Detecting the Strategy of Those Who Left Behind

(Study on Landscape Transformation Triggered by Andesite Mining Activities in Batujajar Village, Bogor Regency)

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Abstract. Landscape transformation could be trigerred by external or internal factors, even the orchestration of both. This article takes the setting of a village that is undergoing transformation due to the presence of mining exploitation activities. This exploitative-destructive mining character causes the village to experience very significant changes in various aspects of life. The social group that vulnerable to these circumstances is farmers as the agricultural land has declined due to mining use. The focus of this writing is about how do the farmers survive the onslaught of these activities. The aims of the research are analyzing land-use changes in the last 20 years, identifying the condition of agriculture land caused by mining activities, and figuring out agriculture adaptation patterns developed by farmers. The method applied were in-depth interview, conducted structured interviews with farmers, and organized FGDs with the community leaders. There were 30 respondents involved, while the FGDs was conducted once with the community. The results show that in areas with minimal agricultural support facilities, farmers adaptation patterns are shaped by their resources and ability to develop resilience. When the main household income is agriculture, the resilience is limited and recovery process is challenging. Meanwhile, when a household has many income alternatives, they will optimize the capital they possess to maximize the economic value of agricultural land.

Keywords: adaptation strategy, farmer vulnerability, landscape transformation, mining

1 Introduction

Rural areas are undergoing significant transformations influenced by multitude factors, primarily driven by urbanization, industrialization, and changes in socio-economic structures. The correlation between these transformations and various interests can be understood through a comprehensive analysis of the dynamics at play. One of the primary drivers of rural transformation is urbanization especially when urban centers expand and rural areas experience shifts in population dynamics. Another factors are the growth of internal population in the city and the mobility of rural people to city area through migration process. Those mechanisms create the need for land increases due to in-migration and to meet the needs of facilities of the cities [1]. The increasing mobility of populations, coupled with advancements in technology

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and infrastructure, has facilitated these changes, leading to a reconfiguration of rural spaces and their functions [2]. Moreover, the economic restructuring that accompanies urbanization plays a crucial role in rural transformation. As industries develop and diversify, rural areas are compelled to adapt their economic bases from traditional agriculture to more varied economic activities, including non-farm employment and tourism [3].

In addition to economic factors, environmental considerations are increasingly influencing rural transformation. The interaction between natural environments and human activities shapes rural development trajectories. For instance, the sustainability of agricultural practices is critical as rural areas face challenges such as land degradation and resources depletion [4]. One of the causes that has a rapid impact on land transformation is the entry of mining investment.

The transformation of landscapes due to mining activities presents a complex interplay of economic development and environmental degradation, particularly impacting agricultural communities. Mining companies often engage in extensive land alteration to extract valuable resources, leading to significant changes in land use and ecological balance. This transformation is not merely a physical alteration of the landscape; it has profound implications for local farmers who rely on the land for their livelihoods. As mining operations expand, they encroach upon agricultural lands, reducing the area available for farming and increasing competition for land use, which can exacerbate food insecurity and economic instability for these communities [5], [6].

The economic theories surrounding mining and agriculture suggest that while mining can stimulate local economies, the long-term consequences often include detrimental effects on agricultural productivity and sustainability. For instance, studies indicate that mining activities can lead to soil degradation, water pollution, and displacement of farming communities, which collectively threaten the viability of agricultural practices [7]–[9]. Moreover, the disruption of local ecosystems can result in altered hydrological patterns, further complicating agricultural activities and diminishing crop yields [10], [11].

In regions where mining is prevalent, farmers frequently face the dual challenge of adapting to changing environmental conditions while contending with the socio-economic pressures imposed by mining operations. The loss of arable land not only affects food production but also leads to increased poverty and social unrest among displaced communities [12].

According to discussions above, it is clear that the community groups most at risk due to land transformation are those who are developing land resources-based livelihoods (one of them is farmer). When the natural landscape is disturbed, the function of the land will change and the farmer have to adapt in utilizing land. This research mainly focusing on the impact of stone (andesite) mining activities on two aspects namely; the condition of agriculture land and figuring out agriculture adaptation patterns developed by farmers. The main driven of those circumstances is the presence of andesite mining activities in the area previously utilized by agriculture. To going deep into the explanation, the research questions are; 1) how does the landscape changing take place in mining activities area, 2) how does the impact of the existing of mining activities on agricultural land, and 3) how does the farmers develop their strategy to response the landscape transformation. According the research questions, this paper aims to reveal the impact of mining activities on the decline in agricultural land function in the village and what adaptation strategies are developed by farmers in responding the landscape transformation. By focusing the correlation between the landscape changing on physical aspect

of the environment and the socio-economic on social community we are able to analyse the ability of specific group in developing the livelihood strategy.

