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GEOSITE AND GEOMORPHOSITE ASSESSMENT FOR GEOTOURISM PURPOSE: CASE STUDY OF THE ISLANDS IN KWANDANG BAY, NORTH GORONTALO

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Abstrak

Keragaman geologi Gorontalo dapat dimanfaatkan untuk pengembangan geowisata, namun kajian geowisata di Gorontalo belum dilakukan secara komprehensif. Tujuan dari penelitian ini adalah untuk mengkaji geosite dan geomorphosite pulau-pulau di Teluk Kwandang, Gorontalo Utara, yaitu Pulau Ponelo, Pulau Saronde, Pulau Bogisa, dan Pulau Hulawa. Tahapan penelitian meliputi tahap pengumpulan data lapangan melalui survei geologi, pengolahan, dan analisis data. Penilaian geosite dan geomorphosite menggunakan metode Kubalikova. Hasil penelitian menunjukkan bahwa terdapat delapan situs di pulau-pulau tersebut, yaitu tebing basalt, wave-cut platform, tombolo, pasir putih Saronde, spit, andesit, dan pasir putih Hulawa. Nilai tertinggi diperoleh Pulau Ponelo dan Pulau Bogisa pada nilai ekonomi karena aksesibilitasnya yang baik. Nilai tertinggi Pulau Saronde adalah pada nilai edukasi karena memiliki aspek geowisata dan merupakan tempat yang banyak dikunjungi masyarakat. Nilai tertinggi untuk Pulau Hulawa merupakan nilai tambah karena terdapat aspek sejarah dan arkeologi kolonial Belanda. Nilai total penilaian geosite dan geomorphosite di Pulau Ponelo, Saronde, Bogisa, dan Hulawa berturut-turut adalah 7,5, 8,5, 6,5, dan 8,5. Geosite dan geomorphosite di pulau-pulau di Teluk Kwandang sangat bernilai baik dari segi ilmiah, pendidikan, konservasi, ekonomi dan nilai tambah.
Kata kunci: *Bentangalam marin, Geologi, Geomorfologi, Budaya.*

Abstract

Gorontalo's geological diversity can be utilized for the development of geotourism, but the study of geotourism in Gorontalo has not been carried out comprehensively. The purpose of this study is to assess the geosite and geomorphosite of islands in Kwandang Bay, North Gorontalo, namely Ponelo Island, Saronde Island, Bogisa Island, and Hulawa Island. Stages of research include the stage of field data collection through geological surveys, processing, and data analysis. Geosite and geomorphosite assessments use the Kubalikova method. The results showed that there were eight sites on the islands, namely basalt cliffs, wave-cut platforms, tombolo, Saronde white sand, spit, andesite, and Hulawa white sand. The highest score gotten by Ponelo Island and Bogisa Island is on the economic value due to its good accessibility. The highest score of Saronde Island is on educational value because it has a geotourism aspect and is a public visited place. The highest score for Hulawa Island is the additional value because there are aspects of history and archeology of the Netherland colonial. The total values of geosite and geomorphosite assessment in Ponelo, Saronde, Bogisa, and Hulawa Island consecutively are 7.5, 8.5, 6.5, and 8.5. Geosite and geomorphosite on the islands in Kwandang Bay are valuable in terms of scientific, educational, conservation, economic and additional value.
Key words: *Marine landforms, Geology, Geomorphology, Culture.*

INTRODUCTION

Geotourism is a sustainable tourism which focus on geological features that leads understanding to environment and culture, appreciation, conservation, and is locally beneficial (Dowling, 2013). Geotourism promotes geosite tourism and biodiversity conservation as well as a scientific understanding of earth science through appreciation and learning for the tourist (Dowling & Newsome, 2010). Geotourism is defined as sustainable earth tourism as it protects geosite. In addition Robinson (2015) defines geotourism as a tourism that focuses on the landform or other geological features which

related to the culture, ecology and creating geotourism products.

Gorontalo province is located in the North Arm of Sulawesi. The lithological composition of Gorontalo consists of igneous, sedimentary and metamorphic rock (Bachri et al., 1993). The North Arm of Sulawesi, including Gorontalo is formed through the complex tectonic process. There are triple-junction of three macro plates: India-Australia, Eurasia, and pacific, as well as the Philippine micro-plate, contributing to complex tectonic processes in the North Arm of Sulawesi. There is also Celebes Sea subduction on the north side and Sangihe subduction on the east and south side of Gorontalo.

