THE EVOLUTION OF AGRICULTURAL LAND AROUND THE SAND MINING AREA FROM 2011 – 2021 IN LELES DISTRICT, GARUT REGENCY, WEST JAVA

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Abstract. Mining activities can alter land use patterns, including converting agricultural land. The transformation of agricultural land is occurring at varying rates, whether rapid or gradual. The evolution of agricultural land may be observed in terms of its shape, area, and land function. This paper was prepared to determine the evolution of agricultural land due to the expansion of limestone mining in Leles District from 2011 to 2021 to support further research in this area. The data collection process employed a combination of historical Google Earth images, secondary data, and land farm surveys conducted in Leles District, Garut Regency, from 2011 to 2021. The images were then assessed to identify land shape, area, and function changes. Subsequently, the data were subjected to analysis and comparison with existing literature. The study results demonstrate the evolution of the site and the utilization of agricultural land as a consequence of mining development. The expansion of the mining area has resulted in the transformation of the surrounding land into agricultural land. During the observation period, the mining area increased by 98%, while the farming area decreased by 27%.

Keywords: *agriculture; evolution; land use; sand mining*

1 INTRODUCTION

Human activities on the land affect the land in both space and time. This impact can be seen in the form and function of the land. Agriculture and mining are the main economic sectors contributing to the country's income. Mining is divided into two sectors: oil and gas and non-oil and gas. Indonesia's non-oil and gas sector contributed USD 34.11 billion to the country's revenue in January - November 2021. The agriculture sector contributed USD 3.68 billion to the country's income in January - November 2021. Agriculture is the second largest sector supporting Indonesia's economy (Dihni, 2022).

Mining is an extractive activity that takes materials from nature. Mining is the extraction of economically valuable materials from the layers of the earth's crust, both modern and conventional, on the earth's surface, below the earth's surface, and in waters (BPS, 2023). Some natural materials mined include oil and gas, coal, gold, bauxite, nickel, iron ore, manganese, sand, and minerals. Mining activities begin with prospecting, exploring, extracting, and processing mining materials. Prospecting is the activity of identifying potential mining materials in the earth's crust (Wasis, 2020). Exploration is finding, measuring, and calculating mineral reserves at a site. After exploration, the site can be exploited by mining or extracting the available mining materials. Further processing is required to produce quality mining products, such as refining or upgrading (Algunadi, 2013; Wasis, 2020).

Historically, mining took the form of extracting natural materials for the personal needs of individuals and groups and was not legally controlled (DSDM Bantenprov.go.id). Local people still conduct mining conventionally (Siburian, 2015). Many mines have legal

management owners, although many illegal mines remain. Illegal and legal mining still affects the environment (Kaltimprov.go.id, 2018). In general, modern mining is divided into surface mining, underground mining, and marine mining. Surface mining is done by excavating or blasting layers of soil or rock. The material below the surface layer is exposed and can then be mined. In underground mining, material or ore is extracted by exploding the walls of rock formations (Siburian, 2015; Demmallino, 2018).

Surface mining can destroy the surrounding environment, such as giant mine holes (Wasis, 2020). When these holes are abandoned, they cause further impacts such as erosion, soil, air, and water pollution. Flying dust particles from mining activities are dangerous to the respiratory system. Mining exposes sulfide minerals in the soil. This sulfide is washed away and dissolved by rainwater. As a result, the environment is polluted by this runoff. The resulting pollutants can disrupt and damage the ecosystem (Yunus, 2005).

The human activities of growing crops, raising livestock, fishing, and forestry are called agriculture. In a narrow sense, agriculture is the activity of growing food crops. Agricultural activities include using livestock to help grow crops (Lasaksi, 2023). Agriculture is the sector most needed to fulfill the country's food supply, which is related to demographic dynamics (Mardikanto, 2007). The agricultural industry absorbs significant labor (Isbah & Iyan, 2016). The farm sector also supports other industrial activities, such as the food industry. Trade networks can be formed from agriculture. Another reason (Lasaksi, 2023) is that agriculture can provide income for the country, employment opportunities, and income for the community. If agricultural land is reduced, it can impact people's production and revenue.