2 Research Methods

This research was conducted in Batujajar Village, Cigudeg Subdistrict, Bogor Regency, West Java. The location of the research was determined with the consideration that in this village there are mining locations spread across 14 spots only in 20 years and encroach on almost all dry land farming on the hills owned by local people.

The conversion of hills into andesite mining use causes the drying up of village water sources which disrupt irrigation. This situation causes rice fields to experience a decrease in productivity. This condition leads to need for various approaches. The farmers in this locus study carry out various responses according to their own abilities. Those two aspects are crucial consideration in choosing research location.

Meanwhile, the drought due to disruption of the irrigation system causes land to become uncultivated and then experience conversion due to land ownership transfers. When economic needs become more urgent while rice fields are no longer productive, farmers choose to sell their land. In the midst of the openness of the village due to the presence of mining activities, agricultural land is increasingly easily converted. This especially occurred to meet the needs of settlement. The presence of immigrants, both as mining workers and as an indirect impact of the presence of mining activity has caused the agricultural land to be transformed into housing purpose.

This study used primary and secondary data. The primary data in this study were obtained by qualitative and quantitative approaches. The method applied was the exploratory sequential method. This method allows researchers to first apply qualitative research before moving on to quantitative methods. In the qualitative stage, the research methods used were Focus Group Discussion (FGD) and in-depth interviews. The results of qualitative information were then processed to obtain an explanation of certain concepts to then be derived into research variables. Furthermore, the quantitative method was applied by providing an instrument in the form of interviews assisted by a list of questions. There were 30 respondents that involved in this research. The criteria for selecting respondents were those who had been engaged in agriculture before mining entered but still exist on the. Meanwhile, secondary data obtained from several sources such as journal, prosiding, the government report, etc. The data obtained were then analyzed using a descriptive method. Descriptive analysis was used to determine the knowledge of farmers on landscape transformation, its impact on land degradation especially agricultural, and the adaptation strategies carried out. The study was conducted from May to June 2022.

3 Results and Discussion

Local Landscape

Administratively, Batujajar Village is located in the Bogor Regency area, West Java Province. However, the distance from DKI Jakarta (the capital city of Indonesia) is only around 40 km, closer than the distance to Cibinong (the capital city of Bogor Regency) which is 73 km. The

altitude of this village is 300-400 meters above sea level so the weather tends to be hot even though the landscape is dominated by hills.

The area of Batujajar Village is 860.86 hectares and the smallest area is in Cigudeg District. The regional organization is divided into five hamlets with a total of 12 neighborhood units (RW) and 27 neighborhood units (RT). Batujajar Village share borders with villages that have similar characteristics, especially in developing local livelihood system namely living from the mining sector with unsufficient agricultural land, especially rice fields.

The landscape is a dynamic system that depends on the action of natural forces as well as type of human activities to modify its structure and function in diverse directions [13]. Many natural action that cause landscape change such as earthquake, tsunami, eruption, and many more. Batujajar village was selected as a research location since the arising of mining corporation leads landscape transformation. So the primary landscape change in Batujajar village is human driven.

This transformation was started by the land transfer process that took place in 1980 and rise gradually until 2000 while opening process for mining activities began in 1990. Before 1980, this village was a source of local fruits. The forest was planted with various wood, bamboo and various local fruits that becomes significant income for the local people. Unfortunately, since 1990, the companies transform the land they owned for mining activities and transform the purposes of the land. Since 1985 mining corporations expand their investment to fulfill the material demand that supported the business property. The corporations opened fertile land and transform into andesite mining area (*tambang galian C*). In the era of property growth, this material plays important roles to support building material.

Referring to the land use map in 2022, the highest use is land use for mixed gardens at 51%. Interestingly, these mixed gardens are mostly located in hilly areas that are no longer owned by residents. Some information states that residents borrowed land owned by the company as a location for intercropping. Most of vegetation planted in that area are sengon (wood commodity) with bananas, cassava, corn and other annual crops planted under the main crops. Even though there is an opportunity to access the land, since the land ownership is not belong to the local people, the people who plant the area do not have any control to the land.

Based on local land use, there are vary purposes of the land. Table 1 displays data on mixed agriculture which occupies the largest area. Meanwhile land use for mining purposes occupies the second top position. The conditions obtained from satellite imagery shows that not all of this land has been opened for mining and still have wide variety of vegetation. However, land with mixed garden does not necessarily indicate that the land is owned by local residents. Further investigation shows us that the land identified as a mixed garden is land owned by the company. Conditions appear to be changing soon when companies open land for mining activities. Detailed land use data appears in Table 1.

