Visual aesthetic analysis of post-mining area for ecotourism destination

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Abstract. Mining area of Pongkor Mountain has various kinds of landscape characters. Those landscapes consist of 15 types of land covers, 5 kinds of landforms and 43 of landscape characters that could be identified from previous researches. The characters of the landscapes hold various visual aesthetic values of ecotourism. The beauty, uniqueness, and distinctiveness of these landscapes have become attractive for visitors to get involved in ecotourism activities. The purpose of this research is to analyse the visual aesthetic of Pongkor post-mining landscape for ecotourism. The research method used was descriptive qualitative with the analysis methods of scenic beauty estimation (SBE) and semantic differential (SD). The land covers that have the high value of SBE are mixed plantation area, vegetation area, road network, and river. The land covers that have low value of SBE are the areas of community fish ponds. The green open space and natural landscapes hold outstanding visual aesthetic values for ecotourism. On the contrary, constructed spaces have less valuable visual aesthetic values for ecotourism. Evaluating visual aesthetic character of the landscape is important in order to develop ecotourism. It is expected that the promoting of ecotourism activities are carried out in the landscapes holding the quality of characters which are interesting, strong, comfortable, harmonious, gentle, bright, somewhat shady, wide, open, somewhat safe, and simple.

Key Words: landscape character, landscape design, ecotourism planning and design, scenic beauty estimation, semantic differential, post-mining area.

Introduction. Pongkor mining area that exhibits various landscape characteristics is an area claimed by Gold Mining Business Unit of Pongkor (GMBUP), PT Aneka Tambang, Tbk (Limited Liability Company) (PT. Aneka Tambang 2013). In this area unique and distinctive biophysical resources, flora and fauna can be adequately observed. The vegetation of lowland forests dominates this area. The land morphology has clearly exposed flat grounds and steep hills offering magnificent scenery for ecotourism. Natural phenomena and human culture have confirmed unique types of landform. The characteristics of landscape in this area are signified by 3 (three) types of landscape, namely vegetation area on the convex landform, construction tailing area of the landform, and area of shrubs on a valley landform (Kusumoarto et al 2017; Kusumoarto et al 2019).

The landscape with numerous configurations of characteristics offers the quality of values for certain utilizations. Human involvement in land cover changes utilizing the natural resources has resulted in the alterations of landscape characteristics and has impacted on the changes of ecosystem (Zonneveld & Forman 1989; Waterman 2009). Those changes are not only brought about by the society, but also by the GMBU of Pongkor as the holder of the authority of this area. People have made changes to land

covers for social and economic benefits, for instance residential areas, farms, rice fields, open fields, fish ponds, mixed plantations, and street networks. The GMBU of Pongkor has undergone changes of land covers for the benefits of mining business, such as constructing big tailing ponds and dams, setting up mining structures (factory and WWTP), developing tourism facilities, and street networks that currently are being used by dump trucks.

An alternative way to protect resources from the damage of natural landscape characteristics and to preserve their aesthetic quality is by establishing the program of ecotourism activities. This program conforms to what the GMBU of Pongkor has wished for as part of post-mining program. The ecotourism activities that are based on the characteristics of the landscape in the post-mining area will gain advantages in controlling environmental degradation, protecting natural resources, education, and conservation of biodiversity, and persevering culture and generating economic benefits (Meletis & Campbell 2007; Blamford et al 2009; Cobbinah 2015; Dologlou & Katsoni 2016; Wang et al 2014; Kusumoarto et al 2017). Ecotourism activities need tourism objects which are unique, exclusive and attractive. They require areas with good visual aesthetic. Moreover, the ecotourism activities need protected and modified landscapes (Kusumoarto et al 2017). As a result, the visitors will be satisfied and will have interesting experiences when getting involved with ecotourism activities. The aesthetic quality can certainly contribute to the formation of character and identity and is definitely able to provide the users satisfaction (Heat 1988; Rahmandari et al 2018; Gunawan et al 2019). With reference to the above-mentioned issues, the purpose of this research is to analyse the aesthetic quality of post-mining areas for ecotourism destinations.

Material and Method. The research method used was a descriptive qualitative method (Kusumoarto et al 2017; Asrina et al 2017), by doing activities, namely: 1) collecting data, 2) analysing classifications of land covers, 3) analysing landforms, 4) analysing characteristics of landscapes, 5) analysing aesthetic visual character of landscapes.

Description of the study site. This research was conducted in the area of GMBU of Pongkor, PT Aneka Tambang, Tbk as a part of Cikaret Fruit Garden, TSF (Tailing Storage Facility) of Pongkor, and GFA (Green Fine Aggregate) of Pongkor. The research place was located at Latitude 9266297 in the North – 926336 in the South UTM (Universal Transverse Mercator) and at Longitude 673097 in the West – 674746 in the East UTM (Figure 1). The elevation of this location is from 400 to 650 metres above the sea level. The research had been carried out from January 2017 to July 2018.

Research materials and tools. The research materials include questionnaires, 2017 UAV aerial photographs, landscape base map of Indonesia, 1:25,000 Scale of Geospatial Information Agency, the interpretation of 2017 UAV aerial photographs, map of land use established by Spatial Planning and Land Agency of Bogor Regency in 2013. The research tools employed for the research are a set of computers equipped with ArcGIS software version 10.3, Microsoft Excel software, R software, and survey of field tools.

Data collection. Data collection methods chosen are: literature study, survey, interview, and filling out questionnaire. The primary data were obtained directly from the field and gathered from measurements, observations, photographs, interviews, and questionnaires. The secondary data were gathered from literature studies (data obtained from previous research studies and other scientific documents which were relevant with the material of research).

