Aesthetic quality assessment in Santolo Beach, West Java Province, Indonesia

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Abstract. The Santolo beach is one of the tourism beaches in Regency of Garut, West Java, Indonesia. The position of Santolo beach which facing towards the Indian Ocean, caused limited water activities that makes beautiful scenery is the main attraction for tourists. This research aims to determine the value of aesthetic quality Santolo beach scenery based on the viewshed. Three analysis approaches are used to solve the research problem, that are the Kernel Density, the Viewshed Analysis and the Euclidean Classification. The results show there are 5 viewshed areas with an average area of 0.14 km². Each viewshed has a varied aesthetic quality value between moderate to good. In generally the Santolo Beach can be developed become the coastal tourism.

1. Introduction
Santolo Beach is the coastal part of Garut Regency in West Java Province, Indonesia (figure 1). The Indian Ocean is located in the south of Santolo Beach, while in the northern part, Santolo Beach is surrounded by mountains (figure 2), which makes Santolo Beach has unique scenery. Santolo Beach is a tourism beach has been visited by 205,595 tourists for the last decade. The total number of tourist visits Santolo Beach less than the number of tourist visits to Cipanas which is the tourist area in the mountains of Garut Regency [1]. The Number of tourist visits to Santolo Beach, prove that Santolo Beach has not developed into tourism beach. One of the solutions for Santolo Beach condition is developing coastal tourism based on aesthetic quality. The aesthetic quality is chosen because recreation in Santolo Beach are limited by oceanographic conditions such as high wave, Rip current and coastal depth. On the other hand, Santolo Beach has the beautiful and natural seascape that can attract tourist to visit.

The aesthetic quality parameter of a coastal tourism development must be measured since it is one of the main reason for tourists to visit an area. Seascape aesthetic quality forms a unity and harmonization between sea and land, which attract tourist to enjoy beach situation. Seascape is the important part in sustainable of social, economy, and environment development [2]. The value of an area can depend on its attributes and one of the attributes can increase value an area is the aesthetic quality. The high value of aesthetic quality will create beautiful scenery. The aesthetic quality is
relating to the view, and good views are often associated with easy access to nature. Good view should not be limited to natural features such as the ocean or a forest, but should also include with attractive landscaping in the area [3].

The aesthetic quality of seascape is an attribute that is generally considered important for those visiting coastal areas to enjoy the ocean and coastal environments. The aesthetic quality assessment assumes the objects viewed have a negative and positive impact on views [4]. The Concise Oxford Dictionary defines Seascape as a picture or view to the sea. In general the concept of seascape is assumed as views from land to sea, views from sea to land, views along coastline, the effect on landscape of the conjunction of sea and land [5]. The aesthetic quality is used as an alternative solution for developing coastal tourism in Santolo Beach. The aim of this research is to assess aesthetic quality of Santolo Beach seascape and then aesthetic quality values are used to determine the tourist zones. This research also seeks the reason behind the attraction of Santolo Beach to tourism and another factors that can impact on aesthetic quality value in Santolo Beach.

2. Data and Methods

2.1. Data
Location of study site along the Santolo Beach of Garut Regency, West Java Province, Indonesia. This research uses Panoramio data photograph that connected to Google Earth (figure 3). Panoramio photograph data positions are assumed as representative of tourist positions. The photo used as the data must capture the figure of sea or land scenery.
2.2.Methods
The research uses a field survey and three analytical methods to solve the research problem. The analysis approaches are the Kernel Density, the Viewshed Analysis and the Euclidean Classification.

2.2.1. The Kernel Density
This research uses The Heatmap Qgis Plugin to get the recreation spot zone in the study area and the Heatmap Plugin uses Kernel Density estimation to create a density raster of Panoramio data photograph. The density is calculated based on the number of points in a location, with larger numbers of clustered points resulting in larger values [9].

2.2.2. The Viewshed Analysis
The viewshed is the coverage that can be seen from the specified location. The viewshed analysis compares the height of an object on earth surface against the height of the earth's surface along the line of sight (figure 4). If the height of the object in earth surface is less than that earth's surface, then the line of sight will be blocked and has no visibility. If it is higher, the object will be seen from the current position [10]. The Viewshed is used to create the boundary of the tourist area. This research uses The Viewshed Analysis Qgis Plugin.

