# Geosite and Geomorphosite Assesment of Parang Hill for Geotourism Development and Spatial Planning in Karangsambung-Karangbolong National Geopark

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**Abstract:** Bukit Parang is a hill that is composed of intrusive diabas igneous rock which breaks through the claystone of the Karangsambung Formation at 39 mya. The process of intrusion forms a columnar joint structure that is exposed around it. The burly structure of the pole is the main attraction for visitors, in terms of geology, morphology and aesthetics. Joint column occurs in intrusive igneous rocks as well as lava flows. Magma or lava breaks down due to cooling forming cracks that are perpendicular to the cooling plane. After cracks then develop to form a polygonal plane. Parang Hill is one of 41 geological sites in the Karangsambung-Karangbolong National Geopark area, which was inaugurated at the end of 2018. The number of geo-sites is necessary so that the priority of regional development and spatial planning is better. The development of geopark and tourist villages around geosite will increase the number of visitors and the carrying capacity of the environment. This study aims to look at aspects of tourism development in terms of geosite and geomorphosite assessment which includes 5 parameters namely scientific value, educational value, economic value, conservation value and added value. The method used is field observation and quantification of the 5 (five) main parameters with weighting as a feasibility value of the Bukit Parang geosite for geotourism. These quantification values can produce information and recommendations for the management of geotourism especially in Bukit Parang, and generally in Karangsambung-Karangbolong Geopark. The values of quantification of the main parameters are 75% intrinsic and scientific value, 88% educational value, 66.67% economic value, 75% conservation value and 60% added value. The total score is 14, Mean 0.74, median 1, standard deviation 0.31 and coeffisient of variation 0.4. Based on the ANOVA test about the feasibility values ranging from 0-1, Bukit Parang has a feasibility value of 0.74.

**Keywords:** anova; columnar joints; parang hill, geology; geopark; geotourism; spatial planning

## 1 Introduction

Geologically and geographically, Indonesia is an archipelagic country flanked by three tectonic plates (Eurasian Plate, Indo-Australian Plate, and Pacific Plate). This has resulted in Indonesia having abundant natural resources, one of which is in relation to geotourism. The concept of geotourism is fairly new in the world of research, on the definition, method and process of assessment of geotourism objects was only carried out in 2001 by the Geomorphosite Group of the International Association of Geomorphologists (Giusti, 2010 in Kubalíková, 2013).

According to Bruneau, 2007 in Kubalíková (2013) there are three important aspects in geotourism namely geodiversity, biodiversity and cultural diversity. Geodiversity is a diversity of rocks, minerals, fossils, landscapes, sediments, soils related to the processes and changes. Definition of biodiversity according to Sudarsono 2005:6 in Prastianto, Dwipayana, Syahroni, & Pumbarino (2018). Biodiversity is the availability of biodiversity in the form of species and wealth of germplasm (genetic diversity in species). The relationship between geodiversity and biodiversity is a key to conservation management in a dynamic environment. While the aspect of cultural diversity serves as a supporter in maximizing the potential of tourist areas.

Parang Hill is a hill composed of diabas igneous rocks which break through the claystone of Karangsambung Formation. Based on data on radioactive isotopes, some intrusive rocks in Karangsambung were 37.5 million years ago (Soeria Atmadja et al., 1994). On the northern cliff, the appearance of the columnar joints is caused by the cooling process of magma. An interesting geological phenomenon in the form of a burly structure on the body of the intrusion of diabas revealed in Parang Hill has become an attraction for visitors who come to the place.

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**Figure 1.** Geosite Location of Parang Hill Marked by a Black Circle

Columnar joints is one of the common structures in igneous rock, both in the form of intrusion and in the form of lava flows. Columnar joints are formed due to pressure responses during cooling of magma or lava (Iddings, 1886, 1909; Mallet, 1875; Spry, 1962). Magma or lava breaks due to cooling forming cracks. After cracks have formed, the cracks develop. This development is perpendicular to the direction of flow. Polygonal shapes such as pentagon, even hexagons are a typical form of a columnar joints. Parang Hill is located in Dusun Parang, Karangsambung village, Karangsambung sub-district, Kebumen. Administratively this hill is called Gunung Parang which is 20 km from the city of Kebumen. The communities around Parang Hill often name this Parang Hill with Mount Wurung. This name comes from the legend of the people around Karangsambung about the existence of a girl who was willing to be proposed by a young man as long as the young man was able to make a mountain in one night. The requirement was agreed upon by the young man and worked earnestly on the appointed night. But the pity of his efforts was foiled by the girl by continuing to pray to God so that dawn soon arrived. The girl’s prayer that the young man refused to marry was granted by God. Dawn as a sign that the end of the mountain was made before the mountain was completed by the young man. Because that is also called Mount Wurung, which means that the mountain is not yet finished.