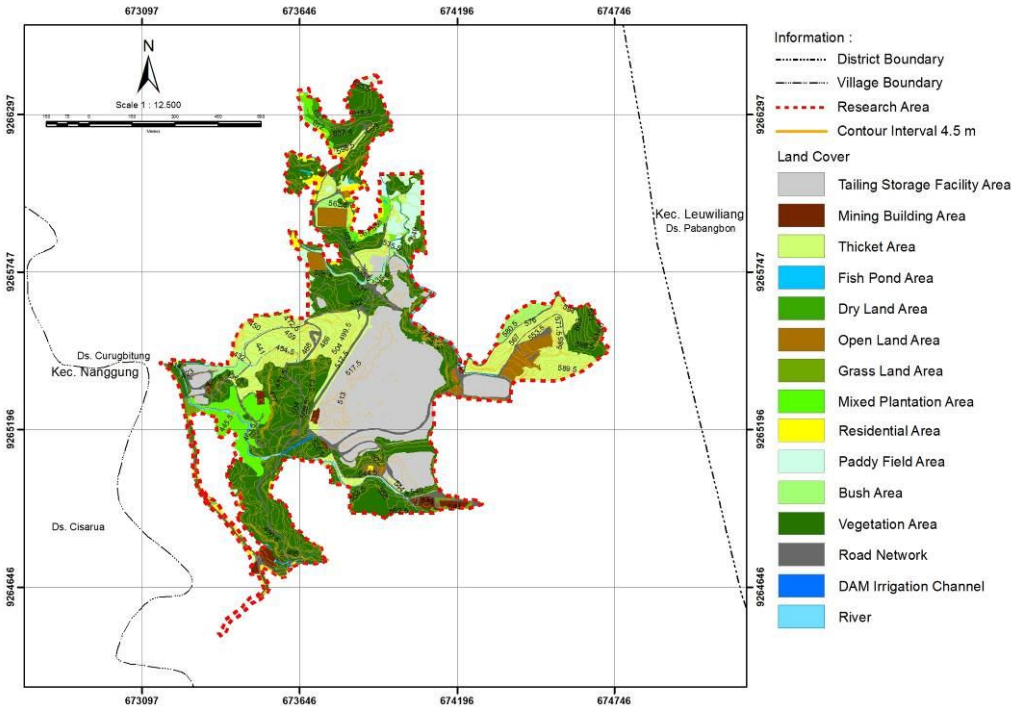


Figure 1. Map of research location (source: UAV aerial photos Analysis 2017).

Analysis of land cover classification. The analysis of land cover classification was referring to SNI 7645 Year 2010 about Classification of Land Cover (BSN 2014). The stages adopted to classify land cover were as follow:

a) The making of photogrammetry using Unmanned Aerial Vehicle (UAV) to produce DTM as the end product. Photogrammetry can be used for terrestrial needs to produce DTM (Digital Terrain Model) of a certain location. The process of UAV photogrammetry will go through the following steps:
   (1) designing the flyway;
   (2) designing land management;
   (3) pre-making coinciding with aerial photography;
   (4) preparing the coordinate of Ground Check Point (GCP);
   (5) producing aerial photographs;
   (6) processing photogrammetry using Agisoft Pro Photoscan 1.2 in order to obtain orthophoto with DSM (Digital Surface Model).

b) The making of DTM by:
   (1) filtering orthophoto from DSM.

c) Processing data of land cover classification:
   (1) calibrating camera to obtain camera parameters employed for interior orientation, relative orientation, absolute orientation, and generating point cloud;
   (2) adopting image matching;
   (3) performing georeferencing on WGS 84 datum and projection of north orientation UTM;
   (4) classifying the land cover using Geographic Information System (GIS) by undergoing the process of ground checking. The classification carried out was based on the guidelines of SNI 7645: 2010.

d) Analysis of land cover classification:
   The outcome of land cover classification was mapped. The identified map was analysed to generate the distribution, width and percentage of land cover. Steps taken in this analysis were:
   (1) carrying out classification based on land cover maps generated from SUAV mapping and processed using GIS;

(2) performing Ground truth check point (GCP) in designated locations to ensure the current types and boundaries of land cover;
(3) delianating the boundaries of land cover to generate the distribution of land cover, the width of land cover, and the percentage of land cover.

Landform classification analysis. Landform analysis was adopted by following the guidelines of classifying proposed by Booth (1983). The steps taken were as follow:
a) Setting up the following landform classification:
(1) Ground Check Point (GCP) landform based on the landform situated in research location;
(2) constructing landform classification.
b) Mapping landform classification with GIS.

Analysis of landscape character classification. The analysis was performed to classify landscape character by following the guidelines of landscape character classification proposed by Starke & Simonds (2013) to combine landform classification proposed by Booth (1983) and analysis of land cover classification based on the guidelines of SNI 7645: 2010. The steps taken were as follow: a) setting up classification of land cover; b) combining classification of land cover and landform to form the map of landscape character classification; c) mapping the classification of landscape character using GIS (Menegaki & Kaliampakos 2006; Brown & Brabyn 2012; Martin et al 2016).

Visual aesthetic analysis of landscape character. Analysis of landscape visual aesthetic character was performed using the analysis of Scenic Beauty Estimation (SBE) (Daniel & Boster 1976) and the analysis of Semantic Differential (Osgood et al 1957). The stages carried out to obtain SBE value were as follow: a) the respondents for this research were 50 college students of IPB University majoring in Landscape Architecture; b) the respondents should get a glimpse of photographs of landscape character units presented randomly for about 8 seconds to assess those photographs and later to fill in a questionnaire; c) the questionnaire distributed to respondents used evaluation on a scale of 1 to 10 depicting the beauty of scenery ranging from the less impressive to the most breath-taking; d) next, the outcome of rated questionnaire was analysed. The data for each landscape character were grouped based on the ranking or an evaluation scale of 1 to 10 in which the frequency, cumulative frequency and cumulative probability, and Z score were calculated according to the table (Daniel & Boster 1976). Furthermore, the mean of Z scores was determined for each landscape character. Out of individual Z score in each point, a Z score of a certain point was confirmed as a standard to calculate the SBE score which the final score was 0 (zero); e) deciding on the class interval of landscape character score.

Semantic Differential (SD) evaluation explains subjective assessment of the quality of landscape character adopting adjective bipolar as the basis of evaluation obtained from psychological responses of an individual upon a particular object (Gunawan & Yoshida 1994; Park et al 2011; Perovic & Folic 2012). SD evaluation was carried out first to evaluate a landscape character. The stages done included: a) the respondents participated in this research were 50 college students of IPB University majoring in Landscape Architecture; b) to present the slides of selected photographs nominated by the respondents. The photographs were in accordance with areas with difference landscape characters. In this presentation, the materials and tools used were: (1) slide projector; (2) questionnaire sheets; and (3) stationary; c) SD questionnaire should be completed with bipolar adjectives selected from 25 pairs of given bipolar adjectives (Gunawan & Yoshida 1994):
(1) Questionnaire format: the questionnaire consists of two parts. The first part accommodates the data of respondent identities, namely gender and age. The second part accommodates the main questions. The respondents were requested to evaluate the areas with different landscape characters;
(2) Evaluation system: each pair of words or criterion is put down in a scale of 5 (five). All criteria are randomly arranged by altering the scores from left to right or a vice

versa, from right to left to avoid regularity (Table 1). The respondents were requested to evaluate each landscape character by crossing the provided scale in every criterion. If the score is 0 (zero), it indicates that a particular landscape is not affiliated to both criteria and a bigger score indicates that a certain criterion has a higher value.

