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Strategic Mining Plan Optimization: Mitigation of Environmental Degradation in Sustainable Development

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Abstract

Mining activities are threatening all living things. Environmental damage, land disputes, and natural disasters are consequences the world must face, bringing the importance of studies on Strategic Mining Plan Optimization: Mitigation of Environmental Degradation in Sustainable Development. Mainstreaming studies for optimizing strategic mining plan aim to prevent environmental degradation in realizing sustainable development and plays an important role in developing knowledge about mining, environment, and social sciences and seeing the impacts caused by sand mining activities, like in Lumajang Regency. This study aimed to analyze and describe how to deal with environmental degradation for sustainable life, in contrast to other studies, which focused on the positive impacts, especially the economic benefits, arising from mining. This paper relied on primary and secondary data collected in stages through qualitative research methods from several platforms, such as news, journal articles, ScienceDirect, and Google Scholar, as well as field interviews. Informants were selected by way of Snowball Sampling. The findings showed that optimizing mines to realize sustainable development needs 1)Mining Area Zoning, 2) Mining Transport Routes, and 3) Operational Hours Setting. This study expectedly could be the basis for the community, government, and parties involved in mining activities to preserve the environmental ecosystem.

Keywords: *Environmental Degradation, Mining, Mitigation, Plan Optimization, Sustainable Development.*

Introduction

Mining activities have changed the ecosystem of living things (Siqueira-Gay et al., 2020). The exploitation of natural resources becomes unavoidable and increasingly massive (Baskara et al, 2023). The existence of mining activities has brought risks to the environment both physically and socially (Siqueira-Gay et al., 2020), not only threatening humans but all living things on earth (Siqueira-Gay et al., 2020). The greed of some business actors not only damages the environment but often creates conflicts (Kemp et al., 2011) between civil society, companies, and the government (Ansahar, 2014). The mining advocacy network (JATAM) noted that 45 conflicts occurred in 2020 and led to environmental damage covering 714,692 Ha. The causes of conflicts were dominated by land grabbing and criminalization of local residents (Rahma, 2021). Even worse, as released by the Australian Ecological Economics study center, Indonesia is a country that has experienced the most severe damage to tropical forests, namely 58.2% deforestation (Arif, 2022). Muh Jamil as the Legal Division of JATAM said the increase in the number of conflicts due to mining activities cannot be separated from several root causes, such as residents' fear of environmental damage, terror and criminalization of local residents, termination of employment, and land grabbing by companies (Rahma, 2021).

So far, studies on Strategic Mining Plan Optimization focused on three main issues: land dispute-related conflicts, the economic benefits of mining products, and impacts on the environment. Ma'rifah et al. (2014) in their research report showed that mining contains disintegrating forces in society and is destructive against the environment. Nisra and Surdin (2016) revealed that the community around the gold mine in Wumbubangka village was good in social and economic conditions. Meanwhile, Baskara et al. (2023) pointed out that mining at Camang Hill has decreased the function of the hill as a catchment area. Such a phenomenon was inseparable from mining activities that had been carried out illegally for years. These three research reports indicated that the studies of mining politics missed out on ways to manage mining, bringing the community to suffer from damage and conflicts. In fact, we should pay attention to how to manage mining to minimize damage.

This study addresses the previous neglect of mining management's importance in mitigating environmental damage, which can lead to issues like community rejection, ecological threats, and pollution. It also examines why mining activities often result in conflicts and community opposition. Findings reveal key reasons, including the absence of mining area zoning regulations, problematic transport routes, and lax regulation of operating hours. This knowledge can assist policymakers, academics, and students in understanding the causes of conflict and rejection in Lumajang's mining politics.

The sand mining in Lumajang lacks sustainability, as it fails to balance economic, social, and ecological dimensions, a fundamental goal of sustainable development. Economic aspects aim for increased income, social aspects focus on peaceful coexistence, and ecological elements aim for ecosystem preservation. Unregulated mining area zoning and troublesome transport routes harm the community through road damage, air pollution, noise, and traffic disruptions. This research is vital in addressing problematic mining activities that lead to conflicts and community resistance, ultimately striving for sustainable development to meet both present and future needs.