In 2018, the Karangsambung Geological Reserve area was inaugurated as the Karangsambung-Karangbolong National Geopark (GNKK), this was based on the increasing number of visits by both general tourists and special interest tourists to study various geological phenomena in this geopark. This research focuses on the aspect of developing geotourism in Bukit Parang related to land management, which is one of the geosites of 41 other geosites in the GNKK geopark region.

**Figure 2.** Columnar Joints are Typical Structures of Igneous Rock seen on the Bukit Parang

### *1.1 Conditions of Regional Geology*

Regional geology Karangsambung has been studied by several researchers (Asikin, 1974; Harloff & Johnson, 1933; Harsolumakso & Noeradi., 1996; Setiawan., Yuwono, & IGB Eddy Sucipta, 2011; Suparka, 1988; Tjia, 1966; Wakita, Tomimoto, Akiguchi, & Kimura, 1994). Some researchers have compiled a stratigraphic sequence in the Karangsambung area. According to Asikin (1974) the stratigraphic order from old to young is:

a. Luk Ulo Melange complex, in the form of mixed rocks (turtle) mixed tectonically in the base of the shale and torn black claystone. Age of Luk Ulo is pre-tertiary (upper paleocene-cretaceous). The rock consists of graywacke, black clay, pillow lava associated with chert and red limestone, turbidite clastic and ofiolite which are inserted between metamorphic rocks and schist. These rocks are the result of tectonic mixing in subduction paths (subduction zones) which also involve rocks from oceanic crust and continental crust. In the Mélange various sizes of rock fragments are found ranging from gravel to lump (mapped). The complex is divided into 2 units based on fragmental domination in its base, namely the Jatisamit Unit to the west and Seboro Unit to the north. Jatisamit Unit is the oldest old rock. This unit consists of a foreign chunk in the base of a black claystone. The blocks are igneous rocks, graywacke sandstones, serpentinite, chert, red limestone and mica schist. The rock forms high morphology such as the Sipako hill and Pagerbako hill.
b. Karangsambung Formation, the lithological characteristics of this formation consist of gray claystone containing iron concrete, numulites limestone, polymic conglomerates and laminated quartz sandstones. Graywacke sandstone to black claystone shows a scaly structure with slices in all directions and almost evenly on the surface. The structure is estimated as a result of the deposition mechanism that occurs under the surface of the water with large volumes. This estimate is supported by symptoms of degeneration seen in sandstone insets. The age of this formation is the Middle Eocene (45 million years) to the Late Eocene (36 million years) seen from the presence of plankton foraminifera.
c. Totogan Formation, this formation has the same characteristics as the Karangsambung Formation. It is characterized by lithology in the form of claystone with a brown color and sometimes purple with a flake structure (scaly). There are also fragments in the form of limestone trapped in mudstone, sandstone, fossil rocks and igneous rocks. The age of this formation is Oligocene (36-25 million years), based on the presence of Globoquadrina praedehiscens and Globigeriona binaensis.
d. Waturanda Formation, the age of this formation can only be determined directly based on the downward stratigraphic position estimated to be the age of the Miocene (25.2-5.2 million years) consisting of volcanic breccia and wacke sandstones with claystone inserts at the top. The base of the sandstone is gray with medium to coarse grains, consisting of igneous rock and obsidian rock pieces.
e. Penosogan Formation, this formation is deposited on top of the Waturanda Formation with lithology in the form of gradual changes from the unit of breccia to the top into the intersection of tuffaceous sandstone and claystone is the boundary feature of the Penosogan Formation which is located above it. In general, this formation consists of thin to medium layers of sandstone, claystone, some side-grains, calcarenite, tuffaceous claystone and tuffs. The lower part is generally characterized by the coating of sandstones and claystone, towards the higher carbonate levels. The upper part consists of coating the side sandstones, marl and calcarenite. The upper part is dominated by tuffaceous claystone and tuff. Layer thickness between 5-60 cm; gray, influenced by turbid currents. According to Iskandar (1974), op.cit (Asikin, Harsolumakso, Busono, & Gafoer, 1992) who discovered fossils of foraminifera in napal showed that this formation was Middle Miocene (N10-N15).
f. Halang Formation, this formation consists of smooth tufa and marl. In this unit there is also a layer of breccia. The difference with breccia from the Waturanda Formation is characterized by the composition of volcanic fragments which are more basaltic. The lower part of this unit is dominated by breccias, with the insertion of sandstones and marl. Upward, there are more inserts of sandstones, marl and claystone intervals. The tufa insert at the top of this is increasingly common. The age of this formation from the foraminifera content of marl at the bottom shows the Middle Miocene to the Late Miocene. At the top shows Late Miocene - Early Pliocene.
g. Peniron Formation, revealed quite extensively from Kebapangan to the west to Mergolangu in the north, is a type of various materials with andesite components, claystone, limestone; base of tuffaceous sandstones, tufa inserts. Fossils were not found, so it was rather difficult to determine their age correctly. According to Suyanto & Roskamil (1975) op.cit Asikin et al. (1992), the age of this unit is Pliocene (N19). This formation can be compared with Volcanic Rock (Tmpv) in Banjarnegara and Pekalongan sheets.
h. Alluvial River (fluvial), consisting of clay, sand, pebbles and cobbles which is not yet compacted and the youngest is the holocene-resen.