Table 1

Examples of SD questionnaire assessments

Weak	*-2*	*-1*	*0*	*1*	*2*	*Strong*
Uncomfortable	-2	-2	0	1	2	Comfortable

(3) Analysis of landscape character quality scores: the scores or landscape character quality were analysed using Factor analysis (Hendikawati 2011). The stages of analysis carried out were as follow: (a) the results of respondents' answers were tabulated and grouped according to the category of land covers with extremely high, high, moderate, low and extremely low of SBE (Daniel & Boster 1976; Kerlinger 1998); (b) to calculate the mean of the scores, followed by KMO and Barlett tests with confidence level of 95%. The analysis test was carried out in order to find out whether factor analysis was feasible to conduct; (c) to determine number of factors formatted using eigen value by observing the number of scores of eigen value which scores more than one and analysing the scree plot; (d) to conduct factor analysis with varimax rotation; (e) to analyse loading factors in order to recognize the tendency of variable grouping in factors interpreting the results of factor analysis.

Results and Discussion

Condition of land cover. The largest land cover area in the research location is vegetation area (Figure 2). The fish pond is considered the smallest area. The width of each respective area is displayed in Table 2. The spread of land cover can be observed in Figure 3. The area for Tailings Storage Facility (TSF) is considered the second largest area. This condition has confirmed that the land covers in this particular location have changed. The domination of these two largest areas has contributed to the unique character and distinctive visual aesthetic value of these areas for ecotourism destination.

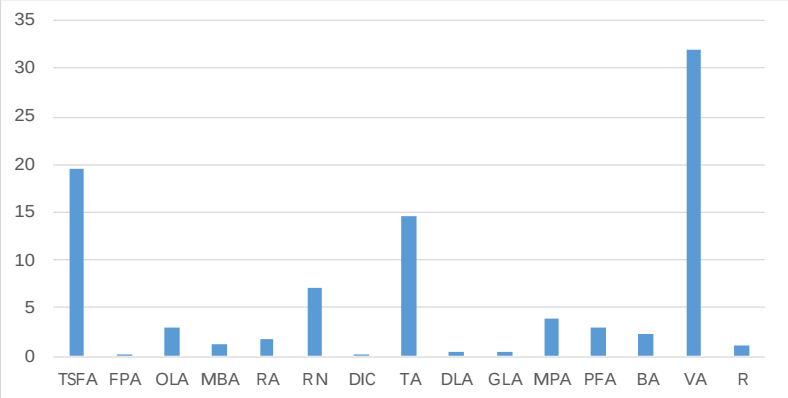


Figure 2. Area of each land cover in the research location (TSFA: Tailings Storage Facility Area; FPA: Fish Pond Area; OLA: Open Land Area; MBA: Mining Buildings Area; RA: Residential Area; RN: Road Networks; DIC: DAM Irrigation Channel; TA: Thicket Area; DLA: Dry Land Area; GLA: Grass Land Area; MPA: Mixed Plantation Area; PFA: Paddy Field Area; BA: Bush Area; VA: Vegetation Area; R: River).

Table 2

Broad distribution of landscape characters, land cover, and landforms

No	Landscape characters	Area (Ha)	%	Land covers classification															Total	Landform type					Total
				OS			BS					GOS						NS								
				TSFA	FPA	OLA	MBA	SA	RN	DIC	TA	DLA	GLA	MPA	PFA	BA	VA	R		CvL	CxL	LL	VL	RL	
1.	The tailing storage facility area in a concave landform	19.552	0.216	19.552															19.5519	19.552					19.552
2.	The mining buildings area in a concave landform	0.248	0.003				0.248												0.24801	0.248					0.248
3.	The mining buildings area in a convex landform	0.0291	3E-04				0.0291												0.0291		0.029				0.0291
4.	The mining buildings area in level landform	0.9333	0.01				0.9333												0.93326			0.933			0.9333
5.	The thicket area in a concave landform	0.919	0.01								0.919								0.91897	0.919					0.919
6.	The thicket area ini a convex landform	2.1481	0.024								2.148								2.14812		2.148				2.1481
7.	The thicket area ini a level landform	0.4182	0.005								0.418								0.41822			0.418			0.4182
8.	The thicket ara in a valley landform	11.118	0.123								11.12								11.118				11.12		11.118
9.	The fish pond area ini a concave landform	0.0778	9E-04		0.078														0.07782	0.0778					0.0778
10.	The fish pond area ini a convex landform	0.0056	6E-05		0.006														0.00564		0.006				0.0056
11.	The dry land area in a convex landform	0.4171	0.005									0.417							0.41713		0.417				0.4171
12.	The open land area in a convex landform	0.1996	0.002			0.2													0.19964		0.2				0.1996
13.	The open land area in a level landform	1.5318	0.017			1.532													1.53184			1.532			1.5318
14.	The open land area in a valley landform	1.216	0.013			1.216													1.21602				1.216		1.216
15.	The open land area in a ridge landform	0	0			0													0					0	0
16.	The grass land area in a convex landform	0.115	0.001										0.115						0.11504		0.115				0.115
17.	The grass land area in a level landform	0.3516	0.004										0.3516						0.35156			0.352			0.3516
18.	The mixed plantation area in a concave landform	0.1339	0.001											0.13392					0.13392	0.1339					0.1339
19.	The mixed plantation area in a convex landform	1.1067	0.012											1.10667					1.10667		1.107				1.1067
20.	The mixed plantation area in a level landform	0.5368	0.006											0.53681					0.53681			0.537			0.5368
21.	The mixed plantation area in a valley landform	2.0948	0.023											2.09477					2.09477				2.095		2.0948
22.	The residential area in a concave landform	0.0027	3E-05					0.003											0.00273	0.0027					0.0027
23.	The residential area in a convex landform	0.1006	0.001					0.101											0.10061		0.101				0.1006
24.	The residential area in a level landform	1.7271	0.019					1.727											1.72707			1.727			1.7271
25.	The paddy filed area in a concave landform	1.6756	0.018												1.676				1.67557	1.6756					1.6756