Theoretical Reference Framework

2.1 Environmental Degradation

Environmental degradation is a series of events caused by a decrease in environmental quality or environmental carrying capacity caused by humans or nature (Li & Reuveny, 2006). It can be caused by activities, such as development, mining, or pollution due to exploitation (Wang et al., 2008). In utilizing nature, humans sometimes do not pay attention to the impacts that may occur, thus causing changes in the quality of the environment. Environmental degradation is a significant threat to human health worldwide (Li & Reuveny, 2006). The harmful consequences of environmental degradation on human health are already being recognized and can grow significantly worse as long as it occurs due to improper use of land and contaminating chemicals, which are not the original components of the environment. Environmental degradation arise from worldwide industrial production activities, leading to environmental pollution (Sari et al., 2018)

Environmental degradation can also occur as a result of land and soil exploitation processes, as what happens in the mining process of tin, gold, and coal (Maksum et al., 2021) and exposure to pollutant substances (pollutants) that can interfere with environmental balance (Maksum et al., 2021). Pollutants are generally coming as a side effect of human activities in development. Based on the type, pollution can be categorized into four: air pollution, soil pollution, water pollution, and noise pollution. Air pollution is caused by, among other things, smoke from combustion products, especially fossil fuels (oil and coal) generated by motorized vehicles, factory machines, aircraft engines, or rockets.

2.2 Sustainable Development

In order to fulfill human wants and aspirations, sustainable development attempts to increase welfare of the population (Syofiarti, 2022). According to Kirkby et al. (1995), the main goal of sustainable development is to achieve an equitable distribution of development across generations. Three criteria, namely (1) the absence of wasteful use of natural resources and depletion of natural resources; (2) the absence of pollution and environmental impacts; and (3) the presence of activities that must be able to increase useable or replaceable resources, can be used to assess the sustainability of development, which generally places more emphasis on the economic aspects. Additionally, sustainable development aims to raise living standards without harming the ecosystems that sustain people's existence (Priyanto et al., 2022). Sustainable development is now widely accepted.

According to the aforementioned idea, intergenerational equality refers to efforts to achieve an equitable distribution of development outcomes across generations. According to Bian et al. (2010), the use of natural resources should be for the purpose of promoting growth while respecting reasonable controls on ecosystems or environmental systems, focusing on replaceable natural resources, and minimizing the exploitation of non-replaceable resources. Attempts at sustainable development also involve safeguarding the preservation of natural resources and the current environment, preventing ecological disturbances, and ensuring a high standard of living for future generations.

Method

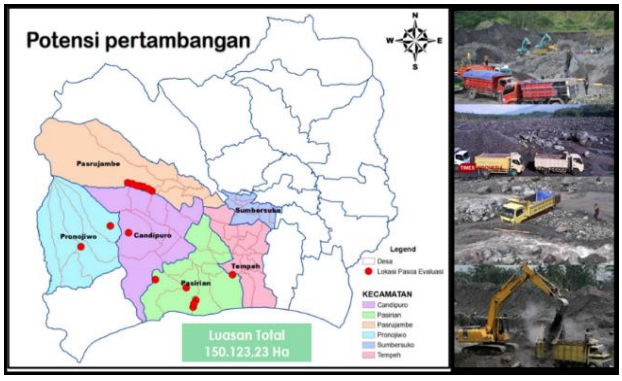
This study employed qualitative research, focusing on open communication, in-depth exploration, and respondent motivations and feelings (Sari et al, 2022). Primary data came from interviews with informants, while secondary data were sourced from previous research reports. Structured interviews were conducted using predetermined questions.

Informants were selected through purposive sampling based on their direct involvement with mining activities and key information. The data collection process involved meetings with informants, allowing the researcher to hear their complaints and understand their emotional states. Data analysis followed an interactive model involving data collection, reduction, presentation, and drawing conclusions (Miles et al, 2014). Data triangulation was utilized to enhance data accuracy and trustworthiness by cross-verifying information from various perspectives, reducing bias and ensuring reliable conclusions.

