EVALUATION OF LIMESTONE MINING ACTIVITIES IN PHYSICAL AND BIOLOGICAL ENVIRONMENTAL ASPECTS AND POST-MINING LAND DESIGN IN BEUMOPU LASIANA VILLAGE, KELAPA LIMA SUBDISTRICT, KUPANG CITY

Elsy Yurienche Lubalu[1], Herry Z. Kotta and Suwari[3]
Environmental Sciences Study Program, Postgraduate Program, Kupang Cendana University
Email: elsylubalu2016@yahoo.com

ABSTRACT

Kupang City has the potential limestone reserves amounting to 139,387,500 m^3 in an area of about 1,032.5 ha, thickness of 15 m, overburden of 10%. The potential of limestone mining can attract the private sector to process mining products to be produced into building materials, brick material and road network materials. Mining and mining operations by entrepreneurs and miners have not followed good planning from the preparation, implementation stage to post-mining land management, so the potential for damage to mining areas is very high. Mining in Beumopu, Lasiana Subdistrict, Kelapa Lima District, is in the vicinity of settlements and schools, which disrupts the environment and learning activities. This study aims to determine the physical and biological environmental damage due to limestone mining activities and provide solutions in the form of post-mining land management design. Research methods in the form of surveys, interviews, and desk study. The results showed that limestone mining caused damage to the physical environment because it caused open land to exceed 20%, namely in the first area 40.19%, the second area 36.50% the third area 23.31%. The first area noise value is 57.89dB (A), the second area is 64.14dB (A) and the third area is 60.94dB (A). The highest important value index in the second area was 47.6%, because it received the largest contribution from the value of dominance and density. The level of damage to open land is 96.7%, including the category of heavily damaged due to ≥40% so that mining activities need to stop mining operations and land restoration through terracing and revegetation.

Keywords: limestone, biological physical environment, post-mining

INTRODUCTION

The Directorate General of Mineral, Coal and Geothermal (2009), states that Indonesia's natural potential is very abundant and various types of mineral resources are contained therein. Considering the non-renewable nature contained in mineral resources, its management needs to be carried out optimally, efficiently, transparently, sustainably, environmentally friendly and just, in order to obtain the maximum benefit for the prosperity of the people. This is also stated in the 1945 Constitution article 33 paragraph 3.

Humans manage and utilize natural resources for their survival. Human activities in managing nature can directly have a positive impact on the availability and fulfillment of the needs and welfare of human life. The positive impact as a source of foreign exchange, a

source of genuine regional income, creates employment. But another thing that also often arises simultaneously or can appear in the future is the negative impact on the use of nature in the form of environmental damage to physical and biological aspects. Human ability is increasingly advanced in managing nature, it is not impossible to cause damage to nature. Moreover, increasing population density, massive exploitation of nature is inevitable. One example of human life needs that is also so important but can damage the environment is mining activities (Juntak, 2015).

Development Planning Agency at Sub-National Level (2012), Kupang City has the potential for limestone reserves in very large numbers, the estimated amount of limestone quarry reserves is 139,387,500 m^3 with an area of land reaching 1,032.5 ha, assuming a thickness of 15m, and overburden of 10%. In general, mining activities in Kupang City are carried out by local communities and local entrepreneurs. Mining activities that are not environmentally friendly can potentially damage the ecosystem, and can cause landslides and soil movement.

The potential of rock mining in Kupang City can attract the private sector to process mining products for production. The mining resources of the mineral mining group in the form of dredged rock class excavated materials are carbonate-based mineral materials, namely limestone, which are used for building materials, brick material, and road network materials. Fulfillment of these raw materials further increases the mining activities of the quarry. Implementation of mining activities by entrepreneurs and miners who have not made good planning from preparation, mining to post-mining land management, the potential for land damage due to mining activities can occur (Najib, 2006).

Research on post-mining environmental damage has been widely carried out by researchers including Wibowo (2006) showing that environmental damage that occurs at the former mining location generally takes the form of loss of fertile soil (top soil) for the growth

and development of standing plants, changes in the capacity of soil infiltration to supplying underground water due to compaction and loss of vegetation, potential for landslides on the walls of the mine, as well as damage to the environment of roads and settlements around the mine.