Table 2

Continuation

No	Landscape characters	Area (Ha)	%	Land covers classification															Total	Landform type					Total
				OS			BS						GOS					NS								
				TSFA	FPA	OLA	MBA	RA	RN	DIC	TA	DLA	GLA	MPA	PFA	BA	VA	R		CvL	CxL	LL	VL	RL	
26.	The paddy field area in a convex landform	1.2063	0.013												1.206				1.20635		1.206				1.2063
27.	The paddy field area in a level landform	0.1455	0.002												0.146				0.14555			0.146			0.1455
28.	The paddy field area in valley landform	0.0219	2E-04												0.022				0.02189				0.022		0.0219
29.	The bush area in concave landform	0.2456	0.003													0.246			0.24563	0.2456					0.2456
30.	The bush area in convex landform	1.5081	0.017													1.508			1.50809		1.508				1.5081
31.	The bush area in a level landform	0.3872	0.004													0.387			0.38724			0.387			0.3872
32.	The bush area in a valley landform	0.1917	0.002													0.192			0.19169				0.192		0.1917
33.	The vegetation area in a concave landform	0.6977	0.008														0.698		0.69773	0.6977					0.6977
34.	The vegetaion area in a convex landform	26.514	0.293														26.51		26.5141		26.51				26.514
35.	The vegetaion area in a level landform	3.4289	0.038														3.429		3.4289			3.429			3.4289
36.	The vegetation area in a valley landform	0.8524	0.009														0.852		0.85239				0.852		0.8524
37.	The vegetation area in a ridge landform	0.5117	0.006														0.512		0.51172					0.512	0.5117
38.	The road networks in a concave landform	0.0231	3E-04						0.023										0.02308	0.0231					0.0231
39.	The road networks in a cenvex landform	0.0002	2E-06						2E-04										0.00019		2E-04				0.0002
40.	The road networks in a level landform	5.0034	0.055						5.003										5.00338			5.003			5.0034
41.	The road networks in ridge landform	2.0518	0.023						2.052										2.0518					2.052	2.0518
42.	The DAM irrigation channel in a ridge landform	0.0914	0.001							0.091									0.09144					0.091	0.0914
43.	The river in a concave landform	1.0783	0.012															1.078	1.07831	1.0783					1.0783
	Total	90.6	1	19.6	0.1	2.9	1.21	1.8	7.08	0.1	14.6	0.42	0.47	3.872	3.05	2.33	32	1.1	90.62	24.7	33.4	14	15.5	2.65	90.6
	%			0.22	0	0	0.01	0	0.08	0	0.16	0	0.01	0.043	0.03	0.03	0.4	0	1	0.27	0.37	0.2	0.17	0.03	1

where: OS: Open Space; BS: Built Space; GOS: Green Open Space; NS: Natural Space; TSFA: Tailing Storage Facility Area; FPA: Fish Pond Area; OLA: Open Land Area; MBA: Mining Buildings Area; RA: Residential Area; RN: Road Networks; DIC: DAM Irrigation Channel; TA: Thicket Area; DLA: Dry Land Area; GLA: Grass Land Area; MPA: Mixed Plantation Area; PFA: Paddy Field Area; BA: Bush Area; VA: Vegetation Area; R: River; CvL: Concave Landform; CxL: Convex Landform; LL: Level Landform; VL: Valley Landform; RL: ridge landform.

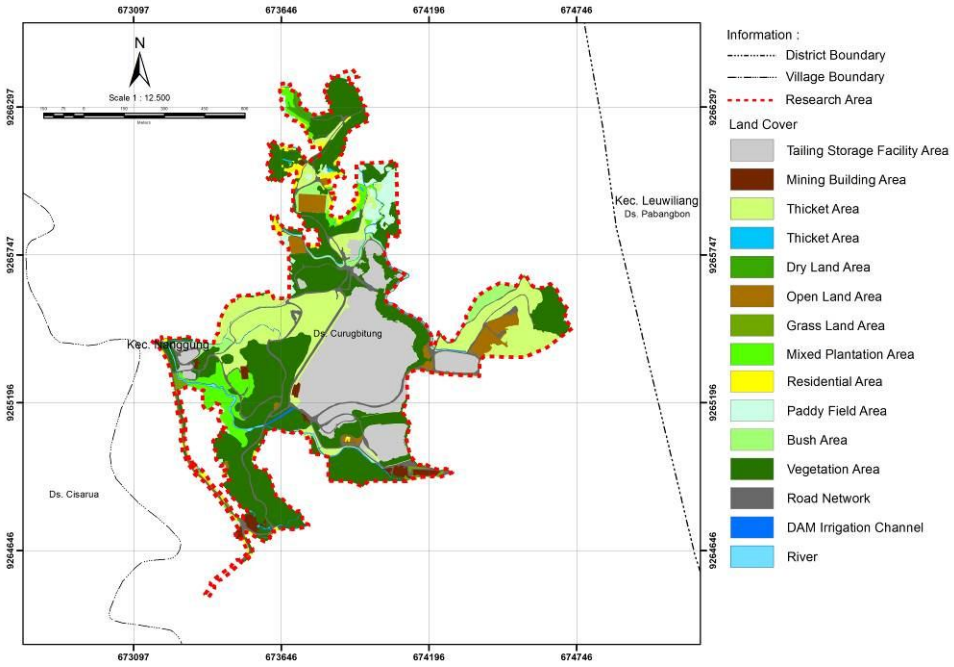


Figure 3. Distribution of land cover at the research location.

Landform condition. The largest area of landform in the research location is convex landforms. The landform of mountain ridge has the smallest area. The width of the respective landform type can be observed in Table 2. The spread of the landform can be seen in Figure 4. The concave landforms are considered the second largest areas. The landforms located in research area have significantly changed. Nevertheless, some landforms are still considered natural. The changes of landforms are mainly driven by the development of street networks, residential areas, tailing ponds, DAM, mining constructions, and fish ponds. Ecotourism activities performed at landforms with unique character offer interesting experiences. Various types of landforms provide distinctive visual aesthetic values for ecotourism destination. The spatial aesthetics of different landform characters certainly will generate distinct impression on the space (Booth 1983).

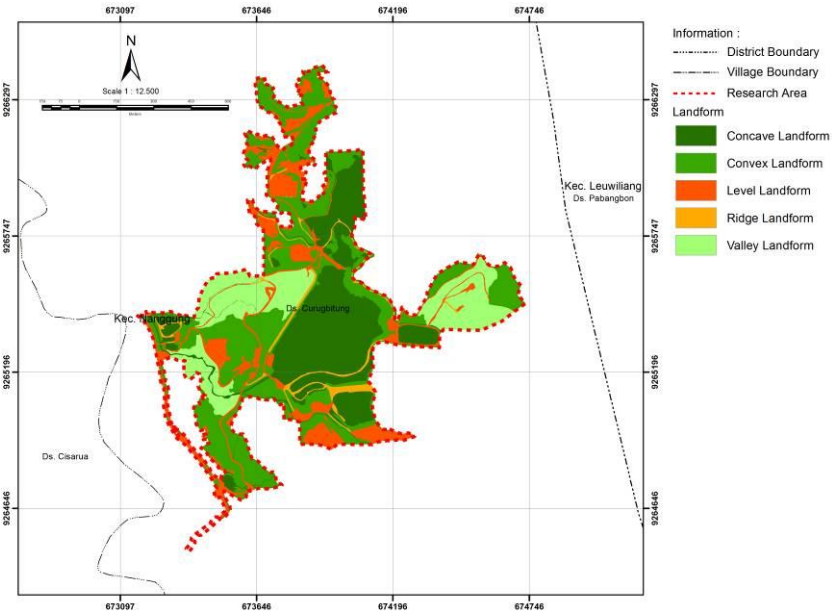


Figure 4. Distribution of landforms at the reserach location.

