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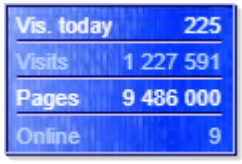

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Assessment of the values of science, education, tourism and the risk degradation of geothermal areas to developing geotourism in the Limboto Lake Plain, Gorontalo

Intan Noviantari Manyoe(a), Yayu Indriati Arifin(a), Siti Suhartini S. Napu(a)*

a) Geological Engineering Major, Faculty of Mathematics and Natural Science, Universitas Negeri Gorontalo
*intan.manyoe@ung.ac.id

Abstract

Geothermal areas are unique. Therefore, it can be developed to become a geotourism destination. Limboto Lake plain has geothermal potential which is indicated by the appearance of several points of

manifestations. This study aims to assess the value of science, education, tourism and the risk degradation in the geothermal area of the Limboto Lake plain. The method used is the assessment of the value of science, education, tourism and the risk degradation issued by the Geological Agency. The assessment was carried out in two geothermal areas located on the plain of Lake Limboto, namely Geothermal Pentadio and Geothermal Bongongoayu. The results showed that the weighting of the criteria for the values of science, education, tourism and the risk degradation in the Pentadio geothermal area were 73.75%, 73.75%, 75%, 65%, respectively. Weighted criteria for the values of science, education, tourism and the risk degradation in the geothermal area of Bongongoayu are 48.75%, 60%, 58.75%, 62.5%, respectively. **(Approx. 155 words)**

Keywords: Geology- Geotourism- Hotsprings- Manifestation- Geodiversity

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Geological study of Pantai Indah for geotourism development in the Gorontalo area based on geological observation and assessment of science, education, tourism and the risk degradation

Yayu Indriati Arifin (a), Intan Noviantari Manyoe (a), Siti Suhartini S. Napu (a)*

a) Geological Engineering Major, Faculty of Mathematics and Natural Science, Universitas Negeri Gorontalo
*intan.manyoe@ung.ac.id

Abstract

Gorontalo has geological diversity that can be developed for geotourism. One of the tourist destinations of Gorontalo that has geological features is Pantai Indah. This study aims to examine the geological features in the Pantai Indah area based on the assessment of the value of science, education, tourism and the risk degradation. The method used is geological observation and geological feature assessment issued by the Geological Agency. The results showed that the landforms of Pantai Indah were composed of intrusion hills and marine plains. The lithology of the Pantai Indah area is granite and alluvial deposits. There is a geological structure in the form of a normal fault. The weighting of the criteria for the values of science, education, tourism and the risk degradation in the Pantai Indah area is 53.75%, 77.5%, 65%, 76.25%, respectively. **(Approx. 135 words)**

Keywords: Geology- Geotourism- Granite- Normal Fault- Geodiversity

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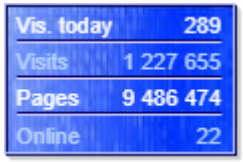

Geological study of Pantai Indah for geotourism development in the Gorontalo area based on geological observation and assessment of science, education, tourism and the risk degradation

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Abstract. Gorontalo has geological diversity that can be developed for geotourism. One of the tourist destinations of Gorontalo that has geological features is Pantai Indah. This study aims to examine the geological features in the Pantai Indah area based on the assessment of the value of science, education, tourism and the risk degradation. The method used is geological observation and geological feature assessment issued by the Geological Agency. The results showed that the landforms of Pantai Indah were composed of intrusion hills and marine plains. The lithology of the Pantai Indah area is granite and alluvial deposits. There is a geological structure in the form of a normal fault. The weighting of the criteria for the values of science, education, tourism and the risk degradation in the Pantai Indah area is 53.75%, 77.5%, 65%, 76.25%, respectively.

Keywords: Geosite, Geodiversity, Granite, Beach, Lahilote Folklore.