Mining activities are clearly regulated in the law, but environmental problems continue to occur. This is because the excavation of nonmetallic minerals and rocks is uncontrolled and unsupervised. According to the NTT Task Force, in 2014 as was the case in Kupang City, limestone excavations in Beumopu, Lasiana Subdistrict, Kelapa Lima Subdistrict began to be traded from 2010 to 2017. Even though the area was a residential and school area. The limestone excavation does not have an official permit, let alone environmental documents. That's why the damage to the environment is getting worse. The mine should not be in the vicinity of settlements and schools because it is very disruptive to the environment and teaching and learning activities in schools.

Hasibuan (2006) study results that one of the mining activities causes erosion of topsoil, which is the top layer containing organic material or dark colored nutrients which is the main place for plant growth. Exist mining pits result in unproductive land, during the rainy season mining pits will be inundated with water so that the potential for mosquito breeding can even change on the surface of the river so that it widens which can cause erosion in the watershed.

Observations at the study site indicate that mining activities are more concentrated on how to utilize the limestone quarry as economically as possible, but efforts have not been made to prevent and repair other damaged natural resources. This has a negative impact especially on the comfort of the people who live around the mine due to a decrease in environmental quality (physical and biological components) and ecological damage. The main problems that arise due to limestone mining activities in Beumopu are the loss of flora

and fauna as well as the loss of soil cover as well as changes in morphology and topography, geological environmental conditions also change followed by changes in soil and rock characteristics and soil compaction.

Based on observations of the condition of the mining land at the location in question, it can be stated the following problem formulation:. What is the level of physical and biological aspects of land damage that occur at the limestone mining site in Beumopu, Lasiana Sub-district, Kelapa Lima District, Kupang City, and how to design the management of the post-limestone quarry. This study aims to determine the physical and biological environmental damage caused by limestone mining activities and provide solutions in the form of post-limestone quarry land management design in Beumopu Lasiana Village, Kelapa Lima District, Kupang City.

METHOD

This research was carried out in the Beumopu limestone mining project site area Lasiana Village, Kelapa Lima District, Kupang City. The variables measured in this study are aspects of the physical environment including open land due to mining, treatment of top soil, and noise during production. While aspects of the biological environment include vegetation and terrestrial macro-fauna types. Data collection in this study uses several methods:

1. Survey in the form of observing and measuring areas damaged due to mining activities.
2. Interview method, namely using a list of questions / questionnaire to directly interview the parties related to mining activities and communities around the limestone mining site so that later researchers analyze how mining activities occur and how to overcome them.
3. Desk study, which is a method for obtaining an indicator condition by conducting a study and review of documents and reports from relevant agencies.

In an effort to assess the environmental damage caused by mining at the study site, a variable was used to determine the criteria for assessing environmental damage to mining land based on criteria issued by the Directorate for Recovery of Open Land Damage, Director General of Pollution and Environmental Damage Control of the Ministry of Environment and Forestry in 2015 concerning damage criteria open access land due to community mining activities so that the level of open land damage can be calculated due to limestone mining activities

RESULTS AND DISCUSSION

1. Overview of Research Locations

Beumopu is geographically located at 10 ° 08'49.8 "latitude and 123 ° 40'50.0" east longitude. Beumopu is one of the villages in Lasiana Village, Kelapa Lima Subdistrict, Kupang City, with an area of 54,45ha Lasiana. Administratively, the boundaries of Beumopu are: North: Matani and Penfui; South: Sefbano; West side: Tuak Sabu and East side: Mata Air Village. Beumopu Lasiana has a dry climate with climatic conditions according to the Lasiana climatology station, which is a minimum temperature of 24.32 ^{0}C; the maximum temperature is 32.38 ^{0}C, and the average temperature is 27.66 0C. Minimum humidity is 66%, maximum humidity is 88% and relative humidity is 77.28%. The average air pressure is 1010.64 mb, the average wind speed is 6.5 knots, the rainfall is 1552.40 mm and the average solar radiation is 75.23% (MCGA Kupang Climatology Station, 2017).

2. The existence of Limestone Mining

Mining activities in Beumopu with an area of 708,200 m^2 is not a new activity, the activities began in 2010 by illegal miners even though mining without permission because it was not equipped with a permit. In accordance with Kupang City Regulation number nine of 2012 concerning the Detailed Spatial Plan of the City, one of the requirements for opening a

mine must be in accordance with the spatial area and environmental permit in accordance with applicable regulations. Limestone mining activities in Beumopu occur because many people are asking for/needing the excavation to make settlement roads/alleys around Lasiana Village and meeting the needs of building materials, adobe materials, as well as for leveling the uneven texture of the soil.