Results

4. 1 Mining Area Zoning

Figure 1. Sand mining area in Lumajang Regency



Source: Lumajang in Figures (BPS of Lumajang Regency).

Optimization of mining management is an important and strategic matter for managing mining activities. Mining area zoning must comply with procedures and rules to avoid damage. In Lumajang Regency, failure of zoning can have fatal consequences and cause conflicts of interest in terms of land use. This turmoil can disrupt social and environmental stability. The parameters used in zoning should be determined before analysis to determine priorities in creating sustainable development to ensure that the mining activities comply with existing procedures and rules. Zoning often causes uproar in the community and becomes one of the complaints of local residents, as stated by one of the informants as follows:

"Such an arrangement needs to be done because the entry and exit of vehicles from the mine site endanger residents; It's a river basin. Mine transportation equipment that passes through village roads also damages community facilities and infrastructure. There needs to be an implementation of a market system, such as stalls, where people can buy in one or two determined places."

This statement shows that the determination of mining zones was often ignored, as what happened in Lumajang Regency. There was no clarity about which areas were legal for mining and which ones were not. As a result, the local community as the most affected people gave an unfavorable response. The regional government should be able to determine two limiting factors: internal limiting factors (Geology, Hydrogeology, Environment, Economy) and external limiting factors (Public Facilities, Policies, Population) related to zoning. The results of sand mining in Lumajang Regency and the zoning process for mining activities, hence, need special space allocation in the regional spatial plan for the creation of sustainable development. Mining area zoning is critical to determine the potential and impact of mining activities in a comprehensive manner as a parameter of whether mining can be carried out or not to be granted a business permit. The arrangements for mining area zoning can be used as input for the Lumajang regional government to develop a Regional Spatial Plan (RTRW) and make it easier for investors to invest in the mining sector in Lumajang Regency.

4.2 Mining Transport Route

The authority to regulate the use of public roads for sand mining hauling activities has become problematic in Lumajang District. A solution for solving the turmoil in the community regarding the permit for the authority to transport sand mines in Lumajang Regency is needed. Roads are the most important transportation infrastructure in supporting the movement of mining products in Lumajang Regency as the main transportation route in the movement of goods from one place to another. Therefore, the availability of good road transportation facilities is an absolute requirement that must be met by all regions in Indonesia. The role of roads for the transportation of mining products concerns the nature of the livelihoods of many people and controls the regional development structure at the national level, especially regarding the realization of inter-regional development. Having the rights to control roads, the government as the power holder has the right to organize roads in general. Road management must guarantee the implementation of the role of the road based on regional spatial planning by paying attention to local residents so that making arrangements related to mining routes can prevent turmoil in the community due to the traffic of mine transport cars which often disrupt the activities of local residents. One of the informants affected by mining activities stated,

"Mining traffic safety issues are no less important than the legality of mining permits, sir. This is really everyone's hope. Because of the dense sand traffic, accidents often occur; district roads and village roads were damaged. Once a special mining road was built, but that still didn't change the situation. Well, that's what worries us all, not only the regent, including the people, school children, and others on densely populated streets. There are lots of big trucks going round and round at high speed that can endanger residents."

Implementing mining product transportation routes requires community involvement for approval, even though the government oversees this process. Every mining business needs an agreement with local residents to prevent conflicts when using public facilities like roads. Roads, crucial for many people, hold significant social importance, and their administration should prioritize the public interest. This aligns with the road law's purpose of facilitating public traffic.

The need for mining transport routes in residential areas arises from potential risks and impacts on residents' well-being and safety. These routes raise concerns due to safety hazards posed by large, heavy mining vehicles, particularly for pedestrians, cyclists, and children in busy residential areas. Additionally, the constant movement of mining trucks creates noise and air pollution, disrupting the peace of residential neighborhoods and affecting residents' quality of life while also posing health risks.

