Suitability analysis of non-metallic minerals and rock mining sites with spatial patterns based on regional spatial planning in Central Lombok Regency

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Abstract. Central Lombok Regency has a potential for non-metallic mineral and rock mining. This study aims to map the distribution of non-metallic mineral and rock mining locations and analyze the suitability of the location distribution with space allocation neighborhood and community unit in Central Lombok Regency. The research uses descriptive analysis method and map overlay. The results show that the location of non-metallic minerals and rock mining is spreading in seven sub-districts in Central Lombok Regency, namely Pujut, West Praya, Southwest Praya, Kopang, East Praya, North Batukliang, and Pringgarata. The distribution of mine sites reaches 49 points. Based on the results of the overlay of the mine location map with the spatial planning map, there are several mines located in the watershed (river border area) and the distance is close to residential areas. Thus the government needs to formulate a policy to provide limits to the development of a mining area. The southern part of Central Lombok Regency is developed as a special area of national tourism. The government must consider this situation to make sure the development of the mining area does not interfere with tourism development.

1. Introduction

Increasing population growth has an impact on development. Construction requires raw materials in the form of rock and soil mining materials such as building materials and raw materials in the industry [1] [2] [3]. Rock and soil mining activities are distributed in almost all regions of Indonesia. Central Lombok Regency has the potential for non-metallic minerals and rock mining. Some of them are still managed in the form of community mining. Mining activities have a spatial impact, namely changes in land use [4] [5]. It also causes negative impacts, such as the movement of landmass/rock [6]; social conflicts [7]; infrastructure; groundwater availability and quality; sedimentation; and changes in the physical environment in a river, for example, the river surface widens, the river flow moves and landslide [8] [9].

The regional spatial plan is an effort to formulate an optimal, efficient and sustainable use of space for human business activities to materialize community welfare within a certain period of time. To guarantee land use based on its suitability, it must be based on the regional spatial plan [10] [11]. The development of mining activities also needs to pay attention on the spatial plan of the local area. As stated in the Minister of Energy and Mineral Resources No. 1457 K/28/MEM/2000 that mining and energy activities must be carried out based on the Regional Spatial Plan [12]. Based on the guideline...
for the technical criteria of cultivation area, the location characteristics and land suitability for non-metallic minerals and rock mining areas are the location of the excavation material is in a flat area, steep or sloping, and the river channel; may not be located in a protected area (protected forest, nature reserve, water body, and water conservation); the location is not in the upstream part of the river basin; excavation sites are not located in areas prone to natural disasters such as ground movement, earthquake path, volcanic eruption hazard, and others [13]. Therefore, an analysis on the suitability of the spatial allocation is required to allow the regional spatial plan be achieved as expected.

Based on the previous explanation, this research focuses on two aspects, namely mapping the distribution of non-metallic minerals and rock mining sites in Central Lombok Regency and analyzing the suitability of the distribution of mining location with spatial allocation based on the community unit in Central Lombok Regency.

2. Method

2.1. Research Tools and Materials
The materials used include satellite imagery, regional spatial planning maps, supporting documents and data from previous reports, and direct field observations. While the tools used are digital cameras, GPS and ArcGIS.

2.2. Analysis Stages
The stages of analysis carried out are mapping the distribution of non-metallic minerals and rock mining locations based on direct observation and interviews (surveys). The coordinates of the mining location were still taken during the field survey. Then analyzing the suitability of the distribution of non-metallic minerals and rock mining sites with space allocation based on the community unit in Central Lombok Regency. The suitability of space allocation is done through overlaying the mining location map with a spatial pattern map in Central Lombok Regency.