### *1.2 Geology of Bukit Parang*

Parang Hill, located 2 km from campus of LIPI Karangsambung, is a unique outcrop because it is a solitary hill that stands out in appearance. This hill is composed of igneous rock diabas with a burly structure that breaks through the claystone of Karangsambung formation. This hill also shows a columnar joints structure, a natural structure that is like adjoining poles. Age calculations use the K-Ar method by Soeria-Atmadja, et.al (1991) op.cit Setiawan., Yuwono, & IGB Eddy Sucipta (2011), the age of this diabas is 39.86 ± 3.31 Ma, which can be compared to the Late Eocene-Oligocene. Other intrusive hills that are the same age as Parang Hill are Basaltic-Andesitic Bujil Mountain (37.55 ± 1.96 Ma).

Setiawan. et al. (2011) argues that Bukit Parang is a product of tertiary volcanic activity with the affinity of the islands arc. Geomorphologically, based on the distribution of tertiary volcanic products and the chemical evolution of rocks can be interpreted that the center of eruption is around Dakah Village. The presence of natrolite as a secondary mineral indicates that mineralization and alteration processes occur in the deep sea environment. The absence of hydrous minerals such as amphibole and the lack of pyroclastic products in tertiary volcanic rocks indicates that volcanic activity is dominated by effusive phases originating from shallow plate subduction (Wilson, 1989 op.cit Setiawan. et al., 2011).

The gravitymeter survey by Kamtono, 1995 in Setiawan. et al. (2011), which produced a geological cross-sectional model of the Karangsambung area suggesting tertiary volcanic presence, especially in Bukit Parang, was a shallow diabas intrusion that break through with sediment melange of Karangsambung Formation and Totogan Formation.

## 2 Research Objectives

This research was conducted to determine the feasibility of Parang Hill as a geosite and geomorphosite of Geopark National Karangsambung-Karangbolong for geotourism development and spatial planning.

## 3 Research Methods

Assessing the feasibility of a site for tourism purposes based on this geology there are several parameters that must be met. Research on geotourism has been carried out by several researchers by quantifying various agreed parameters. But the authors still differ in terms of the details of the parameters that need to be quantified. Some of these authors are (Bruschi & Cendrero, 2005; Panizza, 2001; Pereira, Linden, & Weinberg, 2007; Pralong, 2005; Reynard & Coratza, 2007; Serrano & González-Trueba, 2005; Zouros, 2005).

Kubalíková (2013) has summarized and examined various parameters of the authors who were proposed to be quantified in evaluating the feasibility of a geosite. There are four main parameters agreed upon, namely geodiversivity, geoconservation, geosite and geomorphosite. From the 4 main things, it is divided into 5 main value parameters, namely; 1. Intristic and scientific values; 2. Value of Education; 3. Economic Value; 4. Conservation Value; and 5. Added Value. These five things are quantified (weighted) with values 0, 0.5 and 1. Range of assessment Kubalikova, 2013 from 0-1.

The author proposes that the assessment can be added to other values (other than 0, 0.5, and 1) as long as they are in the range 0-1. This assessment is needed so that this quantification method is more acceptable. After the total value is obtained, it is necessary to divide into three classes (classification) to make it easier to see the feasibility of geosite. The division into three classes uses an analysis of variance (ANOVA) to make a range of values. The three classes proposed are 1. Not feasible (0-0.3); 2. Fair enough (0.3-0.6); 3. Worth (0.6-1).

## 4 Research Results

### *4.1 Field Observation*

Bukit Parang is located 2 km from campus of LIPI Karangsambung to the north. The appearance of morphology is a prominent solitary hill. This hill is located in a fork in the road towards the villages of Dakah and Sadang. The distance from the road to about 200 meters shows the appearance of a vertical pole structure measuring 3-5 meters long and an average width of 0.5 meters. Diabas as a constituent rock of Parang Hill is megascopically blackish, hypocrystalline, porphyritic-phaneric, with black-gray matrix, with pyroxene and plagioclase phenocrysts that show diabasic or ophytic, euhedral structures. In the vicinity of Kali Jebug, hornfels metamorphic rocks are found which are the result of metamorphism from claystone. Hornfels is an indication of the baking effect when magma intrusions in the claystone of Karangsambung Formation. As a result of the magma intrusion, the claystone is altered and vitrified into hornfels metamorphic rocks.