1. Introduction

Geodiversity is the diversity of geological features, including rocks, minerals, fossils, soils, geological units and landscapes that are the result of the evolution and history of the Earth [1]. Indonesia is an interesting area in terms of geology. It is located at the junction of three large plates that collide with each other and within hundreds of millions of years it has resulted in geological diversity in terms of geodiversity and has become a geological heritage. Besides that, 127 volcanoes were recorded, known as the Ring of Fire as a geological phenomenon that has the potential to be developed into geological tourism known as geotourism and on a world scale called a geopark.

Geological diversity and uniqueness provide its own value to become a huge potential geological heritage throughout Indonesia. This potential is very strategic to support the geological resource conservation program and the development of the geological-based tourism sector through the geopark concept. Based on the existing potential, it is necessary to build an integrated management system so that it can be used for the welfare of the community [2].

One of the assessments of the feasibility of geological diversity into a geological heritage can be based on rankings, namely international, national or local. This ranking is based on the determination and assessment of the main aspects of geological diversity in the form of rocks, fossils, geological structures, landscapes and geological evolutionary processes. In addition, an assessment of the aspects of science, education, tourism and the risk of degradation is also carried out, so that the clustering and ranking of geodiversity can be obtained [2].

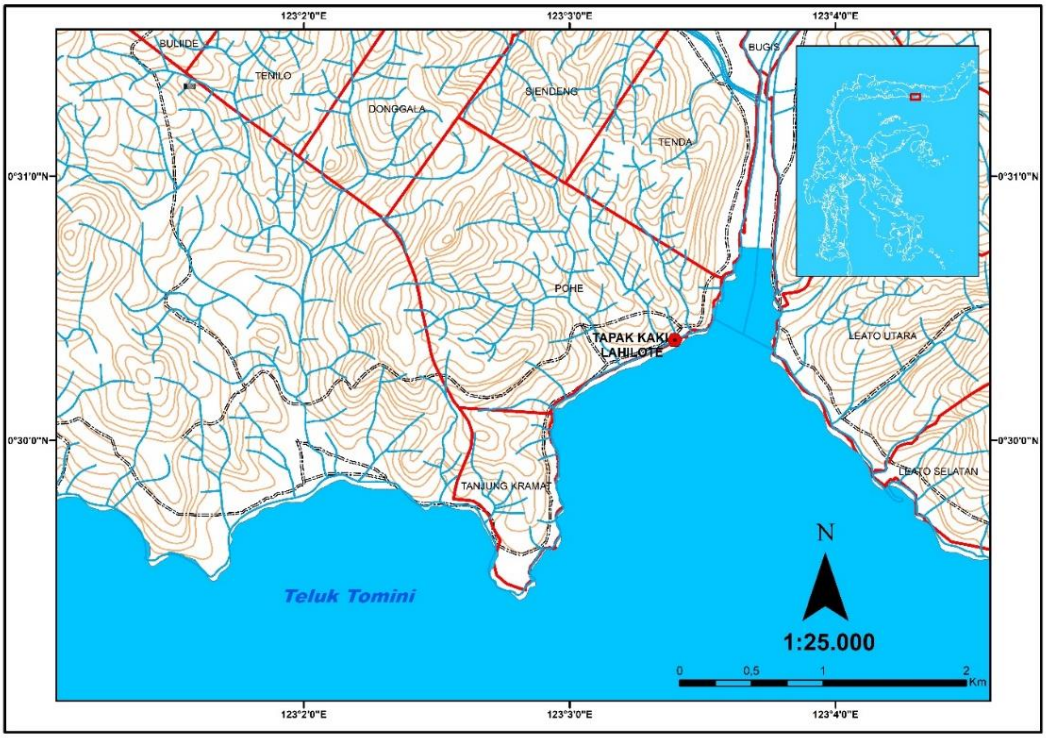

Figure 1. Research location.