Mining in Beumopu Lasiana Village, in addition to exploiting limestone, the forest around the mining area is also cut down, even though it is on the edge of a tributary with a slope of 900. The size of the excavation depth varies, namely in the first area 15-23 m, the second area 7-19 m and the third area 3–28 m. Now all that is left are large gaping holes and damage to the land that cannot be turned into agricultural land. Limestone quarrying in Beumopu, Lasiana Urban Village is owned by individuals located in the border area between the Kupang District and Kupang District, which is used by miners so that it threatens the environment in the Beumopu Area, Lasiana Village. Limestone mining is right behind the 9th High School of Kupang City so there is concern over the landslide of the high school building as a result of mining activities. The equipment used for mining activities is excavators as dredges so that they can change the structure of the soil and the existing ecosystem. The initial reason for excavation of limestone in Beumopu is to level the uneven ground. But the facts on the ground show that the material after being extracted is immediately sold to people in need.

3. Limestone Mining Activities

Mining activities in Beumopu in three areas, with an area of 708,200 m^2 limestone quarry. Land that is used as limestone mining is owned by individuals. Mining activities use modern tools, namely excavators. Limestone mining is carried out almost every day starting at 09.00 - 17.00 central Indonesia time, which is carried out in the dry season and at least the limestone is sold based on erratic consumer demand. Mining activities are found in three

mining areas with the lowest mining intensity in the third area. Mining activities are classified as active in the first and second areas, while mining activities are less active in the third mining area.

Table 1. Extent and Intensity of Limestone Mining

Number	Mining Area with Coordinate point	Mining Area	Large (m^2)	Mining Intensity (%)
1.	I 10°08'44.7"SL 123°40'49.5"EL	I	284.600	40,19
2.	II 10°08'50.3"SL 123°40'50.2"EL	II	258.500	36,50
3.	III 10°08'54.6"SL 123°40'45.5"EL	III	165.100	23,31

The results of observations made at the time of the study, limestone mining in Beumopu is open mining by first removing vegetation and peeling the soil that covers the limestone deposits. Mining activities use heavy equipment to dig. In the limestone mining process, after being excavated in each mining area, trucks are immediately transported to be used according to the interests of consumers.

The results of research in three limestone mining areas in Beumopu show that limestone mining activities in each mining area can have an impact on the biological and physical environment, including on the morphological conditions of the soil. The open mining system applied in the study area leaves post-mining land in the form of gaping holes. Limestone mining activities carried out in Beumopu in three mining areas on average carry out overburden mining placed around the mine area to form mounds of land in each mining area for trucking. With the removal of cover soil, the structure and texture of the soil will be damaged which will result in the soil being unable to store and absorb water during the rainy season.