![Figure 4. The viewshed illustration](image-url)
2.2.3. The Euclidean Classification

Views from land to sea or sea to land have equal weight to classify the seascape quality value. This research uses that statement to classify seascape aesthetic quality based on Euclidean Algorithm. Euclidean Algorithm is adopted from Arkema research [11] about habitat risk assessment. According to Arkema, Euclidean Algorithm can be used to classification if the two factor of classification has the equal effect and interrelated. The two factors in this research are sea view and land view factor. Each factor is consisted by beach physical parameter (table 1). The parameter in this research is adopted and modified from Ergin [12] [13] [14] and Botero [15].

Table 1. The views parameter scores

| Parameter                  | Score Criteria       |
|----------------------------|----------------------|
| Sea Views                  |                      |
| Wave Type                  | Plunging and collapsing | Spilling | Surging |
| Tides Type                 | Semi diurnal and mixed tide prevailing semi diurnal | Mixed tide prevailing diurnal | Diurnal tide |
| Height                     | Macro (>4m)          | Meso (2-4m) | Clear blue | Very clear |
| Water Colour               | Muddy brown or grey | Dark green | Clear green or dark blue |                      |
| Sea objects                | Building None       | None       | Reefs        | Group of islands |
| Biotic elements            | None Coastal vegetation | Reefs only | Biotics reef | Sea animals (such as : dolphin, whale, sea turtle) |
| Water activities           | Motor vessel Water sport vehicles | Sailing | Canoeing or kayaking | No activities |
| Land Views                 |                      |
| Cliff Height (m)           | None 5-30            | 30-60     | 60-90 | >90 |
| Slope (°)                  | None 45°            | 60°       | 75°  | 90° |
| Beach face Type            | Estuary Mud        | Cobble/ Boulder | Pebble/ Gravel | Sand |
| Width (m)                  | None < 5 ; > 100    | 5-25      | 25-50 | 50-100 |
| Colour                     | None Dark           | Dark tan | Light tan/ bleached | White |
| Dune                       | None Remnants      | Fore-dune | Secondary ridge | Several |
| Coastal vegetation         | None Bush          | Meadow | Short lived trees | Long lived trees |
| Litter                     | Continuous accumulations | Full strand line | Single accumulations | Few scattered items | Virtually absent |
| Beach activities           | Heavy industry and/or heavy port | Traditional port | Light tourism | Sensitive tourism | Preserve and/or none |
the Euclidean algorithm:

\[ E = \sqrt{\left|M - 1\right|^2 + \left|T - 1\right|^2} \]

\[ M = \frac{\sum_{i=1}^{N} \frac{m_i}{d_i}}{\sum_{i=1}^{N} \frac{1}{d_i}} \]

\[ T = \frac{\sum_{i=1}^{N} \frac{t_i}{d_i}}{\sum_{i=1}^{N} \frac{1}{d_i}} \]

where:
- \( E \) : Seascape aesthetic quality index
- \( M \) : Views from land to sea value
- \( T \) : Views from sea to land value
- \( m_i \) : Sea view parameter scores
- \( t_i \) : Land view parameter scores
- \( d_i \) : Data quality

The result of the Euclidean algorithm is classified using the aesthetic quality index (table 2) or using the Euclidean chart (figure 5). Classification uses the Euclidean chart is obtained by post the 'M' and 'T' value on the Euclidean chart axis. Euclidean chart classification is useful to show the distribution of value.

**Table 2.** The aesthetic quality index classification

| Aesthetic quality criteria | Aesthetic quality index (E) |
|---------------------------|-----------------------------|
| Very high                 | 5.65 – 7.07                 |
| High                      | 4.24 - < 5.65               |
| Medium                    | 2.82 - < 4.24               |
| Low                       | 1.41 - < 2.82               |
| Very low                  | 0 – < 1.41                  |

**Figure 5.** The Euclidean chart
3. Results

According to outcome of The Heatmap Qgis Plugin, tourists spreading density is divided into 4 classes, there are High density, Medium density, Less density and No density (figure 6). Furthermore high and medium density are selected to determine the tourist position and generate five recreation spot zone, i.e red spots for position A, orange spots for position B, green spots for position C, pink spots for position D, and turquoise spots for position E (figure 7).