Gorontalo Province is included in the North Arm of Sulawesi. Based on the regional lithotectonic structure, Gorontalo Province is included in the West Mandala. The West Mandala is a magmatic route located at the eastern end of the Sunda Shelf. Gorontalo Province is part of the volcanic-plutonic route of North Sulawesi, which is composed of eocene-pliocene volcanic rocks and intrution rocks. Gorontalo as an active magmatic and tectonic path is what causes this area to have a complex geology both in structure and lithology [3].

Pantai Indah is one of the areas in Gorontalo which is on the south coast. Pantai Indah is directly adjacent to Tomini Bay. The tourism research conducted on the south coast is a research by Septian et.al., [4] but this research does not cover all areas on the south coast. Geological research has not been carried out in the Pantai Indah area to assess existing geological features. Meanwhile, research by Kurniawan et.al [5] has discussed the Gorontalo geopark but did not discuss the Pantai Indah area. The purpose of this study is to assess science, education, tourism and the risk of degradation in the Pantai Indah area. This research is expected to be the basis for tourism development in the Pantai Indah area.

2. Methods

Research methods include geological observation and assessment of the values of science, education, tourism, and the risk of degradation (Figure 2). Geological observation aims to identify the geodiversity of geological features of the study area. The assessment of science, education, tourism and risk of degradation aims to assess the geological features found in the study area.