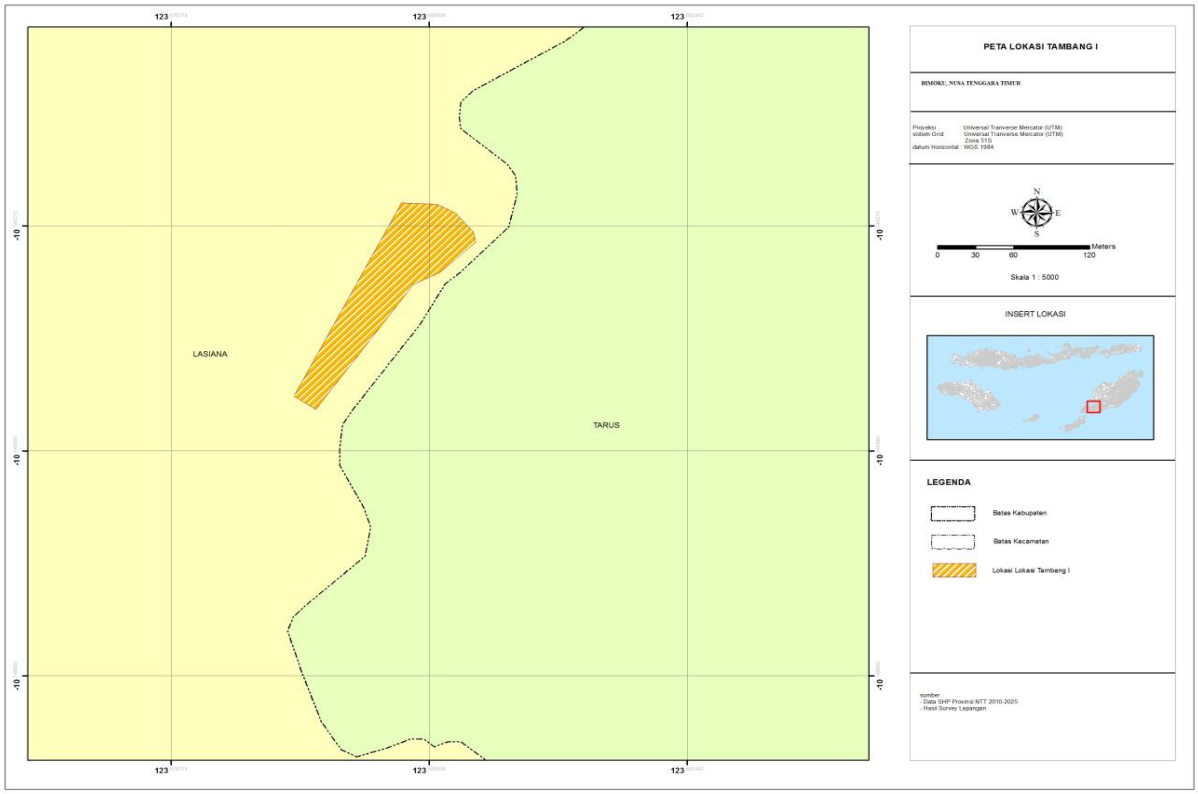

Figure 1. Map of the First Area

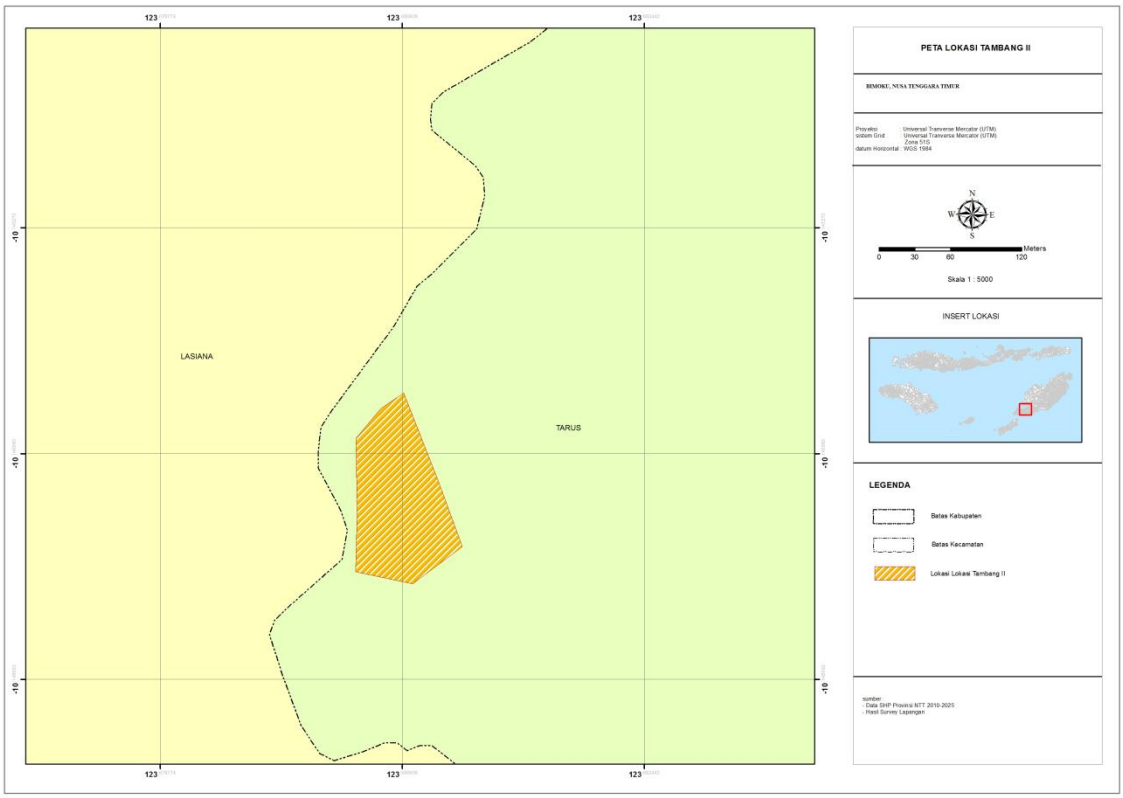

Figure 2. Map of the Second Area

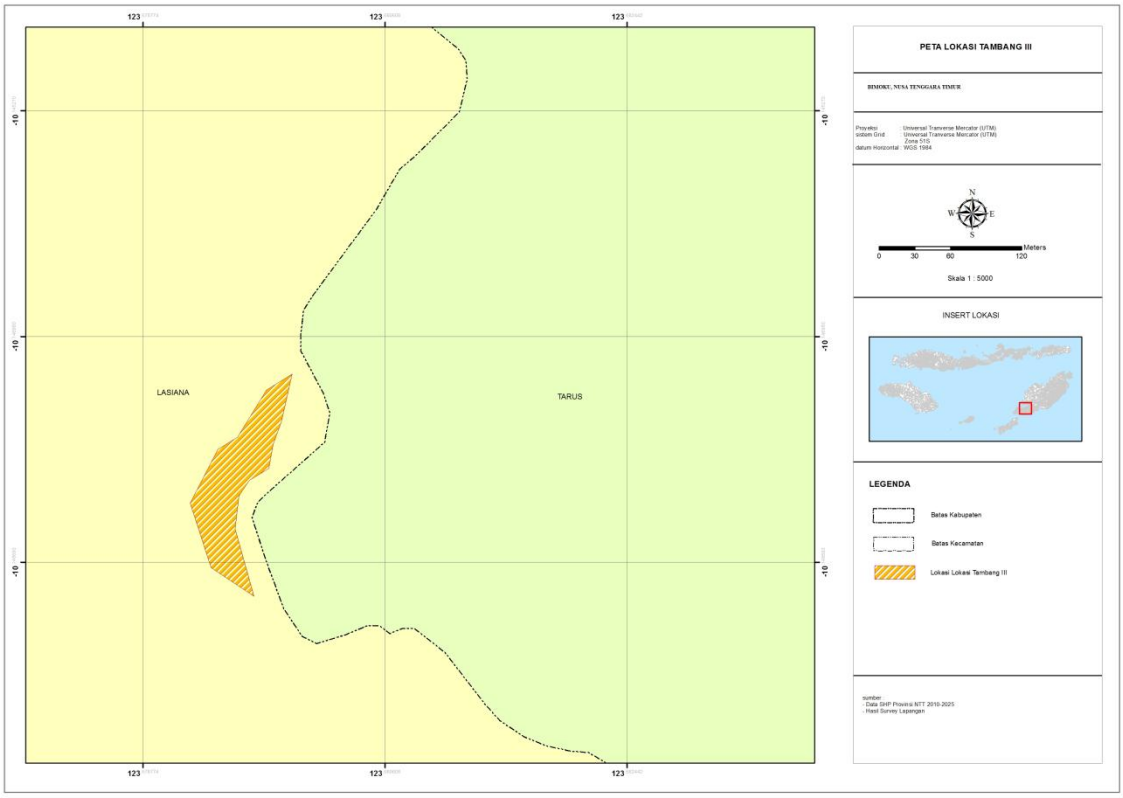

Figure 3. Third Area Land Map

4. Open Land due to Mining

Mining activities in Beumopu give rise to open land in the first area of 40.19%, in the second area of 36.50% and in the third area of 23.31%. Based on the criteria issued by the Directorate for Recovery of Open Land Damage, the Director General of Pollution and Environmental Damage Control of the Ministry of Environment and Forestry in 2015 on the criteria for damage to open access land due to community mining activities that mining activities will cause damage if open land has exceeded 20% of the permit area mining. Thus, limestone mining activities in Beumopu have caused damage because open land has exceeded 20%.