Table 1. Land use areas in Batujajar Village in 2005 and 2022

No	Land Use	2005		2022	
		Size (Ha)	Percentage (%)	Size (Ha)	Percentage (%)
1	Mixed Garden	567.81	63.18	395.40	44.00
2	Plantation	64.95	7.23	64.95	7.23
3	Brick Industry	-	-	2.29	0.26
4	Settlement	29.94	3.33	43.97	4.89
5	Mining	17.43	1.94	200.44	22.30
6	Poultry	0,.7	0.08	-	-
7	Paddy Field	217.46	24.20	190.90	21.24
8	Education services	0.46	0.05	0.77	0.09
	Total	**898.73**	**100**	**898.73**	**100**

Table 1 provides the information about the land use change compared between 2005 and 2022 and the changing of number of areas for each land use. The significant area that increased is mining area. In 2022 almost 25% of total village is utilized for andesite mining purposes. In 2005, the area that allocated for mining is only 17.43 ha, that increase significantly to 200.44 ha in 2022. Meanwhile the area of paddy field has decreased due to housing needs or have been transformed into mining area. The significant number of areas that changing is also showed by the area utilized by mixed garden from 567.81 ha in 2005 to 395.40 in 2022. The decreasing of area of other function influences by the presence of mining.

Degradation of Agricultural Land

The ecological crisis characterized by widespread ecosystem degradation and collapse is a pressing global issue that threatens biodiversity, human health, and the stability of natural systems. The concept of ecosystem collapse is complex and multifaceted, often defined as a significant transformation in ecosystem identity, loss of defining features, and potential replacement by novel ecosystems [14]. This phenomenon is driven by various anthropogenic factors, including climate change, habitat destruction, and alterations in species interactions, which collectively exacerbate the vulnerability of ecosystems and sociosystem. For farmers, the most impactful crisis is when the function of rice farming is disrupted and productivity decreases.

Along with land transformation process, Batujajar experiences a decreasing of environmental quality, especially in the agricultural sector. This happens as a direct or indirect consequences. Hill area that that had been transferred to mining company began to be cleared and mining activities began operating since 1990. This condition caused the hill's function as a water source tend to disappear. Rivers dry up and irrigation systems become disrupted. This causes rice productivity to decrease drastically. Figure 1. shows that the river flow has decreased and only leaves a small amount of water. This condition is very extreme when compared to the condition before 1980. As an impact, paddy field dry up and turn into dry land which no longer allows rice to be planted (Figure 2.)

Fig. 1. River shortage

Fig. 2. Unproductive land

As an agricultural village, the main livelihood of the majority people is in agricultural sector. In this point, water takes a significant roles. Rivers that originate from the mountains fill the river discharge. Rivers played an important role for the basic needs of residents, especially for bathing, washing, and toilets. Rivers are also a source of irrigation for residents' rice fields. Currently, after the mining activities spread all over the village, there are two main issues related to the condition of the river: shallowing and pollution. Mining activities at several points in the river flow, especially in the upper reaches of the river, bring solid material that causes river sediment to thicken. This increasingly sandy river disrupts the management of rice field waters and ends up with the river that no longer functioning as a source of irrigation.

Rivers that are increasingly shallow (Figure 1.) and polluted due to mining activities have also become the cause of the water crisis. Residents experience difficulties in obtaining water for their daily needs. This is because some of the Batujajar people still rely on the river to meet their needs such as bathing, washing and toilets. This condition is further exacerbated by the fact that the community's wells have also been polluted along with increasing mining industry

activity in Batujajar Village. As a result, the people of Batujajar are forced to spend extra money to meet their daily water needs. Table 2 shows the condition of water availability and quality before and after mining.

Table 2. Water availability and quality.

Time	Condition	Amount	Percentage (%)
Before Mining	Many water springs with fast flowing	21	70
	Water quality: clean	9	30
	Total	**30**	**100**
After Mining	Water springs almost disappeared	24	80
	Water quality: dirty	6	20
	Total	**30**	**100**

Based on Table 2, majority respondents agree that before mining activities were carried out, the village had a high number of water springs with high quality of water. In contrast, in 2022 majority respondents assessed that the current condition of water is dry and dirty. Based on in-depth interviews with the respondents, the decreasing quantity and quality of water is caused by the conversion of mountains and hills from agricultural function into mining purposes.

Low water availability significantly disrupts agricultural functions. The rice fields do not receive a water supply so they become barren and cause economically valuable plants to not be able to grow. As a consequence, agricultural land becomes unproductive (Figure 2.). Since 2018, most of the rice fields can no longer be planted. In fact, agricultural productivity before 2018 could reach 7-8 tonnes/ha and was sufficient to meet the food needs of local residents.

Through interviews with local agricultural figures, information was obtained that clean water was increasingly difficult to obtain. Usually people use water from catchments or springs at the foot of the hills around where they live. After the opening of the hill, this was no longer possible. This situation gets worse during the dry season when many rice fields can no longer be planted due to the difficulty of irrigation water.