The geological processes that occur in Gorontalo have a great potential to produce various geosites and geomorphosites. The existence of geosites and geomorphosites can be developed to improve the economy of the local communities.

The research on geosite and geomorphosite in Gorontalo is not yet conducted comprehensively, not proportional to the potential possessed if it refers to geological processes that occur in Gorontalo.

A research by Suharto & Adam (2016) in North Gorontalo was conducted on Raja Island only and focused on potential attraction without a detailed discussion on geosite and geomorphosite. There has not been any research yet on geotourism in the islands located in Kwandang Bay, North Gorontalo. Therefore, this research aims to assess geosite and geomorphosite in the islands located in Kwandang Bay for the purpose of geotourism development.

RESEARCH METHODS

Administratively, the research site is located in Ponelo Kepulauan Sub-district, North Gorontalo District. Astronomically, it is located at the coordinates of N 0°50'49"-0°58'16" and E 122°50'20"-122°54'50" (Figure 1). The research is conducted in four islands at Kwandang Bay, Ponelo Kepulauan Sub-district, North Gorontalo Utara namely Ponelo, Saronde, Bogisa, and Hulawa Island.

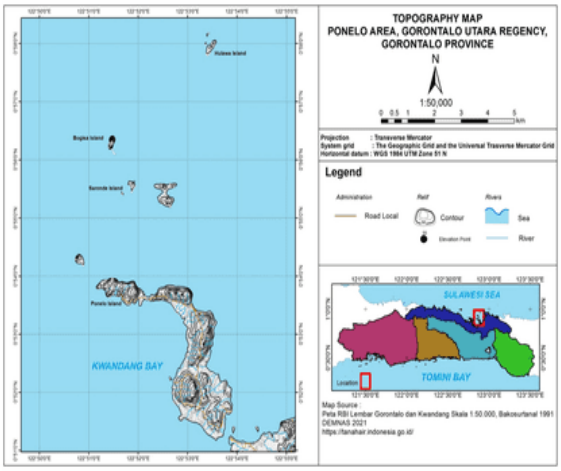

Figure 1. Research location.

The research preparation stage is conducted by preparing field equipment and literature review on previous research. The field equipment used to support the research is Garmin GPS (Global Positioning System) receiver, geological hammer, Brunton geological compass, Grain size comparator, and minerals comparator. Other types of equipment include loupe, digital camera, sample bag, HCL 0.1 N, field geology stationeries, and geotourism assessment sheet. The literature study on the research site subsumes regional geological study and geotourism study.

Geological data collection consist of geomorphology and lithology data. Geomorphology data collection gathered through satellite image and field survey. Lithology data collection gathered through field survey. Data collection produces geotourism sites which are assessed through assessment method based on geosite and geomorphosite parameter by Kubalíková (2013).

RESULTS AND DISCUSSION

The research is conducted in four islands at Kwandang Bay, Ponelo Kepulauan Sub-district, North Gorontalo namely Ponelo, Saronde, Bogisa, and Hulawa Island. Based on the interpretation of satellite image and field observation, it is revealed that geosite and geomorphosite in the research site which have geotourism potential. Should this potential utilized, it can improve the local community's economy.

1. Geotourism Potential of Ponelo Island

Ponelo Island is located on the coordinates of N 0°51'11"-0°53'56" and E 122°51'4"-122°53'56". The elevation of Ponelo Island is 0 - 108 meters above sea level. Geosite

and geomorphosite found in the field are tombolo (Figure 2) and basalt cliffs (Figure 3).

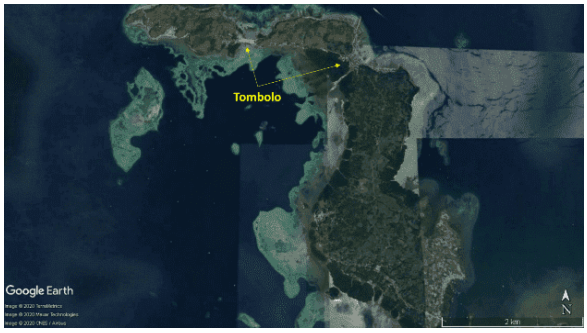

Figure 2. The geological site in Ponelo Island (Google Earth, 2020).