The recreation spots zones are used as input data for The Viewshed Analysis Qgis Plugin, and the result shows the viewshed boundaries of the tourist zone (figure 8). Each zone has the coverage area as follows, zone A area is 0.2 km$^2$, zone B area is 0.23 km$^2$, zone C area is 0.07 km$^2$, zone D area is 0.14 km$^2$, zone E area is 0.04 km$^2$. Besides as tourism zone boundary, in this research, the viewshed is used as the boundary of aesthetic parameter filed survey.
Field survey result shows the area of study is formed by white sand and consists of spilling wave type and also mixed tide prevailing diurnal type with micro height tide type. In general, each parameter criteria of aesthetic quality on every zone almost equal. Only water activity parameter that shows an extreme difference. A, B and C zone are fisherman vessel ships activity (figure 9) so that makes low criteria score. While D and E zone are the area without activity which has high criteria score for water activity (figure 10). Score of each parameter criteria of aesthetic quality on every zone is explained on table 3.

![Figure 9. Fisherman vessel ships port](image1.jpg)

![Figure 10. No water activity at E zone](image2.jpg)

| Table 3. Aesthetic quality parameter scores |
|--------------------------------------------|
| Parameter                  | Zone | Score |
|----------------------------|------|-------|
| Sea Views                  |      |       |
| Wave Type                  | A    | 3     |
|                            | B    | 3     |
|                            | C    | 3     |
|                            | D    | 3     |
|                            | E    | 3     |
| Tides Type                 |      |       |
| Height                     | A    | 5     |
|                            | B    | 5     |
|                            | C    | 5     |
|                            | D    | 5     |
|                            | E    | 5     |
| Water Colour               |      |       |
|                            | A    | 3     |
|                            | B    | 3     |
|                            | C    | 3     |
|                            | D    | 5     |
|                            | E    | 5     |
| Sea objects                |      |       |
|                            | A    | 2     |
|                            | B    | 2     |
|                            | C    | 4     |
|                            | D    | 4     |
|                            | E    | 4     |
| Biotic elements            |      |       |
|                            | A    | 3     |
|                            | B    | 4     |
|                            | C    | 3     |
|                            | D    | 4     |
|                            | E    | 3     |
| Water activities           |      |       |
|                            | A    | 1     |
|                            | B    | 1     |
|                            | C    | 1     |
|                            | D    | 5     |
|                            | E    | 5     |
| Land Views                 |      |       |
| Cliff Height (m)           |      |       |
|                            | A    | 1     |
|                            | B    | 1     |
|                            | C    | 1     |
|                            | D    | 2     |
|                            | E    | 2     |
| Slope (°)                  |      |       |
|                            | A    | 1     |
|                            | B    | 1     |
|                            | C    | 1     |
|                            | D    | 5     |
|                            | E    | 1     |
| Beach face Type            |      |       |
| Width (m)                  |      |       |
|                            | A    | 4     |
|                            | B    | 4     |
|                            | C    | 4     |
|                            | D    | 3     |
|                            | E    | 3     |
| Colour                     |      |       |
|                            | A    | 5     |
|                            | B    | 5     |
|                            | C    | 5     |
|                            | D    | 5     |
|                            | E    | 5     |
| Dune                       |      |       |
|                            | A    | 3     |
|                            | B    | 3     |
|                            | C    | 1     |
|                            | D    | 3     |
|                            | E    | 3     |
| Coastal vegetation         |      |       |
|                            | A    | 4     |
|                            | B    | 2     |
|                            | C    | 2     |
|                            | D    | 5     |
|                            | E    | 2     |
| Litter                     |      |       |
|                            | A    | 4     |
|                            | B    | 3     |
|                            | C    | 4     |
|                            | D    | 4     |
|                            | E    | 3     |
| Beach activities           |      |       |
|                            | A    | 3     |
|                            | B    | 3     |
|                            | C    | 3     |
|                            | D    | 4     |
|                            | E    | 3     |
The Euclidean Algorithm classification shows the tourist zone in the Santolo Beach are rated in medium and high aesthetic quality (Figure 11). The high aesthetic zone is located in southern of the Santolo Beach, on D and E zone. The main reason that makes D and E zone have high aesthetic quality is the existence of rocks on the sandy beach and also no water activity on its area. When the tidal flood is coming on D and E zone, the rocks became clear water natural pools with biotic elements like fish, molluscs and seagrass (Figure 12). In the medium aesthetic zone (A,B,C), fisherman boat activity and the litters are decreasing the aesthetic value, especially in B zone (Figure 13).