Landscape characters. There are 43 landscape characters in research location. The largest area of landscape character is the vegetation area of convex landform, while the smallest area is a flat open area on the landform of mountain ridge. Tailing construction area on concave landform is confirmed to have the second largest area following the area of vegetation on convex landform. The combination of different landscape characters in one area offers interesting experiences while engaging in ecotourism activities. Various landscape characters generate distinctive visual aesthetic values for ecotourism destination. The width landscape character area can be observed in Table 2. The spread of landscape characters can be seen in Figure 5.

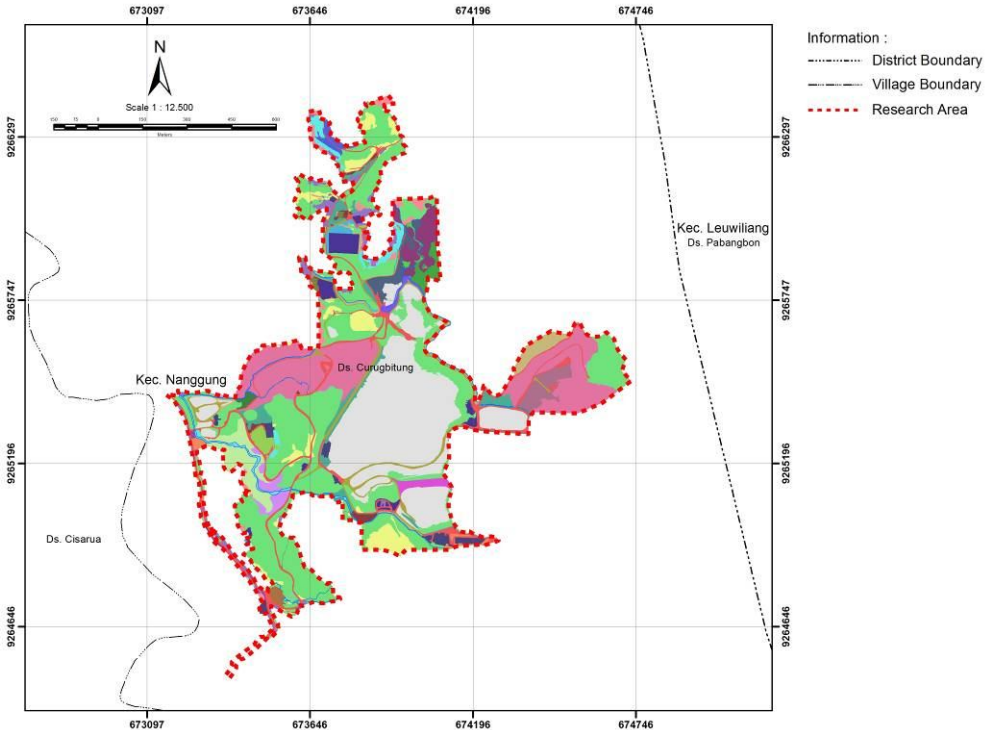


Figure 5. Distribution of landscape characters in the research location.

Visual aesthetic condition of land covers. The visual aesthetic conditions of land covers are categorized into the following: extremely high (SBE > 60), high (20 < SBE ≤ 60), moderate (-20 ≤ SBE ≤ 20), low (-60 ≤ SBE < -20), and extremely low (SBE < -60). The wide spread of land covers with SBE values/scores can be recognized from Table 3. The spread of SBE scores of the land cover can be observed in Figure 6. The photographs of land covers with extremely high SBE scores are obviously seen in Figure 7. The photographs of land covers with high SBE scores can be observed in Figure 8. The photographs of land covers with moderate SBE scores are clearly seen in Figure 9. The photographs of land covers with low SBE scores can be observed in Figure 10. The photographs of land covers with extremely low SBE scores can be identified from Figure 11. The Green Open Spaces (GOS) are areas with extremely high and high SBE scores. The alteration of land covers has generated various visual aesthetic values. Bell (2001) conveyed that the alteration of forest landscape and natural conditions were resulted in different perceptions upon aesthetic values.

Table 3

Extent of each visual aesthetic condition in land cover

No.	*SBE value*	*Land vover*	*Area (Ha)*	*%*
1.	SBE > 60 (extremely high)	a. Mixed plantation area; b. Vegetation area; c. Road networks; d. River.	44.03	49
2.	20 < SBE < 60 (high)	a. Thicket area; b. Dry land area; c. Paddy field area.	18.07	20
3.	-20 ≤ SBE ≤ 20 (moderate)	a. Residential area; b. Bush area; c. DAM irrigation channel.	4.26	5
4.	-60 ≤ SBE < -20 (low)	a. Tailings storage facility area; b. Mining buildings area; c. Open land area; d. Grassland area.	24.18	27
5.	SBE < -60 (extremely low)	a. Fish pond area.	0.09	0
	Sum of total		90.63	

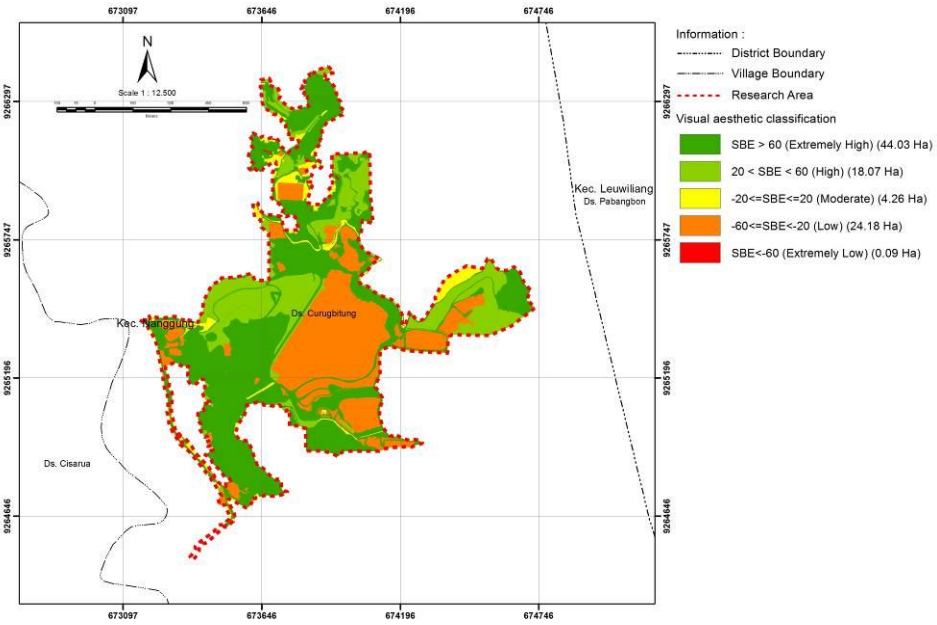


Figure 6. Distribution of visual aesthetics of land covers.