### *4.2 Quantification of Feasibility Value of Geosite and Geomorfosite in Bukit Parang*

The author uses the assessment standard compiled by Kubalíková (2013) in the preparation of the main assessment parameters of the Parang Hill geosite and geomorphosite. The five main value parameters arranged can be seen in tables 1, 2, 3, 4, and table 5. Each main value has several values in accordance with the standards that have been prepared.

Assessment of Bukit Parang Intrinsic and Scientific Values produces a total score of 3 from a maximum score of 4, so the percentage of Bukit Parang Intrinsic and Scientific Values parameters is 75%. Intrinsic & Scientific Values consists of four values, namely; A. Integrity; B Uniqueness (number of location similarities); C. Diversity; D. Scientific knowledge. See tabel 1 and figure 4 for more details.

The assessment of Education Values resulted in a total score of 3.5 of a maximum score of 4, so the percentage of Bukit Parang Education Values parameters was 88%. Education Values consists of faour values, namely; A. Clarity of features/processes; B. Pedagogical use (teaching); C. Excistense of educational products; D. Use of current location for educational purposes. See tabel 2 and figure 6 for more details.

The research area is part of the South Serayu Mountains Zone. Van Bemmelen,1949 specifically divided the South Serayu Mountain Zone into two, the eastern and the western zones. The unique and rare Cretaceous –

Paleocene bedrocks were exposed in the middle of that two zones. In particular, geodiversity in this area makes this region decent to be the one of the national geopark in Indonesia (Bemmelen, 1949).

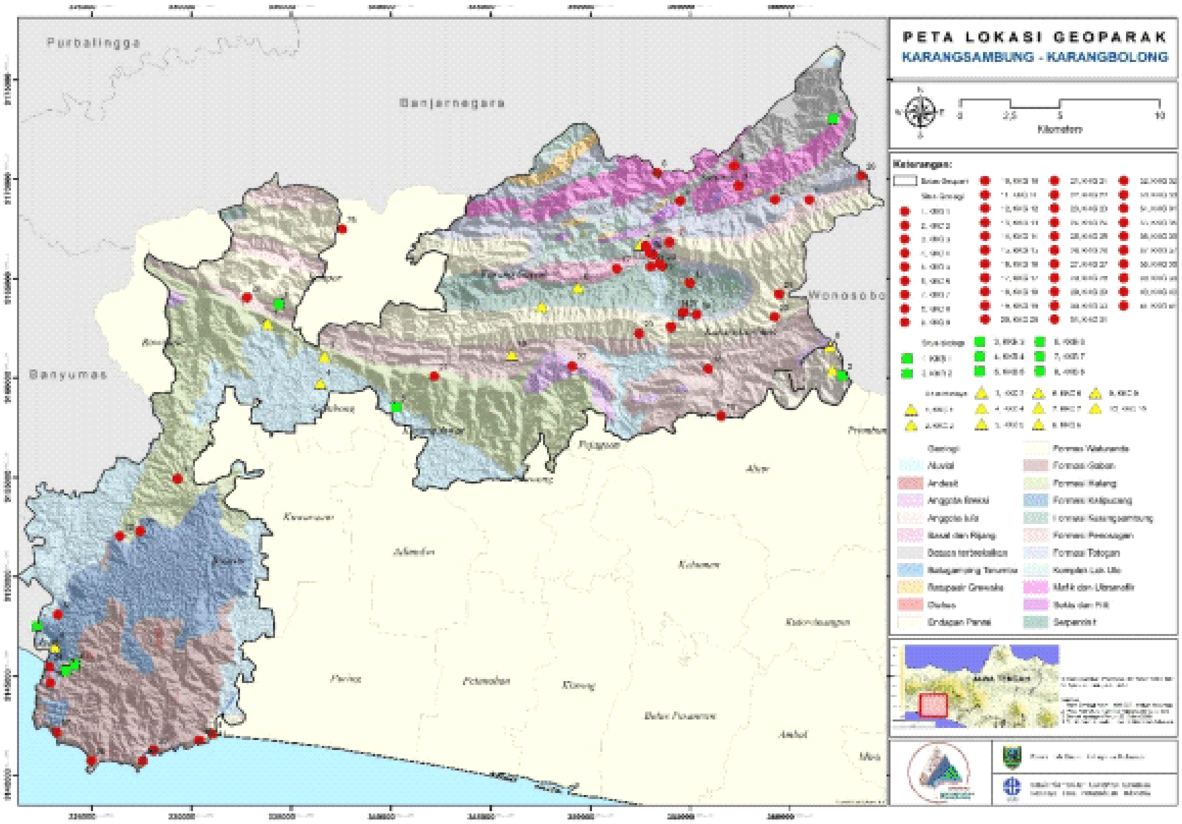


**Figure 3.** Map of geosites location in national geopark Karangsambung-Karangbolong (GNKK), Bukit Parang one of 41 geosites in national geopark Karangsambung-Karangbolong marked by black circle