Tombolo is geomorfological units that connecting an island with wider land or between one island with another. Tombolo is formed from the marine process in the form of sediment deposition due to sea currents. Tombolo in Ponelo Island is currently utilized by the community as residential áreas and public facilities such as school and village administration office.

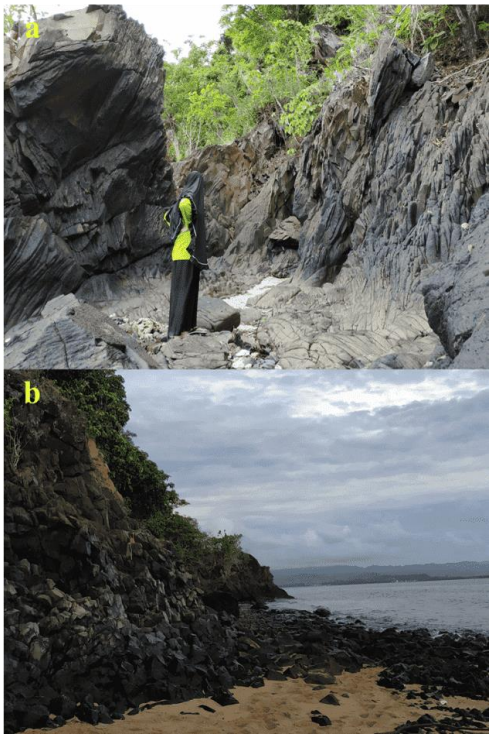

Figure 3. a) Vertical strips on basalt cliffs; b). Basalt cliffs and wave-cut platform.

The second geological site in Ponelo Island is basalt cliffs. Based on the regional geological data (Bachri et al., 1993), Ponelo island is composed of unit of rocks such as conglomerate, sandstone, conglomerate sandstones, tuff sandstones, tuff, claystone, and shale. The result of field geological survey reveals that there is a basalt unit in Ponelo Island

Basalt outcrop located at the northwest part of Ponelo Island, precisely on the coast of Malambe village, with the dimension of width 30 m and height 15 m. The lithology characterized by black-colored (fresh) until gray (weathered), aphanitic, holohyaline and very compact. Outcrop of basalt unit form the cliffs with vertical stripes on the rocks body (Figure 3a). Referring to Bachri et al., 1993, basalt is result from volcanic process. There is vesicular texture observed in the basalt.

The exogenous process that occurs in basalt outcrop is a marine process which erodes the part of outcrop facing the sea. The remains part formed basalt cliffs, and the eroded part formed wave-cut platforms (Figure 3b).

2. Geotourism Potential in Saronde Island

Saronde Island is situated in the coordinates N 0°55'23"-0°55'37" and E 122°51'43"-122°51'58". The elevation in Saronde Island is 0 - 14 meter above sea level. Geosite and geomorphosite found in the field are white sands on the coast of Saronde island (Figure 4a) and sedimentary rocks outcrop (Figure 4b).

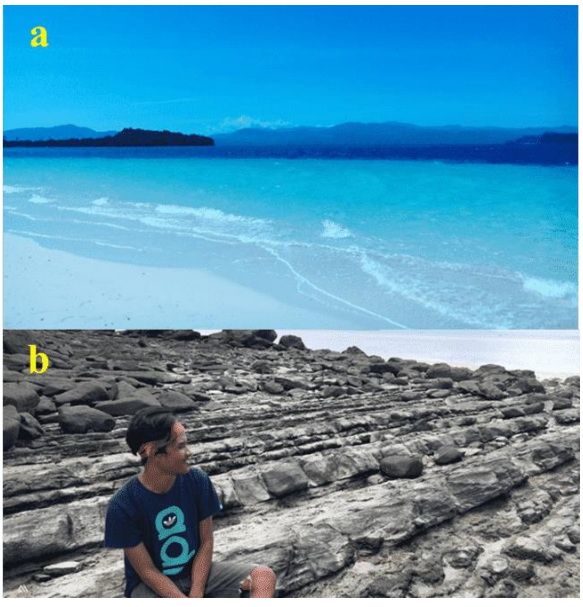

Figure 4. a) White sand in the coasts of Saronde Island; b) Sedimen outcrop and igneous rocks blocks.