3. Result and Discussion

3.1. Distribution of non-metallic minerals and rock mining locations in Central Lombok Regency
Central Lombok Regency has the potential for non-metallic minerals and rock mining and categorized as community mining areas. Based on the results of survey and interviews related to the mining condition in Central Lombok Regency, seven districts have non-metallic minerals and rock mine sites, namely Pujut, West Praya, Southwest Praya, Kopang, East Praya, North Batukliang, and Pringgarata. The mine sites in Central Lombok Regency reaches 49 points. Each sub-district has different mining conditions and potentials. More details are available in the following table 1 and figure 1.

| No | Sub-district | Village | Potential  | Location                          | Status   | Large (ha) | Production (dam/days) | Operation time |
|----|--------------|---------|------------|-----------------------------------|----------|------------|-----------------------|----------------|
| 1  | Pujut        | Pengembur| Andesite and limestone | Gn. Tele, Gn. Batu Dendang, Gn. Kaliango, dan Gn. Sengung Gerentok | Active   | 4.5        | 5                     | 13 years       |
|    |              |         | Tufa       | Buikut Batu Denden                | Active   | 1.5        | 2                     | 8 years        |
|    |              |         | Silicestone | D. bun petung                    | Active   | 3          | 1                     | 4 years        |
|    |              |         | Andesite   | Buikut Repeti                     | Active   | 1          | 4                     | 1 year         |
|    |              |         | Andesite   | Gerintuk Hamlet                   | Active   | 3          | 3                     | 5 years        |
|    |              |         | Tufa       |                                    | Active   | 1          | 5                     | 5 years        |

Table 1. Results of mining survey of Central Lombok Regency
| No | Sub-district | Village       | Potential         | Location                                                                 | Status     | Large (ha) | Production (dam/days) | Operation time |
|----|--------------|---------------|-------------------|--------------------------------------------------------------------------|------------|------------|----------------------|----------------|
| 2  | Praya Barat  | Kuta          | Limestone         | Gn. Segale                                                               | Active     | 4          | 3                    | 10 years        |
|    |              | Selong blanak | Andesite          | Gn. Air Lengis                                                           | Active     | 1          | 1                    | 6 years         |
|    |              | Penunjak      | Andesite          | Gn. Sepiak, desa selong blanak Penunjak Village                           | Active     | 1          | 1                    | 4 years         |
|    |              |               | Coarse agregat    | Penunjak River                                                            | Active     | 1          | 2                    |                |
| 3  | Praya Barat Daya | Pelambik   | Limestone         | Kepompong Sepeluk, Desan Rungkung and Gn. Saren (Bianje)                 | Active     | 5          | 2                    | 7 years         |
|    |              |               | Andesite          | Embung Hamlet                                                            | Active     | 2          | 1                    | 8 years         |
|    |              | Montong Sapah | Clay              | Areas around montong sapah                                              | Active     | 2          | 2                    | 20 years        |
|    |              | Pandan Indah  | Limestone         | Kelambi Hamlet                                                           | Active     | 2          | 2                    | 9 years         |
|    |              | Teduh         | Andesite          | Sejati Hamlet                                                            | Active     | 5          | 4                    | 10 years        |
| 4  | Kopang       | Wajageseng    | Stone and soil    | Peresak Hamlet                                                           | Active     | 8          | 5                    | 4 years         |
|    |              | Aik bual      | Andesite          | Peresak Hamlet                                                           | Active     | 1.5        | 4                    | 1 year          |
|    |              |               | Stone and soil    | Stone and soil                                                           | Active     | 6          | 5                    | 4 years         |
| 5  | Praya Timur  | Kidang        | Stone and soil    | Batu Bokah Hamlet                                                        | Active     | 8          | 4                    | 4 years         |
|    |              | Bilelando     | Stone and soil    | A                                                                       | Active     | 8          |                      | 5 years         |
|    |              |               | Stone and soil    | B                                                                       | Active     | 2          |                      | 2 years         |
|    |              |               | Stone and soil    | C                                                                       | Active     | 10         |                      | 4 years         |
|    |              |               | Stone and soil    | D                                                                       | Active     | 4          |                      |                |
| 6  | Batukliang Utara | Lantan   | Soil and Limestone | Kesah Hamlet                                                             | Active     | 0.2        | 20                   | 2 weeks         |
|    |              | Karang sidemen| Coarse aggregate and andesite | Lendang Tampel Karang Sidemen Hamlet                                    | Active     | 0.1        |                      | 1 month         |
|    |              |               | Coarse            | Dusun                                                                    | Active     | 0.65       | 5                    | 1 month         |
Based on the survey results, Central Lombok Regency has 10 (ten) types of mining products, consisting of building stones, sand sirtu, backfilled soil, limestone, tuff, silica stone, pumice, loam, kaolin, and gravel. Where the most dominant mining products are building stones, sirtu sand, and backfilled soil. Mining products in the form of building stones are scattered in almost seven districts in Central Lombok Regency. While the sirtu sand and the backfilled soil are dominantly found in the East Praya District. The size of the mine sites ranging between 0.02-8 ha. East Praya Subdistrict is an area with the largest mining area, which reaches 50 ha. Generally, the location of the mining point is close to a residential area.