Figure 11. Santolo Beach aesthetic quality classification

![Image](image1.png)

Figure 12. Clear water natural pool at D zone [16]

Figure 13. Litters at B zone

4. Discussion
The Santolo beach has the relatively homogeneous diversity of views parameter, therefore aesthetic quality value is almost similar for each zone. Because of the remote coastal situation, the seascape modification is minimum so the Santolo Beach can be categorized as natural beach condition. The natural coastal condition will increase aesthetic quality value, and aesthetic quality can be used as a tourism identity for the coastal which the undersea conditions cannot be utilized because it is dangerous. Coastal aesthetic quality is affected by land and sea views factors [17] [18]. Ergin [12][13][14] have done some research using fuzzy logic and produce detailed parameters to assess coastal aesthetic quality. The aesthetic quality Ergin method requires many respondents so it can not be used for desolate beaches such as Santolo Beach area, therefore in this research using Euclidean classification method to assess the aesthetic quality. The Euclidean method is selected because this method is simple to assess a condition which is composed of two equal criteria [19]. The criteria in this research are views of land and sea from coastal. In order to apply aesthetic quality assessment
using the Euclidean method as a general method, further research is required on some beaches in Indonesia.

5. Conclusions
The Santolo Beach has five zones that often visited by tourist. Three zones are categorized as medium quality and located in the northern part of Santolo Beach. On the other hand, the two other location has high quality aesthetic and located in the south of the Santolo Beach. Overall, the white sandy beach is the main reason that makes the Santolo Beach is attractive for tourism and the best time to visit the Santolo Beach is during the tidal flood in the afternoon. However, be required limits the number of activities in Santolo Beach, because too many activities might decrease the aesthetic quality value and increasing litters from tourism activities is another thing to consider. In general, Santolo Beach has good aesthetic quality, so the beach is potential to be developed as coastal tourism.

References
[1] Rinaldi, R N and Soewardikoen, D W 2015 Identitas Visual dan Media Promosi Pantai Wisata Garut Selatan (Bandung : Telkom University) p 117
[2] Tudor C 2012 An approach to seascape character assessment (Bristol : Natural England Commissioned Report) p 47
[3] Bourassa S, Hoesli M, Sun J 2004 What’s in a view? Environment and Planning 8 1427-1450
[4] Verutes G 2012 InVEST 2.4.5 User’s Guide:Integrated Valuation of Environmental Services and Tradeoffs (Stanford, CA: The Natural Capital Project) p 205
[5] Hill M, Briggs J, Minto P, Bagnall D, Foley K, Williams A 2001 Guide to best practice in seascape assessment (Dublin : The Marine Institute) p 57
[6] Yayu 2014 Pantai santolo http://www.panoramio.com/photo/108182075
[7] Maulany R 2014 Pantai santolo http://www.panoramio.com/photo/106167676
[8] Victory E 2013 Sunrise on sayang heulang beach http://www.panoramio.com/photo/89394447
[9] Thiede R, Sutton T, Duster H, Sutton M 2014 Qgis Training Manual: Release 2.14 https://docs.qgis.org/2.14/en/docs/user_manual/index.html
[10] Bruy A, Svidzinska D 2015 QGIS by Example (Birmingham : Packt Publishing Ltd) p 412
[11] Arkema K K, Verutes G, Bernhardt J R, Clarke C, Rosado S, Canto M, Wood S A, Ruckelshaus M, Rosenthal A, McField M, de Zegher J 2014 Assessing Habitat Risk From Human Activities to Inform Coastal and Marine Spatial Planning : A Demonstration in Belize Environmental Research Letters 9 1-11
[12] Ergin A, Karaesmen E, Micallef A, Williams A T 2004 A New Methodology for Evaluating Coastal Scenery : Fuzzy Logic Systems Area 36 367-386.
[13] Ergin A, Karaesmen E, Ucar B 2011 A Quantitative Study for Evaluation of Coastal Scenery Journal of Coastal Research 27 1065 – 1075.
[14] Ergin A, Williams A T, Micallef A 2006 Coastal Scenery : Appreciation and Evaluation Journal of Coastal Research 22 958-964.
[15] Botero C, Anfuso G, Williams A T, Palacios A 2013 Perception of Coastal Scenery along the Caribbean Littoral of Colombia Journal of Coastal Research 65 1733-1738
[16] Arirhd 2009 Santolo beach http://www.panoramio.com/photo/22126976
[17] DeWan T, DeWan T J 2008 Scenic Assessment Handbook (Augusta : Maine Coastal Program) p 80
[18] Morgan R, Williams A T 1999 Video Panorama Assessment of Beach Landscape Aesthetics on the Coast of Wales. Journal of Coastal Conservation 5 13-22.
[19] Marco V R, Young D M 1987 The Euclidean Distance Classifier : an Alternative to the Linear Discriminant Function Communications in Statistics- Simulation and Computation 16 485-505