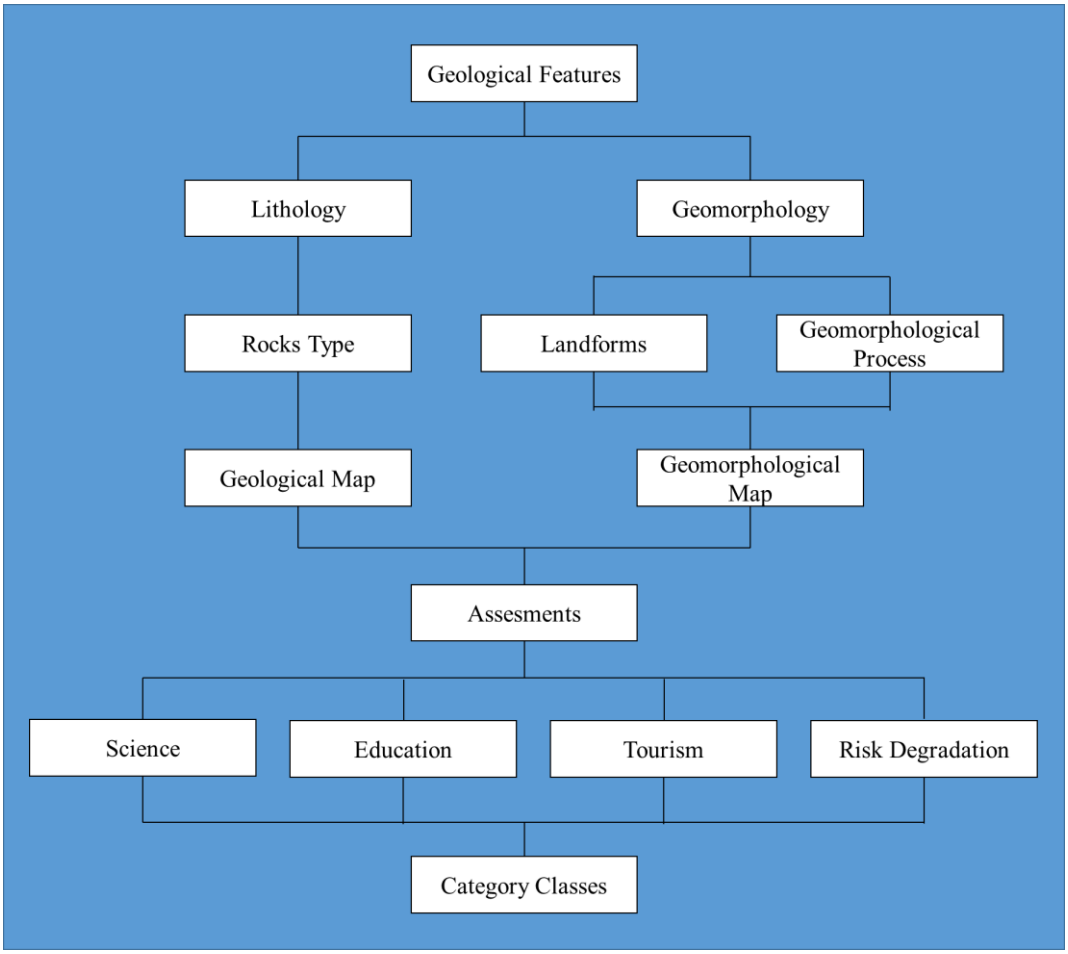

Figure 2. Research flow diagram.

Geological observations include lithology and geomorphological observations. The lithology observation includes the characteristics and types of lithology. Geomorphological observations include observations of landforms and geomorphological processes. Lithological analysis is based on petrological analysis which is carried out macroscopically. Geomorphological analysis of the study area based on the classification of Van Zuidam [6]. Assessment of the value of science, education, tourism and the risk of degradation based on the assessment established by the Geological Survey Agency [2].

After the assessment of the values of science, education, tourism, and the risk of degradation, class categories were determined. Determination of class categories based on the sum of the values of science, education, tourism, and the risk of degradation. The class category is divided into low scientific categories (<200), medium scientific categories (201-300), and good scientific categories (301-400).

3. Results and Discussion

3.1 Geodiversity of geological features

The Pantai Indah area is located in Pohe Village, Hulonthalangi District, Gorontalo City. Based on the geographical conditions, Pohe Village is located at coordinates N 00°30'5.89" – 00°30'36.1" and E 123°2'56.53"– 123°3'3.34". Pantai Indah Lahilote has geodiversity sites in the form of beaches, bays, granite cliffs, and Lahilote folklore site.

Pantai Indah is located in the western part of the Bone River estuary. Pantai Indah is located close to Tomini Bay. The landforms of Pantai Indah include intrusion hills and marine plains. Marine plains are composed of material in the form of sand deposits (Figure 3).