In Indonesia, there have been several cases of mining expansion into agricultural land. For example, the issue of PT. Adaro Indonesia in Bilas village, Upau district, Tabalong regency. A change in one land use can trigger an increase in another land use and a decrease in the area of the other land use (Hidayat et al., 2015). Mining activities, from exploration to exploitation, will affect the surrounding environment. Mining areas can be found around rivers, hills, mountains, caves, and underground. Sand mining itself can be found in places where there are sand deposits. In Keningar village, Dukun District, Magelang Regency, agricultural land has been converted to sand mining (Wicaksono, 2017). Land conversion occurs because the mineral content is depleted and exhausted, so mining expands into the surrounding area. Another case is in Kerta Buana village, Kutai Kertanegara Regency, where the expansion of mining areas into agricultural regions has resulted in many farmers handing over their land to mining owners (Siburian, 2015). This case poses a threat to the sustainability of agriculture in these places. The Leles district has a topography of hills, valleys, and lowlands. Leles has a limestone sand mine on a hill with lithology in limestone mixed with clay. The location of the mine is right next to the access road between sub-districts in Garut Regency, as well as the access road between the town and the district.

Land use and land change are interrelated. The activities of living things, including humans, on the earth's surface almost always result in land development. Land use means all cyclical and permanent human interventions on the land and its components to meet human needs (Malingreau, 1977). Land use is a general classification of land uses such as agriculture, grazing, forestry, and recreation (Rayes, 2007; In et al., 2016). In simple terms, land use refers to human activities on land to meet their subsistence needs. These land uses can change over time. These changes over time can be referred to as land use change. Land use on the earth's surface is complex, so a classification of existing land use is needed for inventory purposes. Different classification standards, such as the Indonesian National Standard (SNI) classification, are used for land use based on information scales of 1:25,000/1:50,000, 1:250,000, and 1:1,000,000 (SNI, 2020). The land use classification of the National Land Use

Database divides land use into 12 major divisions and 49 classes. There are also classifications from the Ministry of Agriculture and Spatial Planning/National Land Agency regulation and according to spatial planning.

Previous studies on land use change due to mining activities, changes in land shape, area, and function are the effects of mining expansion in agricultural areas (Eko & Rahayu, 2012; Dwiyanto et al., 2021). Landform and area are the most prominent aspects of land changes due to mining expansion. The land function is something that requires further analysis. A change in land function means that previously suitable land has become unsuitable for agriculture or has been converted (Kusumaningrat, 2017). Typically, the area closest to the mine has changed function. Mining sites adjacent to agriculture can disrupt agricultural productivity (Nurry & Anjasmara, 2014; Salim, 2016). Disrupted agricultural productivity can lead to disruptions in food security and food sovereignty. This study aims to determine the evolution of agricultural land use and lime sand mining in the Leles district. The land use evolution looks at the form, area, function, and impact between agriculture and lime sand mining, so the reader or stakeholder could use this study as a reference for planning from the evolution.

2 MATERIALS AND METHODOLOGY

2.1 Location

The sand mining and agricultural areas in Leles District Garut Regency are side by side. Several sand mining areas have been found. The most prominent type of sand mining there is limestone sand mining. This mining, seen in Google Earth historical images, has been going on since 2011 and is becoming more widespread today (2021). The results of this mining are calcareous sand and limestone. Calcareous sand is the main mineral. The mining site that is the focus of this monitoring is located on a hill dominated by agricultural land since before 2011. The hill is on the road's edge, connecting Garut Regency with surrounding districts and towns.

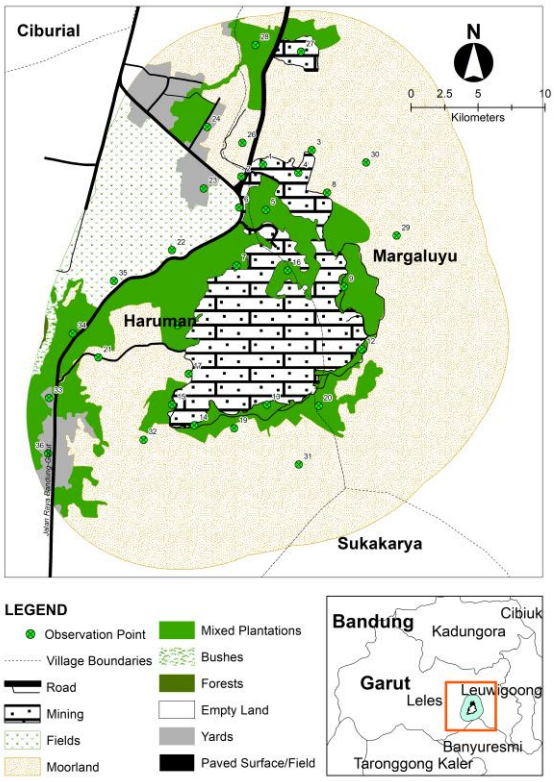


Figure 2-1 Observation Area Coverage.