Mining transport often leads to the generation of dust and particulate matter from the movement of materials. This can become a significant concern for nearby residents, as the fine particles can cause respiratory issues and reduce air quality in the neighborhood. The heavy traffic of mining transport can cause damage to residential roads and infrastructure. The constant vibrations and weight of the vehicles can lead to road deterioration, affecting the safety and longevity of the roadways. The presence of mining transport routes near residential areas can negatively impact property values. Potential buyers may be deterred from purchasing properties in areas with industrial activities, leading to decreased demand and lower property prices. The constant flow of mining transport can disrupt the normal routines of residents. The noise, traffic congestion, and air pollution can create stress and inconvenience for people trying to go about their daily activities.

Mining transport vehicles are at risk of accidents or spills, especially if they are carrying hazardous materials. Such incidents can lead to severe consequences for residents and the environment. Introducing mining transport routes in residential areas can result in conflicts with existing zoning regulations and land-use plans. This can lead to legal disputes and hinder the development of more appropriate and safer transportation routes. The expansion of mining transport routes in residential areas may involve clearing forests, disrupting natural habitats, and causing environmental degradation in the surrounding regions. Addressing the urgency of mining transport routes in residential areas requires careful planning, community engagement, and the implementation of appropriate safety measures and environmental regulations. Sustainable urban planning and the use of alternative transportation methods can help alleviate the negative impacts on residential communities and promote a healthier and safer living environment for residents.

4.3 Operating Hours Setting

The local government's policy of granting mining permits to entrepreneurs/investors must consider the determination of operating hours to avoid exploitation of natural resources and the health of workers, disruption of the activities of the local community, and danger to their workers. The noise generated by the unregulated activities of cars transporting mining products will greatly disturb local residents. Setting the operational hours of mining activities is carried out to improve the quality of life without compromising the ecosystem. Therefore, it is necessary to control to reduce the negative impacts. The regional government needs to be present to take care of the implementation of operating hours arrangements, bearing in mind that the regulation of mining operating hours must be balanced with compliance with the provisions of the applicable laws and regulations. In fact, the operating hours setting that has been done is still often complained about by local residents who are often disturbed by mining activities, as stated by one of our informants in the field.

“There is no clarity regarding the hours of operation. There are even activities carried out at two in the morning. This is what people are worried about. Lots of trucks pass by at

night. Previously, only one or two container trucks are active at night; now, many are active. The diversion of the mining car traffic route is just a matter of diverting the damage; roads that used to be good are now in disrepair. This has a big impact, such as accidents, air pollution, and dust; not to mention the dust covering sewers that cause flooding in the streets."

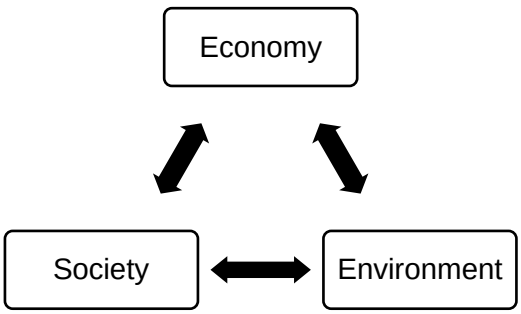
Lumajang Regency, which is rich in natural resources in the form of sand which comes from the volcanic activity of Mount Semeru, must certainly be prepared for all the impacts resulting from the convenience it provides in terms of granting permits. It has at least 6 (six) districts that have sand mining potential, with a total mining area of 150,123.23 ha. From 2018 to 2022, 17,376 workers worked in the sand mining sector spread across the Districts of Pronojiwo, Candipuro, Pasirian, Tempeh, and Pasrujambe. Such a figure shows that sand mining activities have a great impact on the lives of the people of Lumajang. Based on the existing problems, setting the operational hours of sand mining activities needs analysis to obtain standards to create a good governance policy. Important inputs are needed in making environmental management policies in Lumajang Regency in order to realize a sustainable sand-mining management model.