Figure 7. Photographs of land cover with a very high SBE value.

Figure 8. Photographs of land cover with high SBE value.

Figure 9. Photographs of land cover with medium SBE values

Figure 10. Photographs of land cover with a low SBE value.

Figure 11. Photographs of land cover with a very low SBE value.

The wide spread of land covers with extremely SBE scores are mixed plantation, vegetation area, street networks, and rivers. The wide spread of land covers with high SBE scores are areas of scrubland, plantation areas, and rice field areas. The wide spread of land covers with moderate scores of SBE consists of residential areas, brushwood areas, and dam irrigation canals. The wide spread of land covers with low SBE scores is composed of a tailing construction area, a mining construction area, open space area, and area of savannah. The land covers with extremely low SBE scores are comprised of fish pond areas. Assuming from research results, in general, land covers with extremely high SBE scores are dominated by the vegetation cover, natural rivers, well-managed landscapes, such as mixed plantations and street networks. The land covers with low and extremely low SBE scores are dominated by constructed landscapes, open/flat landscapes, improperly managed landscapes, and uncapitalized landscapes which become dormant areas. A vast variety of vegetations contribute to a high visual value (Arriaza et al 2004; Sullivan & Lovell 2006). This is related to the contrast of the colours displayed by the landscape elements. The open/flat spaces and abandoned land or improperly managed land can significantly reduce the visual quality of the landscapes. Arriaza et al (2004) identified that various types of vegetations contributed to high visual quality. On the other hand, open spaces and abandoned (improperly managed) land offer low visual quality.

Aesthetic condition of landscape visual characters. The location of research has various kinds of landscape characters. Landscape characters with high SBE scores are dominated by vegetation landcovers situated on convex landform, a concave landform, and a valley landform, natural river landscape, well-managed landscapes, namely mixed plantations situated on valley landforms and street networks situated on plain landforms. Landscape characters with low and extremely low SBE scores are dominated by constructed landscape characters situated on a convex landform, a concave landform, and a plain landform. These landscape characters are also predominated by open/flat landscape characters either on convex, concave, and plain landforms or on the mountain ridge. Additionally, these landscape characters are signified by poorly managed landscapes on either the convex, concave, plain landforms or on the mountain ridge; the unexploited landscape characters have become abandoned places either on concave, convex, plain landforms, or on the mountain ridges. An individual landscape character is able to generate distinctive landscape visual aesthetic values (USDA 1973; Misgav 2000). Moreover, Misgav (2000) elaborated that the character of open/flat landscape could reduce the landscape visual aesthetic values. On the other hand, vegetation landscape characters (the height and density) were more preferable and generated better visual aesthetic values. Cultural heritage and historical remains were considered preferred landscape characters and could generate good visual aesthetics. Nohl (2001) conveyed that cultural landscape characters should be protected for the purposes of ecotourism destination and recreation.

Some areas of research locations are critical land rehabilitation areas in which replanting trees are being and going to be conducted. According to Hands & Brown (2002), the activities of land rehabilitation performed in vegetation landscape characters were to contribute to better visual aesthetic values. The wide spread of landscape characters with SBE scores and be observer in Table 4. They can also be seen in Figure 12. The comparison of landscape character visual aesthetic conditions is illustrated in Figure 13. Landscape characters in the research location have visual aesthetic scores

which are distributed evenly between the natural green open space landscape characters and open, constructed spaces. The photograph of landscapes with extremely high SBE scores are displayed in Figure 14. The photograph of landscape with high SBE scores can be observed from Figure 15. Photographs of landscapes with moderate SBE scores can be found in Figure 16. The photographs of landscapes with low SBE scores can be seen in Figure 17. The photographs of landscapes with extremely low SBE scores are shown in Figure 18.

Semantic differential (SD) of land covers. Land covers have various distinctive SD scores. The respective SD scores of land cover with the classification of SBE scores can be seen in Figure 19. Fuente de Val et al (2006) conveyed that a vast variety of landscapes was a significant factor to determine the visual aesthetic quality. The land covers with extremely high SBE scores are mixed plantations, vegetation areas, street networks (minor landscape), and rivers (major landscape). The land covers with high SBE scores are bush land, farmland, and rice fields (minor landscape). The land covers with moderate SBE scores are residential area, shrubs, and DAM irrigation canals (minor landscape). The land covers with low SBE scores are tailing construction area, mining construction area, bare-land area, and area of savannah (minor landscape). The land covers with extremely low SBE scores are fish pond area (minor landscape).

The evaluation of land cover SD indicates that some SBE scores are different significantly. The land covers with low and extremely low SD scores generate landscape character qualities which are not interesting compared to the land covers with extremely high, high and moderate SD scores. Tailing construction area, mining construction area, bare-land area and the area of savannah exhibit monotonous scores, fairly static, somewhat arid, rather bare and stiff compared to other areas. Land covers with moderate to extremely low SBE scores provide landscape character quality scores (SD) that exhibit fairly low and rather improper elements compared to the others. It can be interpreted that landscape character quality of SD on areas dominated by vegetations (green open spaces) and the constructed areas which have fairly impressive green open spaces so that they are good and favoured to become ecotourism destinations.

The landscape character quality scores. Landscape character quality scores are obtained from defining the similarities of variables or dimensions which are also called factors. Twenty five (25) factors of evaluation depicted in Figure 19 will be summarized; the information derived from the original variables (the beginning) will be made into one set of new dimensions or variates (factors). Based on factor analysis performed, dominant landscape character of quality scores is spread over several quality scores.