**Table 1:** Assessment of Parameters of Intrinsic and Scientific Values

| | Intristic and Scientific Values | Scores (Kubalikova, 2013) | Score Bukit Parang |
|---|---|---|---|
| Integrity [A] | Overall, the location was damage | 0 | 0.5 |
| | The location is broken, but still shows abiotic formation | 0.5 | |
| | Location without damage | 1 | |
| Uniqueness (number of location similarities) [B] | More than 5 locations | 0 | 1 |
| | 2-5 similiar locations | 0.5 | |
| | Only 1 location in one area is interesting | 1 | |
| Diversity (Number of geomorphic processes that can be seen diversity) [C] | Only 1 location has features/processes that are visible | 0 | 0.5 |
| | 2-4 features/processes that are visible | 0.5 | |
| | More than 5 features/processes that are visible | 1 | |
| Scientific knowledge [D] | Location unknown | 0 | 1 |
| | Scientific paper on an national scale | 0.5 | |
| | Location has been widely known to the global community | 1 | |
| **Percentage (%)** | | | **75%** |

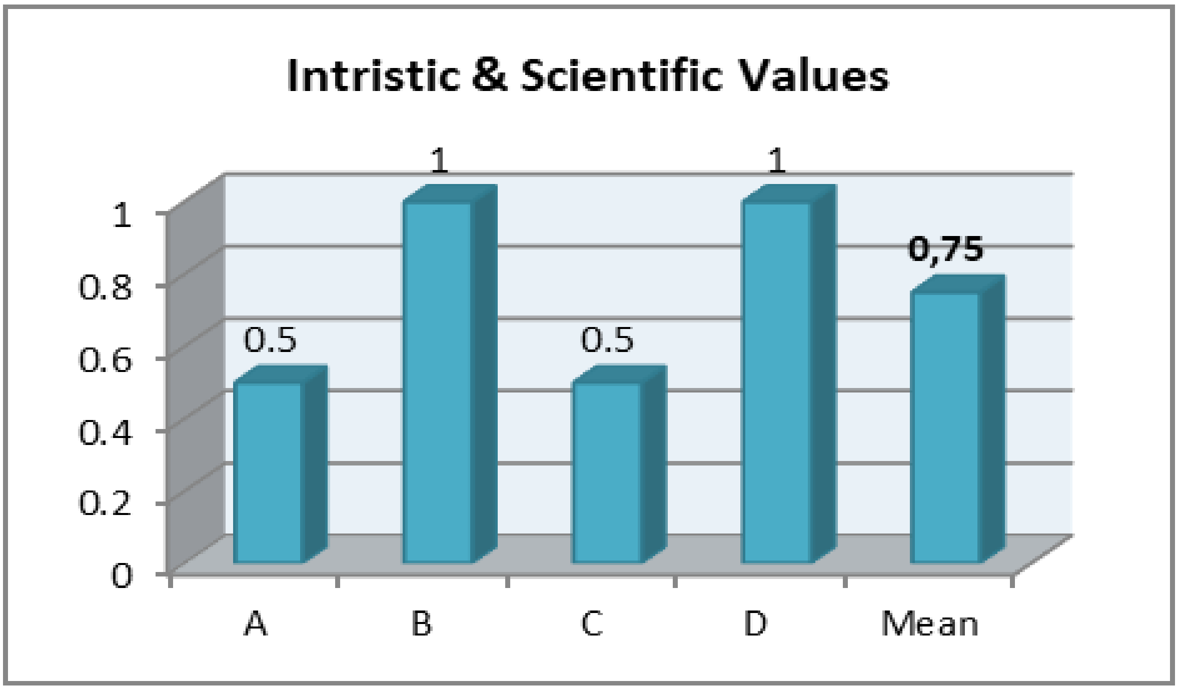


**Figure 4.** Graph of Intrinsic & Scientific Values


**Figure 5.** Existing conditions of Bukit Parang and its surroundings, photos taken 28 April 2019

**Tabel 2:** Assessment of Parameters of Educational Values

| | **Educational Values** | **Scores (Kubalikova, 2013)** | **Score Bukit Parang** |
|---|---|---|---|
| Clarity of features/processes [A] | Low or unclear representation | 0 | 1 |
| | Moderate representation, especially for academics | 0.5 | |
| | High representation can be recognized by ordinary people | 1 | |