Leles District has 12 village administrations. The topography of Leles District consists of rivers, swamps, lowlands, hills, and mountains. Several comments in the Google Maps Comments column expressed concern about mining activities. According to Wasis' (2020) research on the ideal growth of crops, the best growth results are found on agricultural land at least 20 meters away from mining areas. According to Paralegal.id, a settlement is part of a residential environment consisting of houses with supporting facilities and infrastructure. Residents live in residential areas, and they serve as field sources. According to Kaltimprov.go.id (2018), the safe distance for mining from residential areas is 500 meters. Considering the distance of 500 meters helps to determine the place to be observed in the field. The study area is below (Fig. 1).

The boundary of the study area is 500 meters from the outer edge of the mining area (Figure 2-1); see Wasis (2020) for the ideal distance of crop growth from the mining area. Within the study area, the mining area is surrounded by agricultural areas. Within the study area, the mining area

is surrounded by agricultural land. The mining area is located directly on the side of Jalan Raya Bandung-Garut's main road. The study covers three administrative regions: Haruman Village, Margaluyu Village, and Sukakarya Village. Sukakarya village is located outside Leles Regency (within Banyuresmi district).

2.2 Data and Methods

The evolution of land use can be seen in the land's form, area, and function, as well as in the interactions among land uses. Landform and area are examined to determine how much agricultural land has been converted to mining land. This amount can be used for analysis in further research, such as the rate of change and others. The land function is to see the land use near the mine. In terms of process, each land has its role. Land conversion can change the part and even the suitability of the land.

The land's shape, area, and function were checked using Google Earth images in 2011, 2014, 2017, and 2021 (Figure 2-2). Monitoring was conducted for each period, and then the image processing results were validated in a field survey in May 2022. In Google Earth, the sand mining area appeared in 2011 but is still relatively small. Therefore, the image of sand mining selected from 2011 to 2021 seemed to be the most recent image data. Image data is downloaded from Google Earth Pro software for each year. Before downloading, the images are marked with 4 reference coordinates as ground control points (GCP) for geo-referencing. The other data used to support this study is the administrative area of Badan Informasi Geospasial (BIG).

Downloaded Google Earth images are interpreted and digitized annually using ArcMap software (Figure 2-3) to obtain data on sites that have experienced changes in agriculture and mining. ArcMap images are geo-referenced, and the coordinate reference system (CRS) is set to UTM (UTM WGS84 Zone 48S) for better digitization. As with the vector layer for digitization, the CRS for the vector layer is set to UTM. In 2011, there was a cloud cover on the image, so to interpret the land use, it was compared to the image years before and after 2011 (using images from 2010 and 2012). The digitization results are land use maps that can be used to see the evolution of land use. The attribute data that completes the digitization results are further processed using Ms. Excel to display statistical information on land use dynamics.

Figure 2-2 Google Earth historical image with the acquisition date each year.

Figure 2-3 Step by step to create evolution map (agricultural and lime sand mining).

3 RESULTS AND DISCUSSION

Results

Evolution of Land Use

The processed data results in a multi-period land use map (Figure 3-1). The land use classification is based on key technical specifications for more detailed spatial planning. The land use of the study area includes agriculture, livestock, open space, and roads. Agriculture and livestock consist of swamps and fields. Open space includes forests, shrubs, mixed gardens, yards, vacant lots, and limestone sand mining areas. Each type of land use has its dynamics.

