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Disaster mitigation-based environmental management model: a study on ten thousand hills, Tasikmalaya City, West Java

S Fadjarajani^{1*} and R As'ari¹

¹ Departement of Geography Education, Faculty of Teacher Training and Education, Siliwangi University Tasikmalaya, Indonesia

*Email: sitifadjarajani@unsil.ac.id

Abstract. Tasikmalaya seen from the physiographical aspect has its own uniqueness because it has many hills known as the ten thousand hills. The Ten thousand has functions, namely: geological, ecological, hydrological, aesthetic, economic, micro-climatological, natural defense/fortress (buffer zone), as well as education and tourism functions. The method used in this research is descriptive with field observation data collection techniques based on Satellite Imagery analysis. The method used in this research is descriptive with field observation data collection techniques based on Satellite Imagery analysis. Data analysis is based on satellite imagery data processing with ArcGIS which was developed. The facts on the ground show that the extinction rate of the hill reaches 70%. One of the driving factors for the extinction of the hill was the mining of mineral. The distribution pattern and factual conditions in the field showed that 41.67% of the hills experienced extinction and 58.33% of the hills were heavily damaged by sand mining. This disaster mitigation-based environmental management model includes: 1) Zoning of hill areas based on conservation functions, 2) community participation based on economic improvement. Ten thousand hill zoning and community participation based on economic improvement can be used as role models for environmental management based on disaster mitigation in Tasikmalaya which is located in the ten thousand hill area.

1. Introduction

Tasikmalaya seen from the physiographical aspect has its own uniqueness because it has many hills. The hills are spread to the southeast from the mouth of the depression of Mount Galunggung which is north of Tasikmalaya City with varying heights. These hills in the community in Sundanese are known as "Gunung Sarewu" or Bukit Ten Thousand Tasikmalaya. According to the Geological Dictionary, hills are natural heights generally up to <300 m; hills are areas of a collection of hills. Quoted the Geologist Escher in 1925 who argued that the hills found in Tasikmalaya were the result of a major landslide in prehistoric times to the southeast of Galunggung Volcano. The hills were first called the Ten Thousand Hills (The Ten Thousand Hills) by a Dutch geologist Van Bemmelen (1949) in [1], [2], because there were quite a number of approximately 3,684 hills at that time. Furthermore, the existence of the hill attracted attention and was popularized by several geologists such as Kusumadinata (1979), Bronto (1982), and Ahman Sya (1996) in [2].

The hill of ten thousand has provided such great benefits to the lives of the people around it. From a hydrological point of view, the existence of Bukit Ten Thousand serves as a water catchment area that will be able to maintain the stability of the source and depth of groundwater. However, with the decreasing number of the Ten Thousand Hills, groundwater sources are felt to be decreasing and their



availability is getting deeper. The longer the Tasikmalaya area will become dry, arid, and water shortages, so that it no longer has an aesthetic or environmental beauty that is adequate for life. In a study in 1994 – 1995 it was found that one of the hills as a sample had a plant species richness of not less than 20 species.

The study of the Tasikmalaya area which studies the environment has been widely studied in [3]–[6]. Tasikmalaya as a location that has a fairly high level of disaster risk, it needs attention from various stakeholders to study in depth as an effort to reduce the negative impact if one day a disaster occurs. [7], [8]. However, the existence of the hills in Tasikmalaya is poorly understood about its function for human survival. The community only views the function of the hill from an economic perspective without looking at the function from the other side. Seeing mining activities and the decline in the number of hills, it is necessary to have a hill protection zoning to be used as an effort to manage the environment in a sustainable manner. The problem raised in this research is how the pattern of utilization of Bukit Ten Thousand as a function of conservation and protection zones for the use of environmental conservation in Tasikmalaya. The purpose of this study was to determine the pattern of utilization of Bukit Ten Thousand as a conservation function and a protection zone for the use of environmental conservation. The application of the results of this study is expected to be accepted by all parties as a reference for monitoring the level of damage to Bukit Ten Thousand in the context of environmental conservation.

2. Methods

The research location is in Indihiang Subdistrict and Bungursari Subdistrict, Tasikmalaya City. The method used in this research is a survey. The data collection techniques used are observation, interviews, documentation or literature studies. Research activities include collecting data, compiling and classifying data, then data analysis. The analysis was carried out descriptively based on the results of observations, interviews, and literature reviews related to environmental functions. To zoning the distribution of Bukit Ten Thousand, all hills are identified to be classified according to the criteria. Satellite imagery assistance is required for hill inventory. In addition, qualitative and quantitative data from the field are entered into the database and combined with graphical data using ArcGIS software.