| Pedagogical use (teaching) [B] | The low character value is no use of educational elements | 0 | 1 |
| | There are character values with the use of limited educational elements | 0.5 | |
| | High character values and high potential for education | 1 | |
| Existence of educational products [C] | There are no information instructions | 0 | 1 |
| | Leaflets, map, web pages | 0.5 | |
| | There is an information panel at that location | 1 | |
| Use of current location for educational purposes (excursion, accompaniment, etc) [D] | There is no benefit for education in that location | 0 | 0,5 |
| | Location is a place for special excursion (students) | 0.5 | |
| | Public places visited for the public | 1 | |
| **Percentage (%)** | | **87.5%** | |

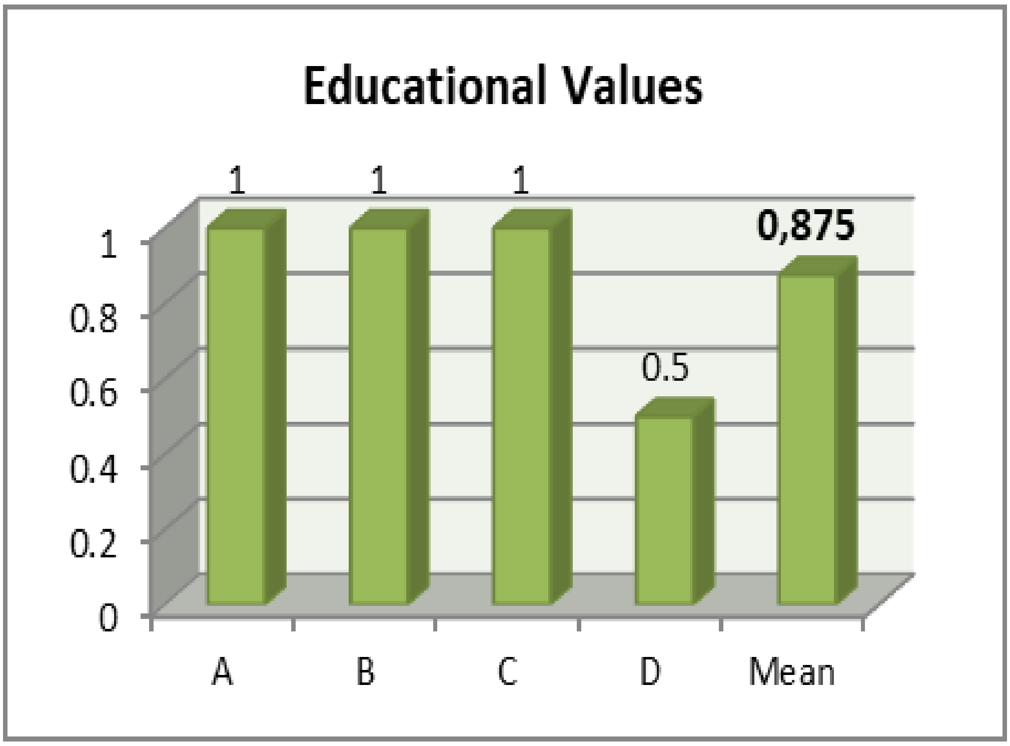


**Figure 6.** Graph of Education Values

The assessment of the Bukit Parang Economic Values resulted in a total score of 2 from a maximum score of 3, so that the percentage of the Bukit Parang Economic Values parameter was 66.67%. Details about the Economic Values parameters are shown in table 3 and figure 7. Economic Values consists of 3 values namely; A. Affordability; B. Density of Visitor Infrastructure; C. Local products.

The assessment of Bukit Parang Conservation Values produces a total score of 3 from a maximum score of 4, so the percentage of Bukit Parang Conservation Values parameters is 75%. Details about Conservation Values parameters are shown in table 4 and figure 8. Conservation values consist of 4 values, namely; A. Threats & Risks; B. Potential Threats & Risks; C. Current status updates location; D. Protection of legislation.