In 2011, agricultural land dominated land use in the study area (Figure 3-1). To the east of the main road are wetlands, and to the west of the main road are fields. The mining area is visible, but its size is still relatively small. The mining area is located at the corner of the main road intersection. Otherwise, the residential yard areas are clustered along the edge of the main road. The method for determining the research area is to select an area 500 meters from the outer edge of the mining area. The mining area in 2021 was chosen as the reference for determining the distance because the mining area has expanded, and the safe distance from settlements is limited. As seen in 2011, the mining area was still tiny compared to 2021, so the coverage of this research area is not extensive, so other land uses will not be visible within the safe distance limit in the latest year. From 2014 to 2021, the mining area has expanded. The conditions around the mining area are mixed plantations and agricultural land. The surrounding agricultural land has been converted into mining land. Meanwhile, the mixed plantation areas around the mining areas and in the middle of the farmland are increasing. Residential areas have also increased, and new farmland has been added south of the research area.

Processing the numerical data from the image digitization produces the extent of mining and agricultural land use in the study area. Figure 3-2 below shows the mining area, which continues to increase from 2011 to 2021. In 2011, the mining area was 3,840.58 m2, and the agricultural area was 2,320,160.53 m2. In 2014, the mining area increased to 47,187.27 m2, and the agricultural area decreased to 2,016,913.65 m2. The mining area increased about 12 times from 2011 to 2014. In 2021, the mining area will be 337,448.88 m2, and the agricultural area will be 1,692,800.73 m2. The farm area decreased by about 1.37% from its initial position in the observation area.

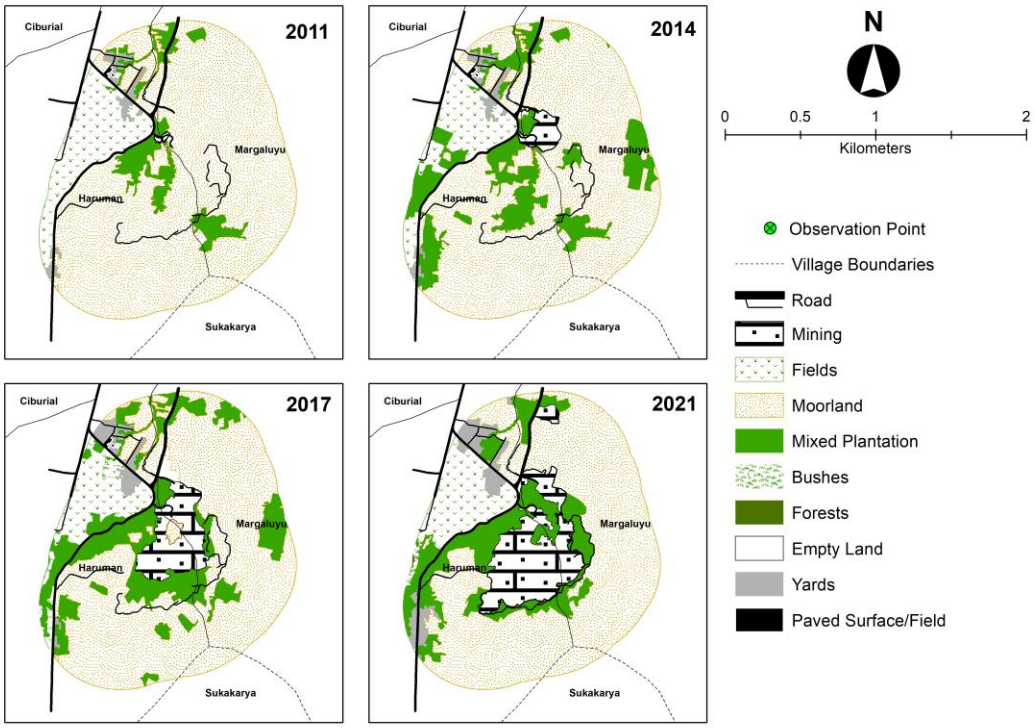


Figure 3-1 Evolution of land use.