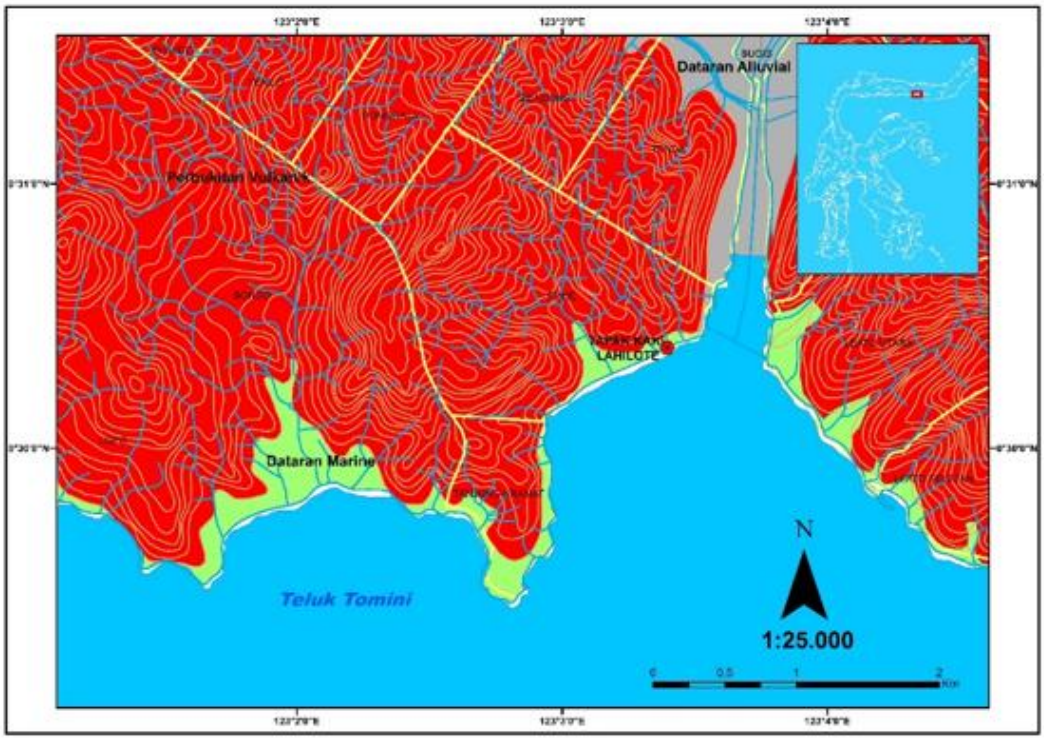

Figure 3. Geomorphological map of Pantai Indah.

The sand on Pantai Indah is the result of sedimentation due to the influence of the waves of Tomini Bay. Sand is carried by the Bone River and Bolango River towards the waters of Tomini Bay. Marine plain land use is as a tourist area and community small business facilities.

In addition to sand deposits on the marine plains, there are also blocks of granite. Granite boulders are the result of granite weathering in the intrusion hills and are transported to the marine plains. The material for volcanic hills is granite. Volcanic hills are used for infrastructure development, settlements and areas of wild vegetation.

Figure 4. Pantai Indah marine plains.

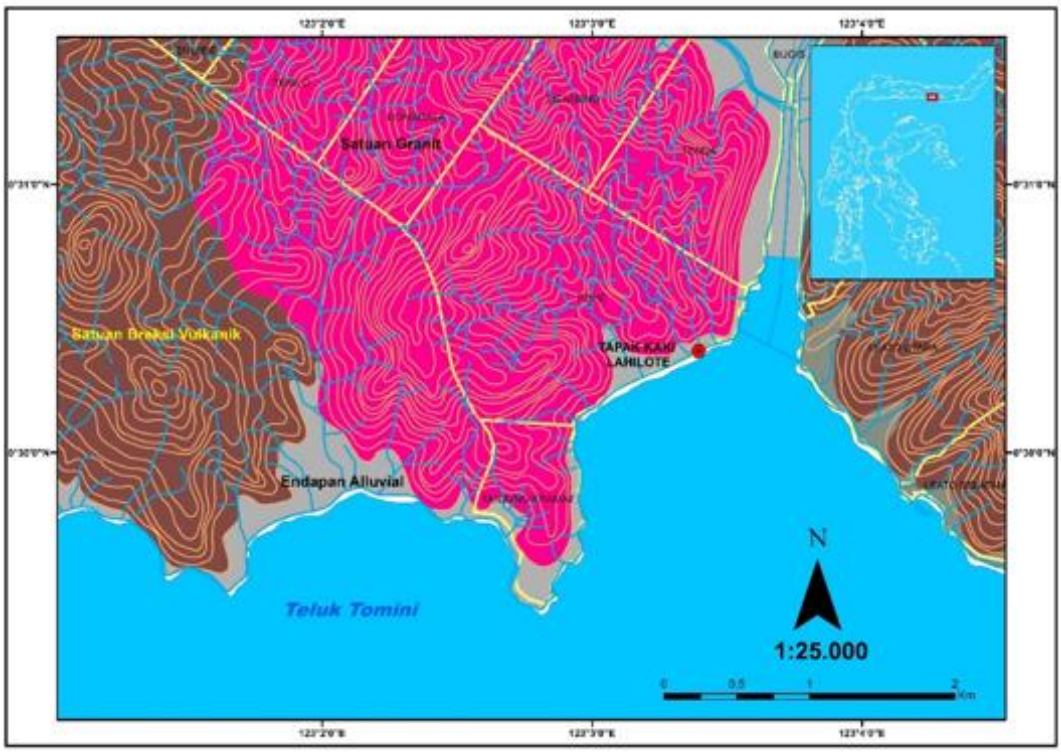

Figure 5. Geological map of Pantai Indah.