Discussion

Careful zoning in mining areas is crucial for optimizing development and spatial planning to prevent environmental degradation. Mining activities often have adverse environmental impacts, such as altering river basins, causing damage to infrastructure, riverside habitats, and reducing water absorption capacity. These activities also impact water quality, groundwater, sedimentation processes, and ecosystem characteristics. Therefore, special attention should be given to mining area zoning in Regional Spatial General Plan preparation.

Sand mining in Lumajang Regency leads to complex socio-environmental and economic problems, including social and economic inequalities, environmental conflicts, policy inconsistencies, institutional coordination issues, road damage, tax evasion, conflicts between manual and heavy equipment miners, and unstable sand prices. Addressing these issues requires environmental preservation policies and aligning with sustainable development principles, which emphasize balanced economic, sociocultural, and environmental development as mutually reinforcing pillars. Sustainability involves utilizing natural resources in a way that preserves their functional capacity to benefit human life without extinction or damage.

Figure 2. The linkage of three aspects in sustainable development



In addition to mitigating environmental degradation, strategic mining plan optimization is also an effort to support the achievement of harmonious and balanced spatial planning by considering various aspects, such as environmental, socio-cultural, economic, and others. This step is taken as an effort to create sustainable development. An important aspect of sustainable development is the emphasis on participatory processes. The emphasis in creating sustainable development is how to include various stakeholders in determining

what needs to be done and how to do it, including development policies that require the connection between the central government and local governments to create a unified program and policy synergy in governance. According to the aforementioned idea, intergenerational equality refers to efforts to achieve an equitable distribution of development outcomes across generations. According to Bian et al. (2010), the use of natural resources should be for the purpose of promoting growth while respecting reasonable controls on ecosystems or environmental systems, focusing on replaceable natural resources, and minimizing the exploitation of non-replaceable resources. Attempts at sustainable development also involve safeguarding the preservation of natural resources and the current environment, preventing ecological disturbances, and ensuring a high standard of living for future generations.

Environmental management involves a comprehensive approach to safeguarding environmental functions. It encompasses policy, planning, utilization, upkeep, restoration, oversight, and control, all with strategic significance. Environmental management policies are particularly vital in addressing development challenges faced by emerging nations in a state of continual transformation, requiring sustainable development. The core aim of sustainable development is to harmonize economic, socio-cultural, and environmental dimensions, acknowledging their interdependence. It contrasts with older development paradigms that prioritize economic growth while neglecting socio-cultural and environmental concerns. Embracing environmental responsibility can enhance a company's reputation, driving better corporate governance, boosting market competitiveness, and increasing overall company value, thereby fostering future growth and sustainable development (Tseng in Rizki & Hartanti, 2021).

Sustainable development acknowledges the existence of flexible limits dictated by societal and environmental factors. The advancement of technology and human capital can facilitate sustainable economic growth. Sustainable development emphasizes the sustainable utilization and preservation of natural resources and ecosystem functions for present and future generations.

This shift from exploitative to enriching practices is essential for protecting natural resources and ensuring economic, social, and environmental well-being. Unlike resource exploitation with short-term gains but long-term environmental harm, science and technology can increase the long-term value of biological resources. Furthermore, sustainable development equalizes the importance of economic, social, and environmental factors, moving away from economic dominance.

Conclusion

Sand mining activities in Lumajang Regency have implications for many sectors of life. The dynamics that occur require stakeholders to be swift in overcoming various problems. Sand mining is one of the mining sectors that continues to grow along with the economic growth of the region in which it takes place. In Lumajang Regency, economically speaking, the contribution of sand mining is very significant. However, it also threatens the lives of local people with environmental damage, air pollution, floods, road damage, accidents, and others. Optimization of strategic mining plans is one of the efforts to mitigate environmental degradation in realizing sustainable development. Mining that exploits natural resources and does not pay attention to aspects of environmental sustainability will eventually endanger all living things. Therefore, it is necessary to have regulations related to mining zoning and activity restrictions to prevent exploitation. This is a challenge for the government of Lumajang Regency to make connections between sand mining activities while still paying attention to environmental conditions. The implementation of mining activities must involve the local community because they are the parties who feel the most impact from mining activities.

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