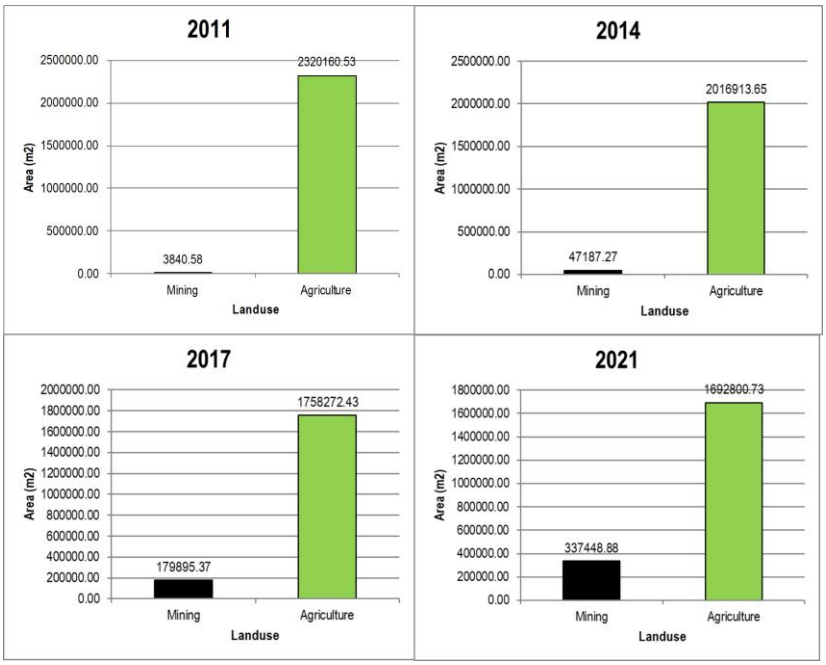


Figure 3-2 Diagram of mining and agricultural areas from 2011-2021.

A field survey was conducted in 2022, showing examples of existing land use. Land changes are visible in 2021 compared to previous years (Figure 3-3). A new sand mining operation has developed in the north. Sand mining uses heavy equipment, such as excavators, on a small hill. The mining area, which has existed since 2011 and will continue to expand until 2021, is also located on a hill. Two hills flank the Bandung-Garut highway. The hill west of the road is green with forest, mixed crops, and fields.

Meanwhile, the hill east of the road is mined. The main crops on the mined hill are corn and tobacco. It borders a mining area. Part of the hill has been excavated to form a cliff, with the top being farmland and the base mined.