Figure 6. The Pantai Indah granite outcrop and the Lahilote site.

Granite at Pantai Indah has the characteristics of white to gray, subhedral, feneritic, inequegranular, and holocrystalline. The minerals that formed rocks are biotite, plagioclase, quartz, and hornblende. There are granite boulders that are shaped like footprints in the valleys of the volcanic mountains. This granite boulder in the folklore of Gorontalo is known as Tapak Kaki Lahilote.

3.2 Assessment of the Values of Science, Education, Tourism and the Risk of Degradation of the Pantai Indah Area

3.2.1 Science Values Assessment

Weights for various criteria used for the assessment of a geological heritage site based on scientific values in the Pantai Indah geosite reach a weight of 53.75% (Table 1). Location criteria that represent the geological framework are 15%, key research locations are 15%, scientific understanding is 5%, geological site conditions are 3.75%, geological diversity is 3.75%, the presence of geological heritage sites in an area is 3.75%, and barriers to use of locations weighing 7.5 %.

Table 1. Weighting criteria for science risk values.

No.	Criteria	Weight (%)
1	A location that represents a geological framework	15,00
2	Key research locations	15,00
3	Scientific understanding	5,00
4	Geological conditions / sites	3,75
5	Geological diversity	3,75
6	The existence of a geological heritage site in an area	3,75
7	Location usage barriers	7,50
Total		**53,75**

Granite rocks are common in the study area. The location of the geological heritage site is used as a research reference and as an article related to the geological framework, published on an international scale. The location of the geological heritage site is not well preserved, and the geological features have undergone changes or modifications in the form of road infrastructure development and sea wave barriers.

The location of the geological heritage site has four geological features related to science, namely minerals, rocks, geological structures and landscapes. In the study area there are four to five other locations that are the same as geological heritage sites, related to the geological framework, namely

lithological similarities. Field activities and sampling can be carried out at the location of this geological heritage site, after resolving obstacles in the form of a permit from the local government.

3.2.2. Assessment of Educational Values

The weights for the various criteria used for the assessment of a geological heritage site based on the educational values of the Pantai Indah geosite are 77.5% (Table 2). The criteria for vulnerability are 5%, location attainment is 10%, barriers to site utilization are 2.5%, security facilities are 7.5%, supporting facilities are 5% and population density is 5%. The relationship with other values is 1.25%, location status is 2.5%, peculiarity is 1.25%, conditions in geological element observation are 10%, information potential of education / research is 20% and geological diversity is 7.5%.

Table 2. Weighting criteria for educational values.

No.	Criteria	Weight (%)
1	Vulnerability	5
2	Location reach	10
3	Site utilization barriers	2,5
4	Security facility	7,5
5	Supporting facilities	5
6	Population density	5
7	Relationship with other values	1,25
8	Location status	2,5
9	Peculiarity	1,25
10	Conditions in geological element observations	10
11	Potential of educational / research information	20
12	Geological diversity	7,5
Total		**77,5**

There is a possibility of damage to major geological elements at the site site. Possible damage to the main geological element, namely in the granite rock because it is used for the construction of road infrastructure and as a wave embankment. The geological heritage site is located less than 100 m from the village road and the bus parking lot. The location of the Pantai Indah site is right opposite the village road. The location of the geological heritage site can be used by students and tourists after overcoming obstacles in the form of permits from related agencies.

Geological heritage sites have security facilities (fences, stairs, handrails, etc.), are within reach of telephone signals, and are less than 25 km from emergency installations. Pantai Indah is 9 km from the emergency installation of Aloe Saboe Hospital. The accommodation and restaurant for groups of 50 people are less than 15 km from the site of the geological heritage site. Lodging and restaurants such as the Maqna Hotel which can accommodate groups of 50 people are 5.3 km from Pantai Indah.