Limestone mining in Beumopu does not have detailed mining and reclamation plans, there are no clear boundaries of the mining area so it is observed that the mining area is very close to residential areas and schools. Limestone mining activities do not adjust the slope

shape to reduce runoff, erosion, sedimentation and landslides so that some of the surrounding land, especially those at the top, will experience landslides. Miners do not apply a terrace system on the surrounding land so that high cliffs are formed. As a result of mining also formed former mining holes resulting in land can no longer be used or become unproductive land and during the rainy season holes will be flooded.

5. Treatment of Top Soil

The part of fertile cover soil is peeled, it should be moved to the landfill because later it will be used again during the reclamation of the mine but mining conducted at the study site does not have any treatment of top soil (does not store top soil). The purpose of this management is to regulate and separate topsoil with other layers of soil. This is because the top soil is a growing medium for plants and is one of the important factors for the success of plant growth in structuring activities, supporting the success of reclamation and environmental recovery.

6. Mining Activity Noise

Mining activities are included in the industrial activities of mechanical equipment users which will surely produce sound, the sound from the work of the tool will be heard up to the surrounding environment and will have a disturbing effect if the sound received in the surrounding environment exceeds the established standard. Limestone mining activities in Beumopu use heavy equipment in the form of excavators which are the main source of noise during the mining process. Noise also occurs in the process of loading limestone that is when the excavator moves the load of excavated material into a dumptruck. The equipment generates quite high noise especially on land that has a relatively steep slope so that the work is relatively difficult and long. So that the ones potentially affected are those closest to the location of the activity.

Table 2. Calculation Result for dB (A) Value

Area	DN dB(A)	NN dB(A)	HDN dB(A)
1	52,53	49,42	57,89
2	56,04	49,56	64,14
3	54,86	49,34	60,94

Measurement Results in the mining area, the highest daytime noise level (DN) was 56.04 dB (A). The highest night noise level (NN) is 49.56 dB (A) and the highest daytime noise level (HDN) is 64.14 dB(A). In accordance with the noise level standard imposed according to Minister of the Environment Decree number 48 of 1996, the value of the daytime noise level exceeds the tolerance threshold which means that limestone mining in Beumopu is not appropriate because it is in the middle of a residential and school environment whose noise standard is 55 dB (A) with a tolerance limit of 3 dB(A)

Table 3. Noisy Prediction at Distance from Source

Area	HDN (dBA)	Noisy level at the source of the moving line (dBA)	Noise Level Is Different (dBA)
1	57,89	55,66	53,44
2	64,14	61,91	59,69
3	60,94	58,71	56,49

7. Components of the Biological Environment

The condition of post-mining vegetation diversity in three areas with a total of eight plots in each area, shows the level of vegetation diversity varies greatly. The existing plants mostly consist of gamal, palm trees, bidara trees, gmelina, kirinyu, and grass. Vegetation data

collection was carried out in three areas of limestone mining and the area around the mine that represents the original land.

Table 4. Vegetation Analysis Results

Area	K	RD(%)	F	RF (%)	D	RD (%)	IVI (%)
1	0,121	46,36	0,75	0,54	0,015	0,011	46,9
2	0,042	46,15	0,63	1,31	0,047	0,098	47,6
3	0,013	36,1	0,63	3,32	0,008	0,04	39,46

Important value index (IVI) is the result of the sum of the relative values of relative density (RD), relative frequency (RF) and relative dominance (RD) that have been measured previously, so that their values also vary. The highest IVI value was found in the second area of 47.6%. The size of the important value index shows the role of vegetation types in the community or in research.

The condition of post-mining macrofauna diversity in three areas with a total of eight plots in each area, shows the level of diversity of macrofauna is very varied. As for the macrofauna, which consists mainly of birds and several types of insects. Macrofauna data collection was carried out in three areas of limestone mining and the area around the mine that represents the original land. Abiotic environmental factors affect the presence and density of an animal population. Overall from the observation that the most abundant land animals found were red ants in the second and third areas while in the first area many black ants were found. Macro-fauna recorded in the table above are found in vegetation compared to non-vegetation.

8. Environmental Damage Assessment

The assessment of the level of environmental damage due to community mining activities refers to the Directorate for the restoration of open land damage, the Director

General of pollution and environmental damage control, the Ministry of Environment and Forestry in 2015.

Table 5. Environmental Damage Assessment

Physical Environmental Values	Biological Environmental Value	Final Value of Mine Management Achievements	Degree of Open Land Damage (%)
2,1	1,2	3,3	96,7

The value of open land damage is 96.7% due to limestone mining in Beumopu included in the category of heavily damaged due to the level of open land damage ≥ 40%. With this level of damage known, the mining activities evaluated need to cease mining operations.