Hammer remains to be the average equipment used to produce non-metallic minerals and rock mining products in Central Lombok Regency. This influences mining duration and the number of mining production, which is small. Based on the interviews with several miners, sometimes mining products cannot meet consumers demand. However, in Kopang District, heavy equipment such as excavator and stone mills are used and hired up to 20 workers.

Mining activities in several sub-districts such as West Praya and Southwest Praya are only carried out in the rainy season only and no activities are carried out during dry season. However, several mine sites in Kopang District only do mining activities during dry season due to the risk of landslides. Mining activities in North Batukliang Subdistrict are relatively new, overagely for about one month in operation.

![Figure 1. Map of distribution of non-metallic minerals and rock mining locations in Central Lombok Regency](image-url)
3.2. Analysis of the suitability of the non-metallic minerals and rock mining distribution sites with space allocation based on the community unit in Central Lombok Regency

Based on Regional Regulation No. 7 of 2011 concerning Spatial Planning for Central Lombok Regency, the mining allocation area consists of nonmetallic minerals and rocks. Potential mining of metal minerals, non-metallic minerals and rocks are scattered in Southwest Praya Sub-district, West Praya Sub-district, Pujut Sub-district and East Praya Sub-district [14]. Meanwhile, based on the survey results, there are seven districts conducting mining activities namely Pujut, West Praya, Southwest Praya, Kopang, East Praya, North Batukliang, and Pringgarata.

Based on results of the overlay map of the non-metallic minerals and rock mining sites distribution, there is a mining location point located on the riverside (figure 2). As happened in several villages in East Praya and Kopang Subdistricts, the community experience environmental damages of land erosion around the riverside. Based on the results of the interviews, several mining locations in Kopang District only conduct mining activities during dry season due to the danger of landslides in the rainy season due to the close distance of the location to the residential area. Also, based on the technical criteria of a non-metallic minerals and rock mining allocation, it is stated that the location must not be too close to the settlement [13].

![Figure 2](image)

**Figure 2.** The appropriation of non-metal and rock-based distribution of mineral mines based on the space allocation of the regional spatial planning in Central Lombok

Sand and gravel mining activities have the same potential to damage the environment as materials mining. This is because sand or gravel mining is technically easy to do. It can be done with simple equipment (manual) or heavy equipment (mechanical). The district government should consider providing licenses for mining activities. Moreover, there are three sub-districts that are not allocated as mineral mining locations in the regional spatial plan, therefore, it is necessary to engage all stakeholders from the community, business people, related agencies, environmental observers, and private sectors at the stage of the feasibility of mine area development [15].

4. Conclusion

The conclusion drawn from the research about suitability analysis of non-metallic minerals and rock mining sites with space patterns based on the regional spatial planning in Central Lombok Regency, are as follows:

a. The location of non-metallic minerals and rocks mines in Central Lombok reaches 49 points.

b. There are 9 (nine) mine sites, which according to the criteria of non-metallic minerals and rocks mining locations stipulated in the regional spatial planning, are not suitable for mining activities. The locations are spread in Kopang, North Batukliang, and Pujut Districts.
c. Some parts of the locations are on river border area and close to residential areas. Thus, a new policy related to potential mines is required to prevent adverse impacts of mining activities to the community and environment.

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