3. Result and Discussion

3.1 Damage Rate on Ten Thousand Hills in Tasikmalaya

Tasikmalaya physiography is closely related to the activity of Mount Galunggung. The formation of hills scattered in Tasikmalaya is caused by the efflata of Mount Galunggung to the southeast. As a result, the research area, namely Bungursari and Indihiang Subdistricts, physiographically has the characteristics of many hills with vegetation cover tending to forest and mixed gardens. Figure 1 shows the location of Mount Galunggung and Bukit Ten Thousand. The geological structure of the research area is closely related to the presence and activity of Mount Galunggung. Most of the research area contains rocks resulting from pyroclastic deposits from the eruption of Mount Galunggung. According to experts, the formation of tens of thousands of hills scattered in Tasikmalaya is the result of the activity of Mount Galunggung which erupted in 1822. The rock content in the hills in the study area contains rocks resulting from pyroclastic deposits and belongs to the C excavation material [9]. can be used by the community to be used as land for livelihoods as a mining area of C-Gahan, which can be profitable from an economic point of view.

The Ten Thousand hills has provided great benefits to the lives of the surrounding community. The condition of the remaining hills at this time is still mostly overgrown with vegetation that is closer to forest vegetation. Ecologically, this situation provides protection against the hydrological and weather systems in Tasikmalaya. The distribution pattern of Bukit Ten Thousand is included in the pattern of uneven distribution (random pattern). In general, the farther away from Mount Galunggung, the relatively smaller size. Ten Thousand Hills is currently in poor condition, every year the ten thousand

hills extinction rate is increasing. Figure 1 presents the damage level of a hill part of Bukit Ten Thousand.



Figure 1. Development of Ten Thousand Hills Damage Level

The results showed that the number of hills in Indihiang and Bungursari sub-districts was not evenly distributed. Of the six sub-districts in Indihiang Sub-district, there are three sub-districts that no longer have hills because they have disappeared, namely Parakansag Village, Sirnagalaih Village, and Panyingkiran Village with one hill remaining in a damaged condition. The extinction of the hills in the three urban villages is due to the expansion of urban areas [10]. The condition of the hills in the two sub-districts is very worrying with the number of hills being damaged and in the process of mining minerals C. The number of hills in each sub-district in Indihiang and Bungursari sub-districts can be seen in Figure 1. Facts on the ground show that there are many hills that have become extinct which are now only in name.

3.2. Ten Thousand Hills Zone Zoning For Environmental Management

Ten Thousand Hills in Indihiang and Bungursari sub-districts are in a state of extinction, as can be seen from the many abandoned excavations. This allows the degradation of environmental quality in Tasikmalaya. The management of ten thousand hills will help preserve the environment, this is in accordance with Law No. 32 of 2009 [11] concerning Environmental Protection and Management which states that the environment is a unitary space with all objects, power, circumstances, and living things, including humans and their behavior. that affect nature itself, the continuity of life, and the well-being of humans and other living things.

Zones are areas, lane areas, or zones. Zoning is a grouping of an area that has one thing in common or uniformity. Zoning in landscape science is the formation of zones or areas that have certain uniformity in an area with regional restrictions or topographical formations. This zoning is used to preserve the Ten Thousand Hills in Tasikmalaya, especially in Indihiang and Bungursari sub-districts. Zone I is a zone where the condition of the ten thousand hills that are still intact (in the form of a hill) has no mining activity. Zone II is a zone where ten thousand hills are damaged and in the process of mining minerals C. Zone III is a zone where ten thousand hills are extinct and have been converted. The zoning criteria that have been determined above, the Ten Thousand Hills Zoning Map in Indihiang and Bungursari Districts can be presented in Fig.2.