> "Since 2018 I have no longer been able to plant rice, because there is no water to irrigate the rice fields. And that is experienced by almost all farmers. "The rice fields that can still be planted are in the Curug area because they are quite close to the upstream, so the water can still rise." (Ng)

Adaptation Strategy

In general, Dharmawan *et al.* [14] explains three large groups of livelihood adaptation mechanism strategies, namely:

1. Economic adaptation mechanism: implementing strategies by diversifying income sources, utilizing savings accounts, selling household property (durable goods), and borrowing money from related institutions.
2. Ecological adaptation mechanism: implementing strategies by utilizing natural resources and improving agro-ecological technology.

3. Social adaptation mechanism: implementing strategies by asking for help from the community, utilizing local social ties to support survival, and using social assistance from external sources.

In Batujajar, the adaptation strategy is developed for two types of agricultural land, namely dry land agricultural land and rice fields. These two categories of land have different characteristics. Dry land experiences a sudden change in ownership, but the appearance of the land does not immediately change and remains the same as when ownership was in the hands of farmers. Dry land that has been opened for mining is no longer possible for farmers to cultivate. Meanwhile, land that has been purchased by the company but has not been opened is widely used by farmers to plant several commodities. This planting choice is based on an agreement between the company and residents, residents are allowed to work for a certain period of time until the land is utilized by the company. On this basis, the variety of commodities is adjusted to the duration of time available. Some are planted with hardwood with a short harvest time, some residents only plant secondary crops. On the other hand, rice fields experience a gradual change in condition and productivity following the level of environmental quality in the village.

In contrast to rice fields that ownership is still in the hands of local farmers, the lack of management of rice fields is more due to changes in land quality due to the influx of mining. As a result of mining, the agricultural sector faces water scarcity which is adapted in various ways. One of the strategies developed is applying high technology and innovation so that rice fields can still be cultivated. Farmers with large capital use pumps to raise river water to meet rice cultivation needs. Another strategy is to convert rice commodities into secondary crops. Others choose to plant commodities that only require a small amount of water, such as sweet potatoes, corn, cassava, chilies, etc. Some farmers even leave their land covered with bushes. While water becomes increasingly difficult to obtain, farmers use machines to drain water from rivers and even dig to a certain depth using drills. In order to deal with water evaporation, some farmers apply plastic mulch in the process of cultivating their secondary crops **Figure 3.** For those who leave their land empty, they can fulfill their food needs such as fruit and vegetables by purchasing agricultural products from outside the area because the variety of fruit and vegetable plants available in the village is decreasing.

Fig. 3. Mulch application in unirrigated farming.

In summary, the agricultural adaptation strategies implemented after the introduction of mining can be seen in Table 3.

Table 3. The farmer adaptation strategy to remain in agricultural activity.

Time	Environmental Condition	Adaptation Strategy	
		Hilly-Dry Land	Paddy Field
< 1990	Hilly-dry land and paddy field growth in a normal condition.	Dry land was planted with various vegetation such as wood, local fruits, herbal, and also bamboos	Semi-irrigated rice fields can be planted at least twice a year, while one season is devoted to secondary crops.
1990 - 2010	Three categories ● Several hills were opened for mining. ● The hill is opened and terrace land/red soil is taken. ● The hill is left intact even though the land has changed ownership	The hills that were opened can no longer be cultivated by residents. The unopened mining area is planted with short-lived wood. Intercropping with secondary crops.	Rice fields are still safe to cultivate with productivity still normal. The rice field is planted once with rice and once with secondary crops.
2000 - 2024	Mining activities have increased. The increasing of hill opening.	There was nothing to do on the hill that was already open	The paddy fields are only planted once without secondary crops. Rice fields are planted with rice/other commodities by applying technology. The fields are not planted.

4 Conclusion

The declining on environmental quality was obvious following the introduction of mining activities. Compared to data in 2005, the area of mixed plantations has decreased by around 30.3% in 2022. The same thing happened to rice fields which were originally 217.46 ha in 2005 to 190.9 ha remaining in 2022 or experienced a decrease of 12.2%. Mining also causes the emergence of various ecological crises. The type of crisis that can quickly be identified is the water crisis which causes the destruction of productive agricultural land. The farmer experiences vulnerability both in ecology and also in the social system. The declining on the function of wetland agricultural land has given rise to various farmer responses in the form of adaptation patterns from various community groups. Community groups that rely on the agricultural sector have developed three types of strategies, namely; continuing to utilizing rice fields by increasing investment/capital (providing water pumps to raise water from rivers or applying mulch to reduce evaporation), replacing water-resistant commodities, and leaving rice fields unproductive. The third strategy is implemented so that the farmers do not experience worsening

poverty due to spending money for agricultural expenditure. Those strategies prove that farmers can develop survival techniques under the pressure of mining activities.

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