The process which forms white sand accumulation on the coasts of Saronde Island is a marine process. Ocean currents and sea waves carry out the process of erosion, transportation and deposition on the Saronde coast which produces large amounts of sand. White sand in Saronde Island stretches out to the shallow waters following the coastline. If coastline shifts towards the ocean, sand accumulation will be visible. Other than white sand, there is a sedimentary rocks outcrop in Saronde Island. Igneous rocks blocks are above the sedimentary rocks outcrop.

3. Geotourism potential in Bogisa Island

Bogisa Island is situated in the coordinates of N 0°56'2" - 0°56'24" and E 122°51'18" - 122°51'36". The elevation in Bogisa Island is 0 - 39 meter above sea level. Geosite and geomorphosite found in the field is spit (Figure 5).

Figure 5. Spit of Bogisa Island.

Spit is a landform of marine process. According to Balasubramanian (2016), spit is one of the most common coastal landscapes. Spit is an accumulation of linear sediment which is joined to the mainland at one end. Spit mainly stretches and is in the form of narrow land a few meters above sea level.

The spit is formed through wind and wave processes. When the waves energy dissipates, sand sediment will be formed for the wave looses its ability to transport. Sands transported by waves or sea currents are those located in a relatively calms area.

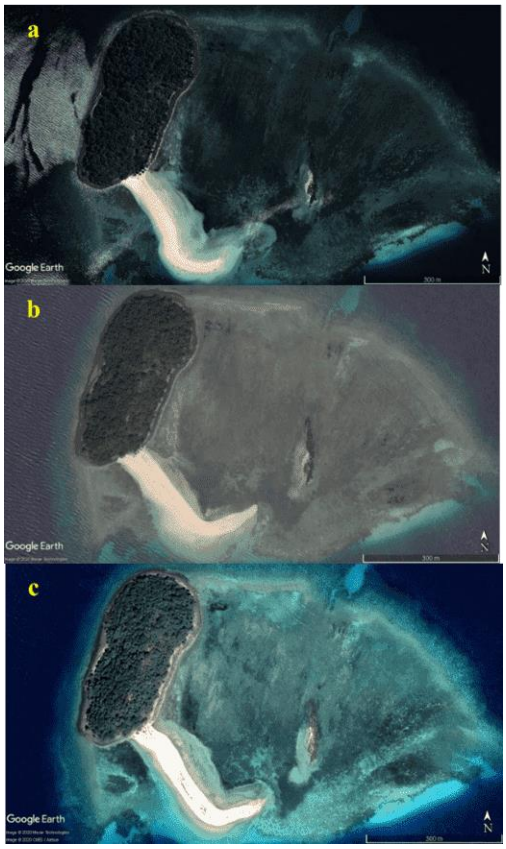

Figure 6. Temporal changes on the spit in Bogisa Island retrieved from Google Earth.a) 2010; b) 2012; and c) 2017.

The temporal changes on the spit at Bogisa Island is displayed in figure 6. Based on the spatial data, spit in Bogisa Island changes from time to time. The changes in the form of the spit at Bogisa Island is mainly seen on the spit turn. Prior to being in stretch form, the spit was formed near the land of Bogisa Island through continuous deposition by a sea wave.

4. Geotourism Potential in Hulawa Island

Hulawa Island is located in the coordinates of N 0°57'47"-0°58'5" and E 122°53'20"-122°53'35". Geosite and geomorphosite found in the field are andesite, and white sand on the coast of the island.