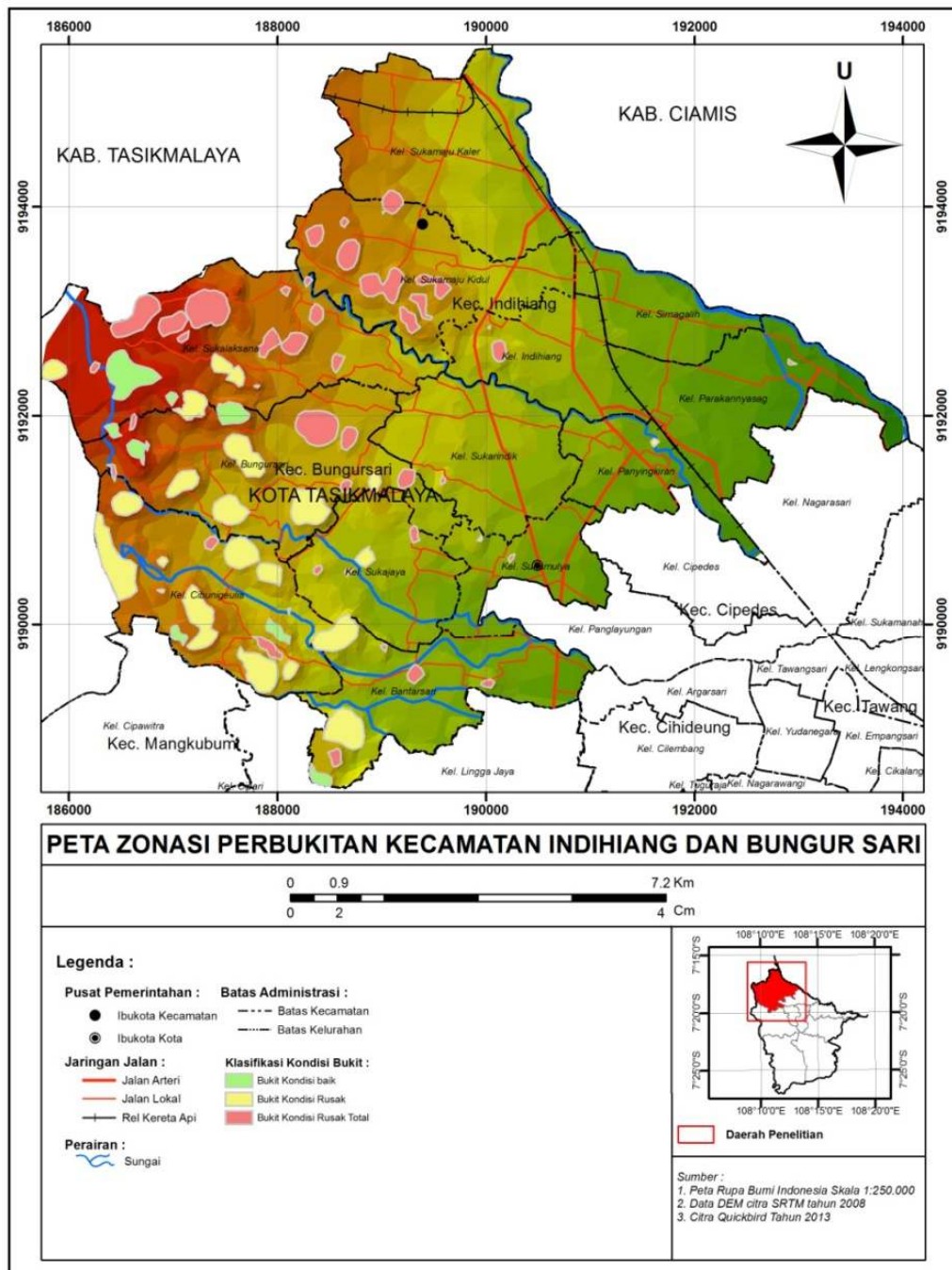


Figure 2. Ten Thousand Hills Zoning Map In Indihiang and Bungursari Districts, Tasikmalaya City

The rapid rate of hill extinction has an impact on the environmental conditions of the people in Indihiang District and Bungursari District, Tasikmalaya City. Society in general has felt the negative impact of the destruction and extinction of Bukit Ten Thousand. Some of the problems faced by the community include the depth of the dug wells has increased in depth, farming communities who work on rainfed rice fields feel that the dry season their cultivated fields experience drought, and if the rainy season the quantity of water in the rice fields recedes quickly and even landslides often occur [12] [13]. The hills, which are quite numerous, are a source of life and prosperity. This can be observed from

several functions of the existence of these hills, including geological functions, ecological functions, hydrological functions, aesthetic functions, economic functions, defense functions, as well as education and tourism functions.