The landscape character quality with high SBE score is spread over a natural landscape, a well-managed green open space. On the contrary, the landscape character quality with high SBE score is spread over a green open space (unnatural). The distribution of landscape character quality scores with extremely and high SBE scores is prevailed over the landscape character quality scores which area captivating, secure, comfortable, harmonious and refined (Table 5).

Based on the analysis results, the landscape character quality with moderate SBE scores is spread over the green open spaces (unnatural) and well-managed open spaces. The distribution of landscape character scores with moderate SBE scores is spread over fairly distant landscape character quality scores. The quality scores of landscape character with high SBE scores have been distributed similarly. Moreover, the distribution of landscape character quality with moderate SBE scores is spread over the landscape character qualities which are somewhat shady, wide, open, fairly safe, and somewhat simple (Table 6 and 7). The quality scores of landscape character with extremely high SBE scores have been distributed similarly.

Table 4

The area of each visual aesthetic condition in the landscape characters

No.	SBE value	Land cover classification														Landform type					Area (Ha)	%	Total (Ha)	%
		TSFA	MBA	TA	FPA	DLA	OLA	GLA	MPA	RA	PFA	BA	VA	RN	DIC	R	CxL	CvL	LL	RL	VL				
1.	SBE) > 60 (extremely high)								v												v	2.095	0.023	7.789	0.086
													v					v				0.698	0.008		
													v				v					3.824	0.042		
													v								v	0.852	0.009		
														v					v			0.153	0.002		
																v		v				0.166	0.002		
2.	20 < SBE ≤ 60 (high)			v																	v	11.119	0.123	30.257	0.334
						v											v					0.417	0.005		
									v								v					1.107	0.012		
											v							v				1.676	0.019		
											v						v					1.206	0.013		
											v								v			0.146	0.002		
													v				v					14.125	0.156		
													v						v			0.161	0.002		
																v		v				0.300	0.003		
3.	-20 ≤ SBE ≤ 20 (moderate)			v														v				0.919	0.010	23.191	0.256
									v									v				0.134	0.001		
									v										v			0.537	0.006		
										v									v			1.727	0.019		
											v										v	0.022	0.000		
												v					v					1.508	0.017		
												v							v			0.387	0.004		
													v				v					8.558	0.094		
													v						v			3.268	0.036		
													v							v		0.512	0.006		
														v					v			4.575	0.050		
														v						v		0.340	0.004		
															v			v				0.092	0.001		
																v		v				0.612	0.007		

Table 4

Continuation

No.	SBE value	Land cover classification															Landform type					Area (Ha)	%	Total (Ha)	%
		TSFA	MBA	TA	FPA	DLA	OLA	GLA	MPA	RA	PFA	BA	VA	RN	DIC	R	CxL	CvL	LL	RL	VL				
4.	-60 ≤ SBE < -20 (low)	v																v				19.554	0.216	28.087	0.310
			v															v				0.248	0.003		
			v														v					0.029	0.000		
			v																v			0.933	0.010		
				v													v					2.148	0.024		
				v															v			0.418	0.005		
					v												v					0.006	0.000		
							v										v					0.120	0.002		
							v												v			1.532	0.017		
								v									v					0.115	0.001		
								v											v			0.352	0.004		
										v								v				0.003	0.000		
										v							v					0.101	0.001		
												v						v				0.437	0.005		
												v									v	0.192	0.002		
														v				v				0.023	0.000		
														v			v					0.000	0.000		
														v					v			0.276	0.003		
														v						v		1.712	0.019		
5.	SBE < -60 (very low)				v													v				0.078	0.000	1.294	0.014
							v														v	1.216	0.013		
							v													v		0.000	0.000		
	Total																					90.618	1	90.618	1

Where: TSFA: Tailings Storage Facility Area; MBA: Mining Buildings Area; TA: Thicket Area; FPA: Fish Pond Area; DLA: Dry Land Area; OLA: Open Land Area; GLA: Grass Land Area; MPA: Mix Plantation Area; RA: Residential Area; PFA: Paddy Field Area; BA: Bush Area; VA: Vegetation Area; RN: Road Networks; DIC: DAM Irrigation Channel; R: River; CvL: Concave Landform; CxL: Convex Landform; LL: Level Landform; VL: Valley Landform; RL: Ridge landform.

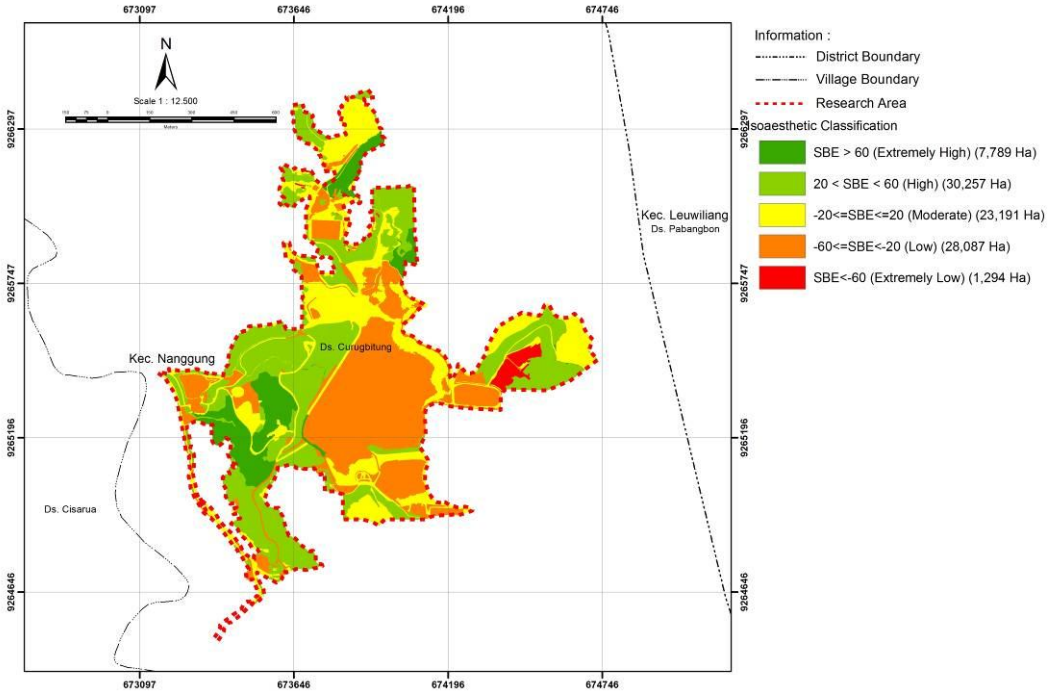


Figure 12. Visual aesthetic distribution of landscape characters.