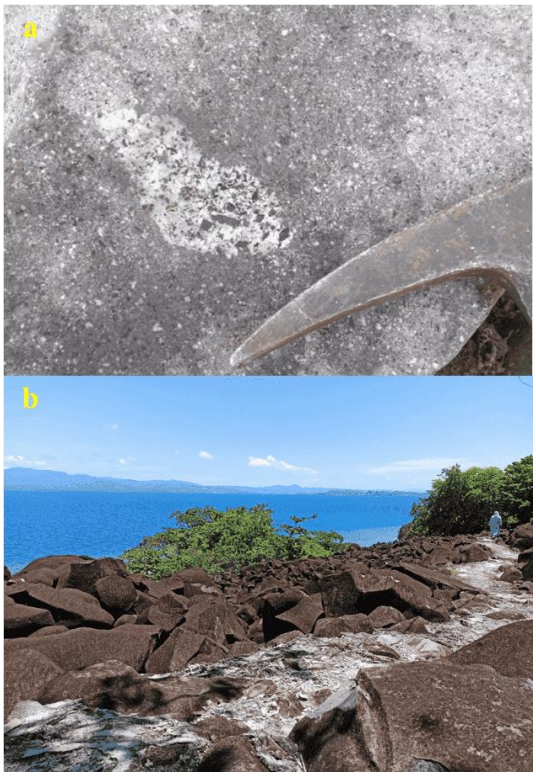

Figure 7. a) Granitic inclusion in andesite rocks; b) Andesite blocks.

Andesite rocks are dark grayish colored, holocrystalline, and inequigranular. The observed minerals on the rocks are hornblende, plagioclase, mica (biotite), and a little composition of quartz. There is inclusion in the form of granitic rocks (Figure 7a). Andesite rocks are mainly formed due to the volcanic process.

Andesite blocks occupy 2/3 of Hulawa Island while sand material occupies 1/3 of the island. Andesit blocks spread out from the hill to the coast of the island (Figure 7b). In the northwest of Hulawa Island, there is a small island composed of andesite rocks (Figure 8a).

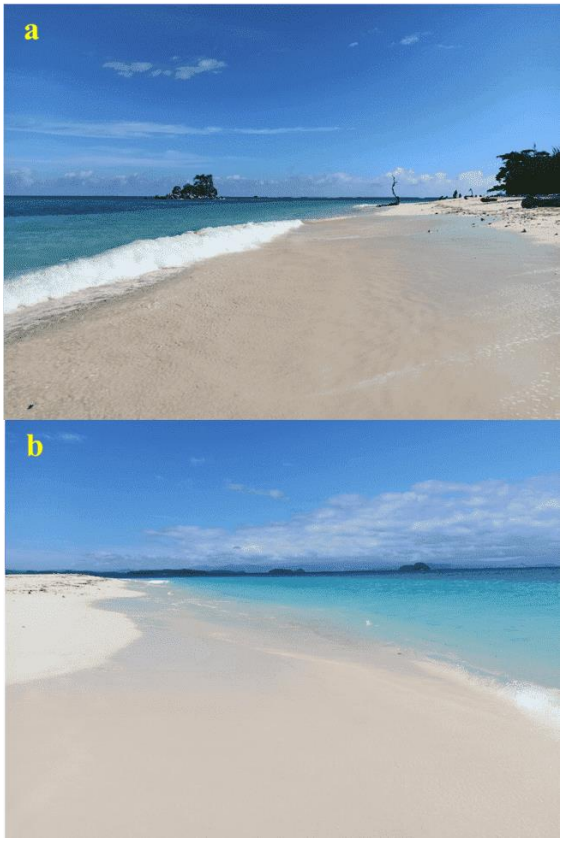

Figure 8. a) A small island in the northwest of Hulawa Island; b) White sand.

White sand in Hulawa Island is accumulated from the southwest of the island to shallow waters following coastline (Figure 8b). The white sand on the coast of the island is formed due to deposition by marine processes.

5. Geosite and Geomorphosite Assessment

Geosite and geomorphosite assessment consist of group of scientific value, education value, economic value, conservation value, and additional value. The total scores of geosite and geomorphosite assessment in Ponelo, Saronde, Bogisa, and Hulawa Island consecutively are 7.5, 8.5, 6.5, and 8.5.

The highest scientific values are achieved by Ponelo and Hulawa Island as there are sites with different numbers of geomorphological processes (Table 2). Basalt cliffs in Ponelo Island are formed due to the volcanic process and goes through erosion by the marine process.

Table 1. The result of geosite and geomorphosite assessment.

