining operations contribute to environmental degradation and harm local populations. Furthermore, the study addresses SDG 15 (Life on Land) by assessing the impact of mining on local vegetation, demonstrating a decrease in biodiversity and the need for reforestation efforts.

CONCLUSION

Based on the results of the analysis of the impact of mining activities on Mount Kuda, the quality of the environment can be seen from the quality of the water, air and the presence of local vegetation. Horse mountain mining activities have an impact on reducing environmental quality in the form of river water quality status in the horse mining area of Cipanas Village which is classified as heavily polluted, with a value of Plj 10.39. The air quality around the mining area is dusty, especially in the dry season, and the diversity of local vegetation decreases. Analysis of the impact of Mount Kuda mining activities on environmental quality is used as a context for science learning which is packaged in contextual learning resources based on SDGs to train problem solving skills and awareness of environmental ethics.

The study has various limitations that should be recognized. One significant disadvantage is the absence of longitudinal data, as the study only gives a snapshot of environmental factors at the time of observation. A more thorough investigation would necessitate long-term monitoring to track changes

in pollution levels and environmental recovery over time. Furthermore, while the report identifies mining activities as a major contributor to environmental deterioration, it does not distinguish their influence from other potential sources of pollution, such as agricultural runoff or other industrial activity in the region.

Future study should overcome these limitations by performing long-term environmental monitoring to gain a better understanding of pollution trends and the effectiveness of mitigation strategies. Expanding data collection activities, such as adding sample points and doing more extensive chemical analysis, would provide a more precise assessment of environmental quality. Furthermore, including a socioeconomic and health impact analysis would aid in understanding how mining-related pollution directly impacts the livelihoods and health of local populations. By addressing these elements, Gunung Kuda mining research can contribute not only to scientific knowledge but also to practical solutions that help sustainable development and environmental conservation.

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