9. Environmental Conservation Efforts

Based on the calculation of the percentage of open land due to mining activities in Beumopu, the open area in the first area is 40.19%, in the second area is 36.50% and in the third area 23.31% so that it is compared with the percentage value issued by the Directorate for Recovery of Open Land Damage , Director General of Pollution and Environmental Damage Control of the Ministry of Environment and Forestry in 2015 on the criteria for damage to open access land due to community mining activities that mining activities will cause damage if open land has exceeded 20%. Thus, limestone mining activities in Beumopu have caused damage because open land has exceeded 20%. Therefore there is a need for land rehabilitation efforts because the condition of such land will affect the existence and life of flora and fauna in the area.

The results showed that the impact of limestone mining activities in Beumopu is on the physical and biological aspects of the environment, so the need for post-mining improvement efforts in the form of reclamation and land revegetation. In three research areas,

environmental conservation efforts have not yet been seen. For this reason, an activity as an effort to preserve the environment is needed to prevent further damage. These efforts can be taken by rehabilitating damaged ecosystems. Efforts to preserve the environment are a shared responsibility between the government and the community. A person's behavior is crucial to the quality of the surrounding environment.

10. Reclamation and Revegation of Land after Mining Activities

Reclamation is an effort to repair land damaged by mining business activities, so that it can function optimally according to ability. Law Number four of 2009 defines reclamation as an effort to repair or restore damaged land and vegetation so that it can function optimally according to its purpose. The goal of the reclamation is to return the mining land to a condition similar to the condition before the mining (Adman, 2012).

The limestone quarry area at the study site has not been reclaimed or revegetated. Actually, this reclamation activity must be carried out by mining actors and in the implementation of revegetation, it is necessary to select plants that are in accordance with land suitability. Based on the Government Regulation of the Republic of Indonesia Number seventy-six of 2008 concerning Forest Rehabilitation and Reclamation requires every mining company to carry out revegetation on ex-mining critical land.

The level of community knowledge about environmental damage caused by mining activities is still lacking and the level of community knowledge affects the reclamation activities that will be carried out. It is proven that mining activities are continuing, the eroded land is widening but not accompanied by management efforts as an act of environmental preservation. Implementation of unlicensed mining activities from the government will require reclamation of post-mining land by mining companies, landowners and surrounding communities who are also concerned about the environment.

Location of limestone mining in Beumopu, after overlapping on a spatial pattern map, the location is included in a residential area. Mining locations that are very close to residential areas clearly violate the rules. Based on the Minister of Environment and Forestry Regulation Number four of 2014 concerning Environmental Friendly Parameters, the minimum distance of mining with a minimum settlement of 500 m.