Geological heritage sites are located in districts/cities with densities of more than 1000 people/km^2. Pantai Indah is located in Gorontalo City. The population density of Gorontalo City is 2268.37 people/km^2. One ecological value and/or cultural value is found less than 10 km from the location of the geological heritage site, namely the Laholite folklore site. Geological heritage sites are used as local tourist destinations. Generally, the location of the site is used by the community for beach tourism.

Geological heritage sites are common locations throughout the country. The location of this geological heritage site displays geological features taught at all levels, namely the geological features of the marine plains. Geological heritage site locations have 3 geological diversity features. The site location is not found in any fossil elements.

3.2.3. Tourism Values Assessment

Weights for the various criteria used for the assessment of a geological heritage site based on tourism values in the Pantai Indah geosite reach a weight of 65% (Table 3). The criteria for vulnerability are 5%, location attainment is 10%, barriers to site utilization are 2.5%, security facilities are 7.5%, supporting facilities are 5% and population density is 5%. The relationship with other values is 1.25%, location status 7.5%, specificity 2.5%, conditions on geological element observation 5%, interpretive potential 7.5%, economic level 1.25% and weight close to 5% recreation area.

The assessment of the interpretive potential value shows that the community needs some geological knowledge to be able to understand geological features in a geological heritage site. Meanwhile, the economic level assessment shows that the location of geological heritage sites in cities with household income is lower than the national average because the income of the population in Gorontalo City is Rp. 3,795,931.44.

Geological heritage sites located less than 5 km from recreational areas or tourist attractions. Pantai Indah is a tourist attraction managed by the Gorontalo City government. Pantai Indah is 5.3 m from the religious tourism village of Bongo.

Table 3. Weighting criteria for tourism values.

No.	Kriteria	Weight (%)
1	Vulnerability	5
2	Location reach	10
3	Site utilization barriers	2,5
4	Security facility	7,5
5	Supporting facilities	5
6	Population density	5
7	Relationship with other values	1,25
8	Location status	7,5
9	Peculiarity	2,5
10	Conditions in the observation of geological elements	5
11	Interpretive potential	7,5
12	Economic level	1,25
13	Close to recreation areas	5
Total		**65**

3.2.4 Assessment of Risk of Degradation

The weights for the various criteria used for the assessment of a geological heritage site based on the values of the risk of degradation in the Pantai Indah geosite reach a weight of 76.25% (Table 4). The criteria for damage to geological elements are 26.25%, adjacent to areas / activities that have the potential to cause degradation by 20%, legal protection 5%, accessibility 15%, and population density with a weight of 10%. The risk of degradation in the Pantai Indah area reaches 76.25 which means it

has a high risk of degradation.

The possibility of damage to the main geological features of the granite rock due to infrastructure development. The location point is less than 50 m with the area/activity that causes degradation. Besides being close to the road, it is also in the Gorontalo Fault zone.

The location point is located in an area that has legal protection and has access control from the local government. The location is located less than 100 m from the main road and there is a bus parking lot. The location points are in a city with a population density of more than 1000 inhabitants/km^2. The population density of Gorontalo City is 2,668 people/km^2.

Table 4. Weighted criteria for degradation risk values.

No.	Criteria	Weight (%)
1	Damage to geological elements	26,25
2	Adjacent to areas / activities that have the potential to cause degradation	20
3	Legal protection	5
4	Accessibility	15
5	Population density	10
Total		**76,25**

6. Conclusions

Pantai Indah has four geosites, namely beaches, bays, granite cliffs, the folklore site of Lahilote. Educational values have the highest weight. The lowest weight belongs to science values. The Pantai Indah area has a high risk of degradation. Tourism values have low values. There is a need for management of the geosites at Pantai Indah to increase the value of science, education and tourism and to avoid the risk of degradation.

Acknowledgements

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