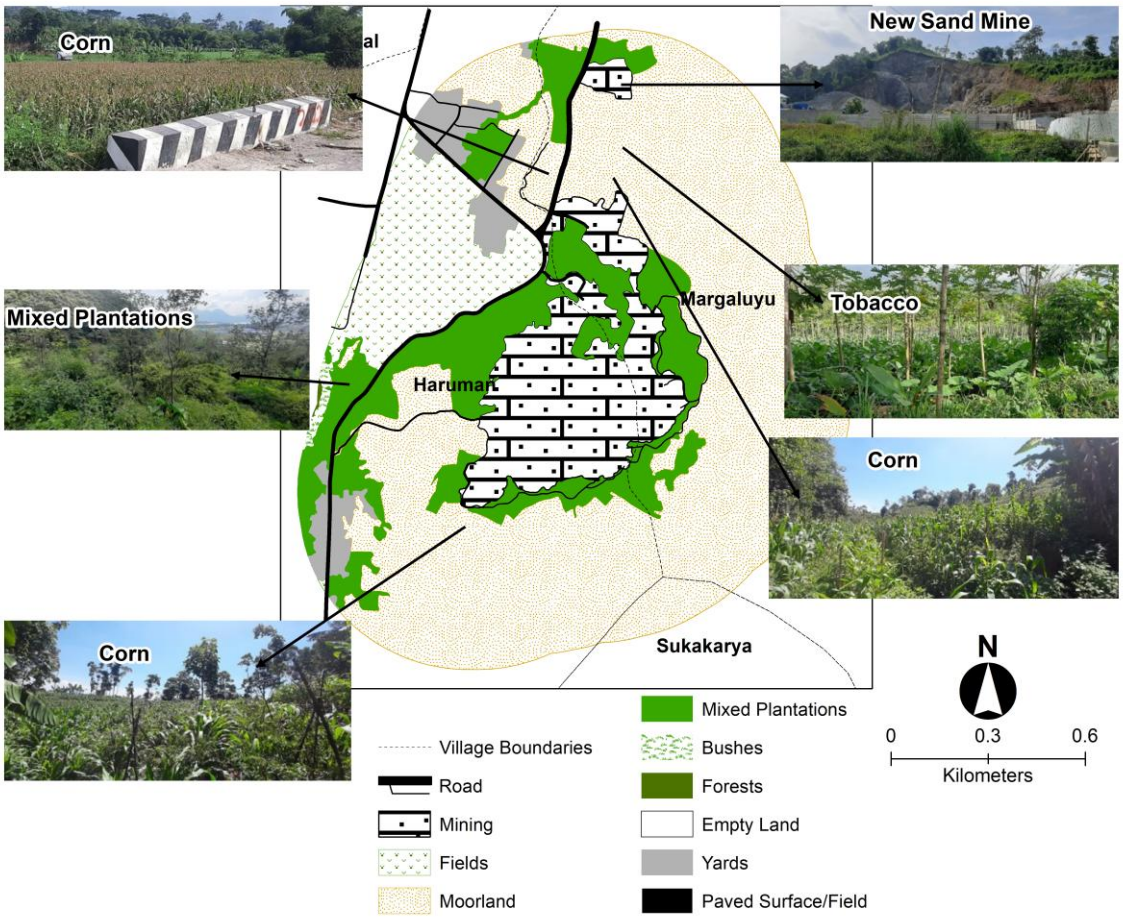


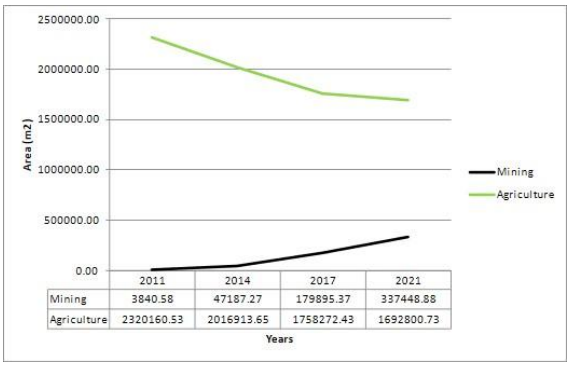
Figure 3-3 Land use in 2021-2022.

The edge of the ridge is still farmland. On the farmland, the hillside planting system in raised beds is used. Fields of chili, papaya, and cassava were also found. The mixed plantations have vegetation cover, such as wild plants and bamboo trees, and some interspersed with agricultural land, such as cassava, papaya, corn, and chili.

Discussion

Evolution of Land Use in Several Villages in the Research Area

The concept of land use is constantly evolving in terms of its form and function. Based on the findings of Hidayat et al. (2015), it can be concluded that changes in one land use can potentially affect other land uses. Furthermore, the gradual nature of these changes means that land use is subject to continuous transformation. The map collection in Figure 3-1 shows the evolution of each land use type in terms of form and function. 2011, the mining area was just a narrow strip at a road bend. Over time, however, the mining area has expanded. Figure 3-1 also shows that the function of the agricultural land around the mining area in 2011 changed to the mining area in the following years. This case is similar to Wicaksono (2017), where sand mining tends to expand into agricultural regions. The magnitude of the changes in farming and mining land is shown in the graph below (Figure 3-4).



	2011	2014	2017	2021
Mining	3840.58	47187.27	179895.37	337448.88
Agriculture	2320160.53	2016913.65	1758272.43	1692800.73

Figure 3-4 Graph of increase and decrease in mining and agricultural land area.

Meanwhile, agricultural land, which initially dominated the land in the hills, has decreased due to the expansion of the mine. According to Pratomo (2010), agricultural land, which should be able to increase regional income, is reduced due to mining expansion. Reducing agricultural land can minimize the regional income from the agricultural sector. Especially in Leles, tobacco is one of the most important agricultural products. Brief interviews with local people in the form of village officials explained the impact of mining on farmland regarding land, people's livelihoods, farmland productivity, and the environment. The findings of this study are similar to those of Salim (2016) and Siburian (2015). Mining sites located near agricultural land will disturb the farmland. The limestone hills were initially used as agricultural land as the primary sector. However, the abundant lime content encouraged mining entrepreneurs to mine the hills. Mining activities produce air pollution in the form of dust from the excavated limestone rocks. This pollution affects not only the air but also the surrounding agricultural land. Agricultural land is contaminated with airborne limestone dust. Dredging can also make the soil less fertile because the dust contaminates it. Farmers have tried to add more fertilizer to their crops, but these efforts are still insufficient. The reduced fertility of farmland and the location of farmland on limestone hills has caused farmers to begin selling their land to mining companies. It is only a matter of time before all remaining agricultural land is converted to mining. Mining continues, and new mining areas have appeared on other smaller hills.