**Tabel 3:** Assessment of Parameters of Economic Values

| | Economic Values | Scores (Kubalikova, 2013) | Score Bukit Parang |
|---|---|---|---|
| Affordability [A] | More than 1000 m from the parking place | 0 | 1 |
| | Less than 1000 m from the parking place | 0.5 | |
| | More than 1000 m from the public transportation stops | 1 | |
| The availability of visitor infrastructures [B] | More than 10 km from the location there are tourist facilities | 0 | 1 |
| | 5-10 km of tourist/tourist facilities | 0.5 | |
| | Less than 5 km of tourist/tourist facilities | 1 | |
| Local products [C] | There are no local products related to the location | 0 | 0 |
| | Some products | 0.5 | |
| | Center for several local products | 1 | |
| **Percentage (%)** | | **66.67%** | |

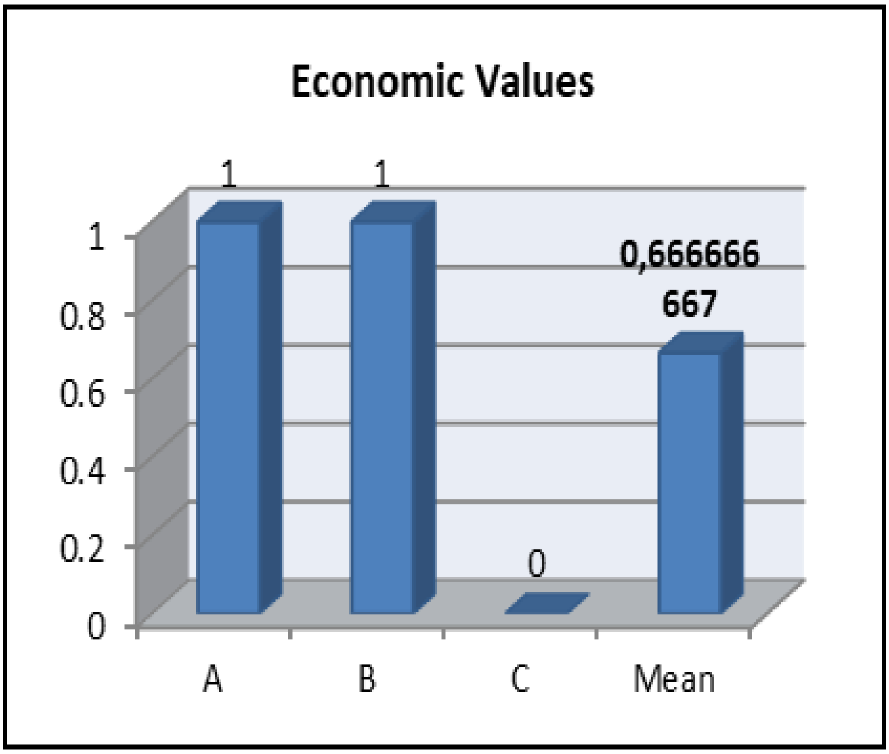


**Figure 7.** Graph of Economic Values

The assessment of the Bukit Parang Added Values resulted in a total score of 3 from a maximum score of 5, so that the percentage of the Bukit Parang Values Added parameter was 60%. Details about the Add Values parameter are shown in table 5 and figure 9. Added Values consists of 5 values namely; A. Ecological value of historical / archeological presence; B. Ecological Value; C. Aesthetic Value; D. Space structure; E. Viewpoint.

Statistical calculations using Surfer 7 software, produces a total score of all parameters 14, mean 0.74, median 1, standard deviation 0.31, with the coefficient of variation 0.4. After all statistical calculations about various assessments, the author classifies and calculates ANOVA to determine into three classes, namely Not Feasible, Fair Enough and Worthy. So that the total score of the class division is shown in table 6.

Bukit Parang, as a geosite in National Geopark of Karangsambung-Karangbolong has a total average value of all parameters is 0.74. This value is included in Worthy class type in Classification of Total Average Score Assesment. This Worthy Class type shows that Parang Hill is suitable and feasible to be developed as a tourist place in one of the geosite parts of the GNKK. The existence of Gunung Parang is in accordance with spatial planning, land use and can be developed as geotourism area. See tabel 6 for more details.

Some of the things that still need to be developed in the geosite of Parang hill so that the geotourism area can be increased in value are local products in economic value and ecological, aesthetic value, and the structure of space in added value can still be improved.