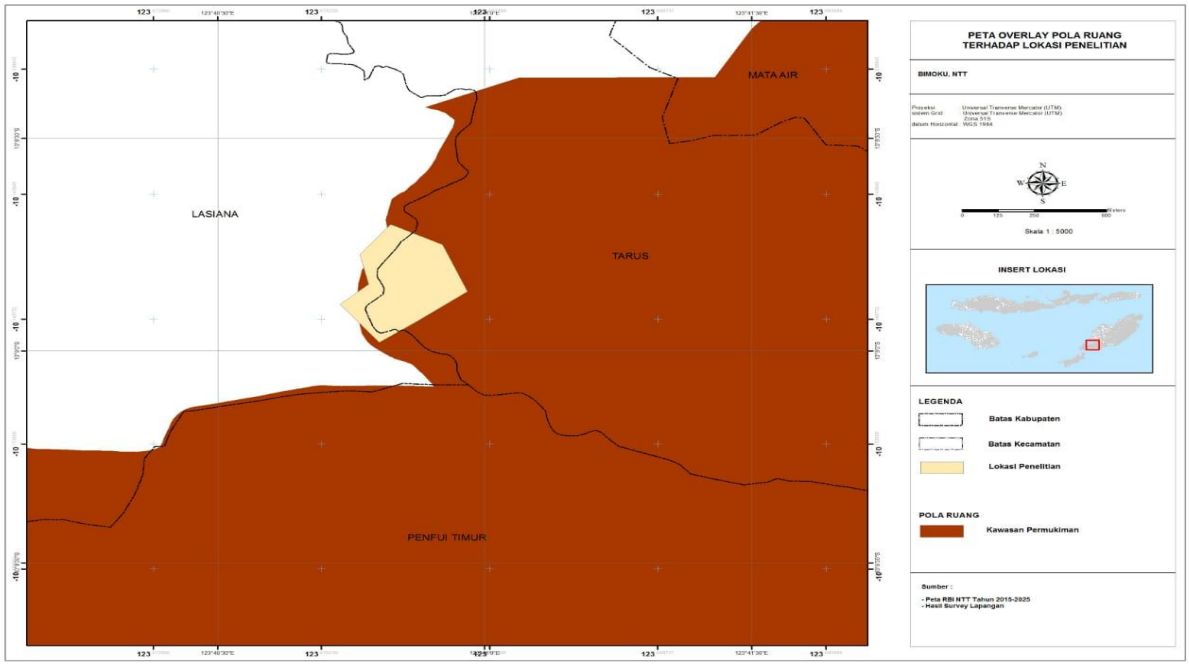

Figure 4. Map of Overlay of Spatial Pattern on Research Locations

CONCLUSION

From the research that has been done, it can be concluded that :

1. The level of physical damage to land includes:
   a. Open land due to mining activities in the first area is 40.19%, the second area is 36.50% and the third area is 23.31% so it has caused damage because open land has exceeded 20% of the mining permit area.

b. There is no treatment for top soil so it cannot be returned at the time of the closure of a former mine pit so revegetation has not been carried out to improve the quality of the environment.

c. The value of daytime noise level (Lsm) of the first area is 57.89 dB (A), the second area is 64.14 dB (A) and the third area is 60.94 dB (A) so that the value of daytime noise level exceeds the tolerance threshold which means that mining limestone in Beumopu is not appropriate because it is in the middle of a residential and school environment whose noise standard is 55 dB (A) with a tolerance limit of 3 dB (A)

d. The index value of the highest importance was found in the second area 47.6%, the first area 46.9% and the third area 39.46%.

e. The level of open land damage was 96.7% due to limestone mining in Beumopu included in the category of heavily damaged because the level of open land damage was ≥ 40%. With this level of damage known, the mining activities evaluated need to cease mining operations.

2. The condition of the post-limestone quarry land in Beumopu, Lasiana Subdistrict, Kelapa Lima Subdistrict, Kupang City, requires reclamation activities by revegetation and reclamation techniques including the creation of kridit terraces, bench terraces or guludan terraces and individual terraces that are adjusted to the depth of each area.

SUGGESTION

1. It is very necessary for landowners to reclaim and revegetate ex-mining land because the land is heavily damaged.
2. Due to time and cost constraints, it is recommended for further research in connection with aspects of the laws and regulations of mining, chemical environmental aspects, socio-economic aspects of culture and aspects of public health and the environment

REFERENCES

Development Planning Agency at Sub-National Level. Regional Development Planning Agency. 2012. Report on the Kupang City Spatial Plan. Kupang

Directorate General of Mineral, Coal and Geothermal. 2009. Mineral, Coal and Geothermal News. Development of RPP Implementation of Minerba Law. Issue 4. Jakarta

Directorate for Recovery of Open Land Damage. Director General of Pollution and Environmental Damage Control. KLHK, 2015 concerning Criteria for Damage to Open Access Land Due to People's Mining Activities. Jakarta.

Hasibuan, P.M. 2006. The Impact of Mining Group Galian Materials on the Surrounding Environment in Deli Serdang Regency. University of North Sumatra.

Juntak, E.S. 2015. Environmental Paper and the Negative Impact of Mining Activities. Jakarta

Meteorology, Climaology and Geophysics Agency Kupang Climatology Station, 2017

Najib. 2006. Environmental Geology Study in Evaluating the Level of Land Damage Due to Mining of Group C Mineral Material, Engineering-Vol. 28 (3).

Republic of Indonesia Government Regulation No. 76 of 2008 concerning Forest Rehabilitation and Reclamation.

Wibowo Mardi. 2006. Environmental Damage Evaluation of the Tufaan Sandstone Mining Area in Kec. Prambanan and surroundings, Kab. Sleman. PTL-BPPT. Jakarta