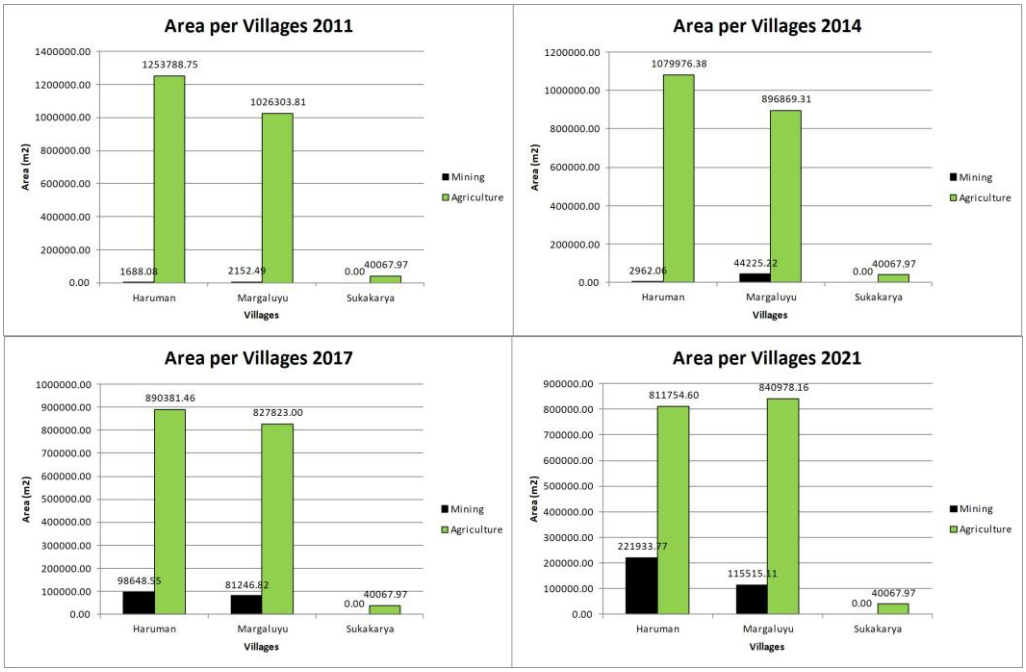


Figure 3-5 Area of mining and agricultural land use per village in 2011-2021.

Three villages in the study area, namely Margaluyu Village, Haruman Village, and Sukakarya Village, show different changes in mining and agricultural land use. The graph in Figure 3-5 shows the changes in the three villages' mining and agricultural land use. 2011 Haruman Village had the highest agricultural land area of 1,253,788.75 m2. Each year, mining continues to expand in Haruman Village and Margaluyu Village. Based on the graph, the farmland of Haruman Village continues to decrease yearly. In Margaluyu Village, the agricultural area in 2011 was 1,026,303.81 m2, which continues to decline to 827,823.00 m2 in 2017. However, in 2021, the area of Margaluyu agricultural land will increase from 2017 to 840,978.16 m2. See explicitly in Figure 3-1. This

increase is believed to be due to the change of mixed crop areas to agricultural land. As for Sukakarya Village, there was no change in land use during the observation period from 2011 to 2021. Only a tiny part of the Sukakarya area is included in the monitoring area, and it is located relatively far from the limestone sand mining area.

4 CONCLUSION

This research aims to determine changes in agricultural land's form, area, and function around limestone mining. Changes in agricultural land use from 2011 to 2021 show a decrease in size. In 2011, the area of agricultural land was 2,320,160.53 m2 to 1,692,800.73 m2 in 2021. Some agricultural land adjacent to mining has been converted to limestone mining, and other land is used for mining purposes. Limestone mining itself continues to increase in area. Since 2011, the area has risen from 3,840.58 m2 to 337,448.88 m2. Looking at the land use in the three villages (Margaluyu, Haruman, and Sukakarya), the extent of land use change is different.

Many agricultural lands have been converted into mining areas due to the expansion of mining. The fertility of agricultural land is also reduced due to pollution from limestone mining. Agricultural land will decrease because mining companies have taken over many agricultural land ownerships. Considering the farm sector as one of the most essential economic supporters, stakeholders must balance existing agricultural resources. This research can be a reference for further research and management planning for rural land to maintain the balance of farming resources amid mining exploitation.

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