**Tabel 4:** Assessment of Parameters of Conservation Values

| Conservation Values | | Scores (Kubalikova, 2013) | Score Bukit Parang |
|---|---|---|---|
| Current threats and risks [A] | High natural and environmental risks | 0 | 0.5 |
| | Existing risks can damage the location | 0.5 | |
| | Low risk and almost no threat | 1 | |
| Potential threats and risks [B] | High natural and environmental risks | 0 | 0.5 |
| | Previously there were risk that could damage the location | 0.5 | |
| | Low risk and almost no threat | 1 | |
| Current status regarding location [C] | Further damage on location | 0 | 1 |
| | Location has been damaged but the management has measuring to prevent damage | 0.5 | |
| | There is an informational panel at that location | 1 | |
| Legislative protection [D] | There is no benefit for education in that location | 0 | 1 |
| | Location is a place for special excursion (students) | 0.5 | |
| | Public places visited for the public | 1 | |
| **Percentage (%)** | | | **75%** |

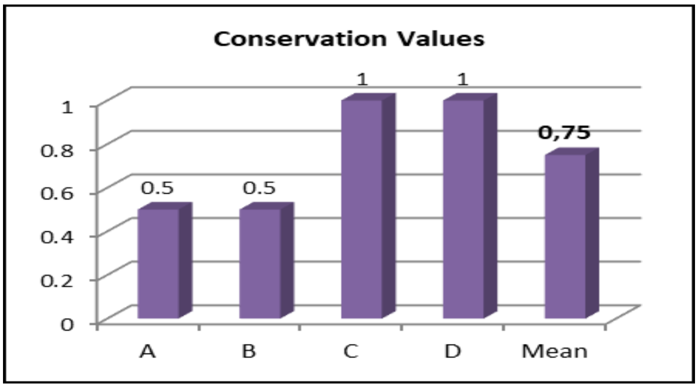


**Figure 8.** Graph of Conservation Value

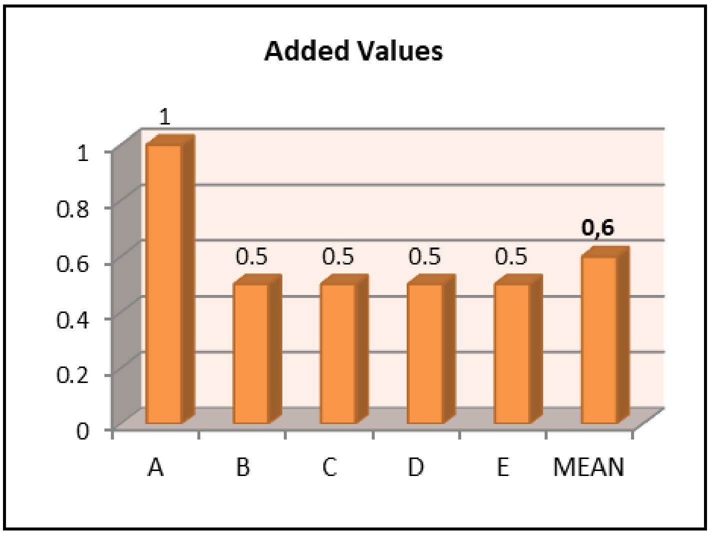


**Figure 9.** Graph of Added Values

**Tabel 5: Assessment of Parameters of Values Added**

| | Values added | Score (Kubalikova, 2013) | Score Bukit Parang |
|---|---|---|---|
| Ecological value; historical/archeological presence [A] | There is no cultural elements | 0 | 1 |
| | There are cultural elements but no related to abiotic elements | 0.5 | |
| | There is a strong cultural connection with abiotic elements | 1 | |
| Ecological value [B] | Not Important | 0 | 0.5 |
| | There is influnce but not too important | 0.5 | |
| | The importace of the influence of geomophic aspect of the ecology araound it | 1 | |
| Aesthetic value [C] | One color | 0 | 0.5 |
| | 2-3 color | 0.5 | |
| | More than 3 color | 1 | |
| Space structure [D] | Only 1 pattern | 0 | 0.5 |
| | 2-3 pattern | 0.5 | |
| | More than 3 patterns | 1 | |
| Viewpoint [E] | There is no viewpoint | 0 | 0.5 |
| | 1-2 pattern | 0.5 | |
| | More than 3 patterns | 1 | |
| **Percentage (%)** | | | **60%** |

## 5 Conclusions and Recommendation

Based on the research on the assessment of geosite and geomorphosite in Bukit Parang, are several that can be concluded, there are; Parang Hill is a 39 Ma diabas igneous rocks intrusion hill. Bukit Parang is one of 41 geosite in national geopark GNKK. Bukit Parang has a total average value of all parameters of 0.74 where the value is included as Worth Class Type, so that the hill of Parang is suitable and appropriate as part of geosite and geomorphosite in the national geopark GNKK. With a value of 0.74, then the Parang Hill is in accordance with regional planning, land use and the development of geotourism going forward. Some things that can still be improved are producing local products as part of economic value. Another aspect that can still be improved is added value which includes ecological values, aesthetics and spatial structure.

**Tabel 6:** Classification of Total Score Assesment

| Class type | Total Assesment Score |
|---|---|
| Not feasible | 0 – 0.3 |
| Fair enough | 0.3 – 0.6 |
| Worthy | 0.6 - 1 |

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