1. **Geological Function** Geologically, these hills are specific natural formations. Its existence can serve as a natural fortress from possible Galunggung lava floods. On the other hand, the rocks and sand that exist on each hill are used by the community for road paving, foundations, dams, concrete construction, and others. The sheet structure is widely used as an outboard stone. This makes it necessary to arrange utilization for mining.
2. **Ecological Function** From an ecological point of view, Bukit Ten Thousand has a role as an open green area that is useful for maintaining the balance of the micro-ecosystem in Tasikmalaya. Ecosystem is an arrangement of elements of the environment which is a unified whole and influences each other in shaping the balance, stability, and productivity of the environment [11].
3. **Hydrological Function** From the hydrological point of view, the existence of Bukit Ten Thousand serves as a water catchment area that will be able to maintain the stability of the source and depth of groundwater. Groundwater is water that is in a saturated area below the ground surface [14]. With the ten thousand hills, an aquifer will be formed, namely a pocket of water that is in the ground. Thus, from a hydrological point of view, Bukit Ten Thousand Hills is very useful for meeting water for domestic and agricultural needs, because on every hill that is still intact there are several locations of springs that can be utilized by the community. Water conservation in principle is the use of rainwater that falls to the ground for agriculture as efficiently as possible, and regulating the flow time so that there is no destructive flood and there is enough water in the dry season [15]. So with the existence of ten thousand hills, it becomes an indirect form of water conservation [16].
4. **Aesthetic Function** Vegetation is a plant that is found on the surface of the earth or somewhere [17]. In the mechanism of shared life, there is a close interaction, both between the individual constituents of the vegetation itself and with other organisms so that it is a system that lives and grows and is dynamic. The existence of an intact hill provides its own benefits in terms of aesthetics, considering the function of land cover vegetation (plants) that live on hill land will look green, so Tasikmalaya will look beautiful and shady. In addition, the protection of the hills shows that environmental ethics in Tasikmalaya are maintained. Considering that Environmental Ethics does not only talk about human behavior towards nature, but also talks about the relationship between all life in the universe.
5. **Economical Function** Economic benefits from the exploitation of Bukit Ten Thousand Most of the content of Ten Thousand Hills in Indihiang and Bungursari sub-districts is mineral C. Mineral C is non-strategic and non-vital minerals [18]. Ownership of existing hills is owned by individuals so that people who are generally farmers can easily earn income quickly by selling sand and rocks found on hill land. Various ways are done, including selling the hill, or mining it yourself and selling only the sand and rock content.
6. **Education Function** The educational function in Ten Thousand hills can be used as a means to communicate knowledge of earth and environmental concepts to the community or in schools. This is done so that the community understands the nature of Bukit Ten Thousand so that they behave wisely with the conditions of the surrounding environment. Bukit Ten Thousand is a natural laboratory that can be used as a place for research activities in collaboration with universities, and contacts with local experts. The collaboration between the parties is intended so that there is a complete synergy so that the research outputs produced will be more useful for people's lives. Then it can be used as a learning object for excursion studies of school children and teachers, seminars and scientific lectures.
7. **Tourism Function** Tourism is everything related to tourism, including the exploitation of tourist objects and attractions and related businesses in that field [19]. The tourism potential of Ten Thousand Hills cannot be separated from the condition of geodiversity which has its own

uniqueness. Existing geodiversity will be related to biodiversity and cultural diversity because the existing elements will produce a reciprocal relationship as a unique phenomenon. Geopark is an area that has outstanding geological elements including archaeological, ecological, and cultural values in it where local people are invited to participate in protecting and enhancing the function of natural heritage. Geopark is a tourism management concept in accordance with the current condition of Ten Thousand hills.

8. Defense Function Mount Galunggung is an active volcano type A, namely a volcano that has experienced a magmatic eruption at least once after 1600. Mount Galunggung has erupted after 1600. Its eruption history was recorded in 1822, 1894, 1918 and finally 1982 [20]. The Galunggung eruption belongs to the VEI (Volcano Explosion Index) 4-5 which is characterized by a plume of 10 - 25 km and a volume of > 0.1 km³. Eruptions that occur at Galunggung are usually accompanied by vertical air columns, lava flows, lava flows and pyroclastic flows or hot clouds.

4. Conclusion

From the results of the research, it is known that in the Indihiang sub-district there are 22 hills in intact condition and 9 hills that are damaged and are being exploited. For Bungursari District, there are 56 hills that are still intact and 40 hills in damaged condition and are being exploited. The factual conditions in the field show that 41.67% of the hills are damaged, while 58.33% of the hills are in the intact category but experience a decrease in number every time due to the sand mining process. The distribution pattern of Bukit Ten Thousand is included in the pattern of uneven distribution (random pattern). In general, the farther away from Mount Galunggung, the relatively smaller size. Efforts to protect hills by forming hill zoning for groundwater resource protection areas are expected to prevent environmental crises, especially water scarcity in Indihiang District and Bungursari District, Tasikmalaya City. The existence of an understanding of the importance of the preservation of the hills and the protection zone of Bukit Ten Thousand which are still intact can form global citizenship with the principle of eco-efficiency for sustainable development, so that the community will not experience the negative impact of the extinction of the Bukit Ten Thousand.

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