Site Name/ Group of Value	A	B	C	D
1. Scientific values	1.5	1	1	1.5
2. Education values	1	3	1	1.5
3. Economic values	2	2	2	2
4. Conservation values	1.5	1.5	1.5	1.5
5. Added values	1.5	1	1	2
Total values	7.5	8.5	6.5	8.5

Note: A = Ponelo Island; B = Saronde Island; C = Bogisa Island; D = Hulawa Island.

The highest education value is achieved by Saronde Island as it has a high geoutourism aspect, has a website, and it is the most common site visited by the public. The economic values of all islands are the same as they have the accessibility of less than 5 km from the existing tourism facilities and more than 1 km from public transportation stops.

The conservation values for all islands are the same as every island has a real risk to be harmed, has a high risk of potential damage both naturally and artificially, there is no damage on the sites and the sites have no legal protection yet. The sites which do not have legal protection yet are geosite and geomorphosite, such as basalt cliffs, tombolo, white sand, spit, and andesite.

The real risk that can be harmful is the plastic trash carried by sea currents. According to the research by Manyoe, Arif, & Lahay (2019), the natural high risk potential is subduction of Celebes Sea in the north, which can trigger earthquake and tsunami. While the artificial high risk potential on the site can be from human's action of vandalism.

The highest added value is achieved by Hulawa Island as it has culture value such as history event and colonial archeological aspect. There is a Netherland colonial house (Figure 9), Netherland grave and the lighthouse monument (Figure 10). House building and lighthouse monument (BPCP Gorontalo, 2014) was built by the Netherland in 1917. The lighthouse pillar is shaped like a prism and is composed of coral reefs and mortar. Besides, there are light fixtures built in a row up to the top of the hill.

Figure 9. Historical relics and archeological aspects in Hulawa Island. a) Netherland colonial house; b) Netherland house equipped with a tubular building that functions to collect rainwater.

Figure 10. a) The lighthouse monument of Netherland relics; b) Netherland graves.

The highest total values are achieved by Saronde and Hulawa Island. Geosite and geomorphosite in Saronde Island are not only important in terms of education but also in economic and conservation value. Geosite and geomorphosite in Hulawa Island are not only important in terms of scientic value, education, economic and conservation value, but also from additional values such as aesthetic and cultural value. Kubalíková & Kirchner (2016) states that a site which can be developed for geotourism purpose should not only have scientific value which stuck in geology and geomorphology but also it has to have education, economic, conservation and added value such as culture and aesthetic value. Referring to the previous discussion, all of the sites located in four islands at Kwandang Bay can be developed for geotourism purposes.

CONCLUSION

There are eight potential sites of geosite and geomorphosite located in the islands at Kwandang Bay. Geosite and geomorphosite in Ponelo Island are basalt cliffs, wave-cut platform, and tombolo. Basalt cliffs are formed through volcanic and marine processes. Wave-cut platform and tombolo are formed through the marine process.

Geosite and geomoprhosite in Saronde Island are white sand and sediment rocks. White sand deposits are formed through the marine process while sediment rocks are formed through sedimentation. Geosite and geomorphosite in Bogisa Island are spits. Spit is formed through the marine process due to sea waves and currents. Geosite and geomoprhosite in Hulawa Island are andesite and white sand. Andesite is formed through the volcanic process. White sand is formed through deposition of the marine process.

Geosite and geomorphosite in the islands at Kwandang Bay are not only valuable from the scientific side but also education, conservation, economics, and additional value. The highest total value for geotourism assessment is achieved by Saronde and Hulawa Island. In the group of economic value, the highest value is achieved by geosite and geomorphosite in Ponelo Island. In addition, in the group of education value, the highest value is achieved by geosite and geomorphosite in Saronde Island. In the group of economic value, the highest value is achieved by geosite and geomorphosite in Bogisa Island. Lastly, in the group of additional value, the highest value is achieved by geosite and geomorphosite Hulawa Island.

Geosite and geomorphosite are still intact, but legal protection/local regulation is needed to protect the sites. It is necessary to improve the existence of tourism infrastructures in the islands at Kwandang Bay for geotourism purpose. The production of local products related to geosite and geomorphosite is necessary to be done in order to improve economic value. The mitigation efforts towards real risk and potential risk, both naturally and artificially on geosite and geomorphosite are also needed to be done. The existence of geosite and geomorphosite can be developed for geotourism and have the chance to benefit the local community in the future.

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