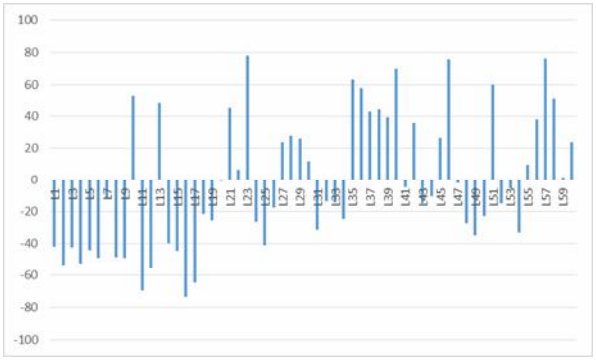


Figure 13. Comparison of visual aesthetic character quality landscape.

SBE Value = 78

SBE Value = 64

SBE Value = 70

SBE Value = 76

SBE Value = 61

SBE Value = 76

Figure 14. Photographs of landscape characters with very high SBE values.


SBE Value = 53


SBE Value= 48


SBE Value = 45


SBE Value = 24


SBE Value = 29


SBE Value = 26


SBE Value = 58


SBE Value = 43


SBE Value = 44


SBE Value = 40


SBE Value = 36


SBE Value = 26


SBE Value = 38


SBE Value = 51


SBE Value = 24

Figure 15. Photographs of landscape characters with high SBE values.

SBE Value = -12

SBE Value = 0

SBE Value = 6

SBE Value = -18

SBE Value = 12

SBE Value = -13

SBE Value = -15

SBE Value = -5

SBE Value = -15

SBE Value = -10

SBE Value = -2

SBE Value = -15

SBE Value = -5

SBE Value = 10

SBE Value = 1

Figure 16. Photographs of landscape characters with medium SBE values.


SBE Value = -42


SBE Value = -54


SBE Value = -42


SBE Value = -53


SBE Value = -44


SBE Value = -49


SBE Value = -49


SBE Value = -49


SBE Value = -56


SBE Value = -40


SBE Value = -45


SBE Value = -22


SBE Value = -26


SBE Value = -27


SBE Value = -41


SBE Value = -31


SBE Value = -25


SBE Value = -27


SBE Value = -35


SBE Value = -23


SBE Value = -33

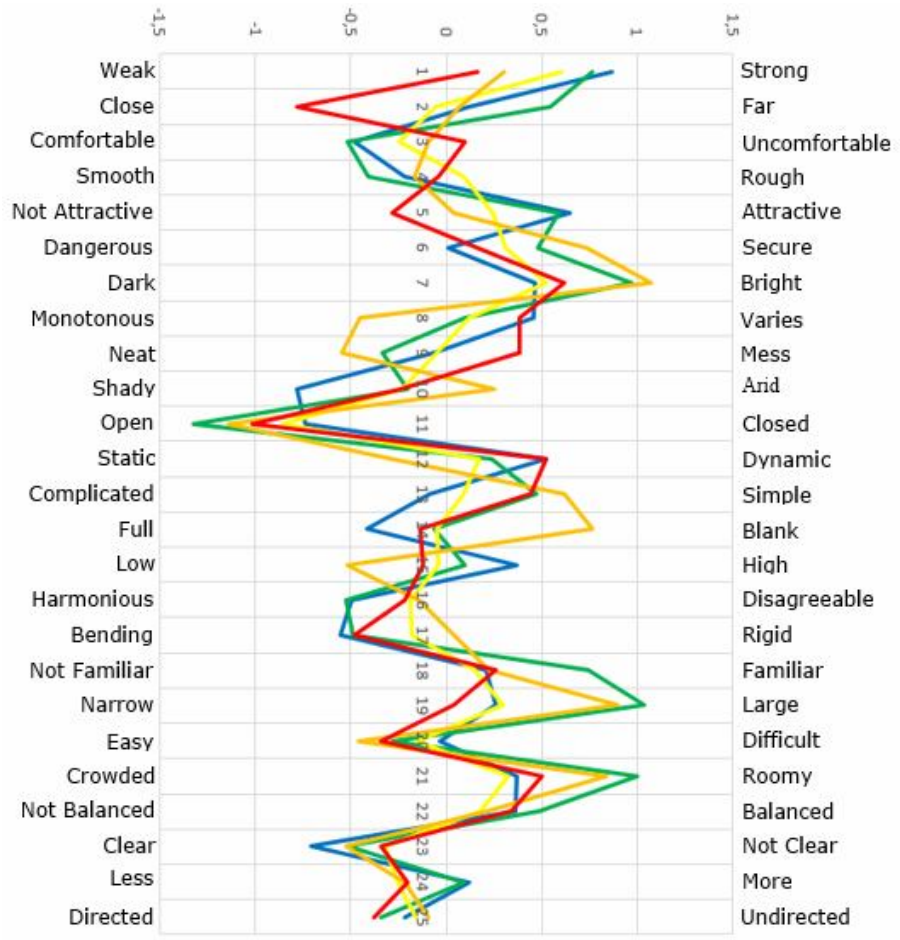
Figure 17. Photographs of landscape characters with low SBE values.

SBE Value = -70

SBE Value = -74

SBE Value = -65

Figure 18. Photographs of landscape characters with very low SBE vlues.



Where SBE:

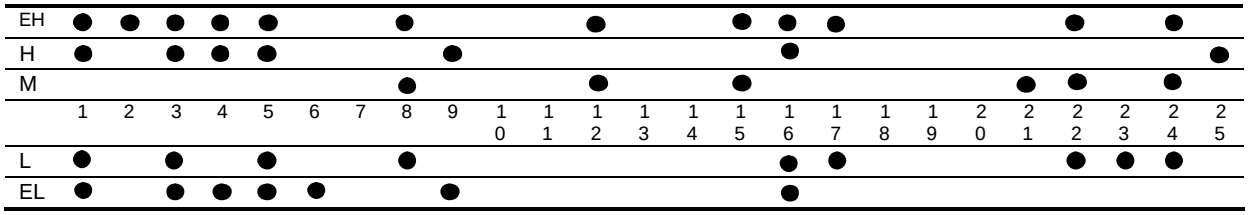
Very High — High — Medium — Low — Very Low

Figure 19. Difference in semantic differential values of land cover.

According to the analysis results, the landscape character quality with low SBE scores is spread over the open spaces, constructed spaces, and poorly-managed green open spaces, while the landscape character quality with extremely low SBE scores is spread over poorly-managed open spaces. The distribution of landscape character quality scores with low and extremely low SBE scores is spread over the scores of landscape character qualities which are dull, less powerful, not captivating, not harmonious and neither refined nor rough (Table 5).

Table 5

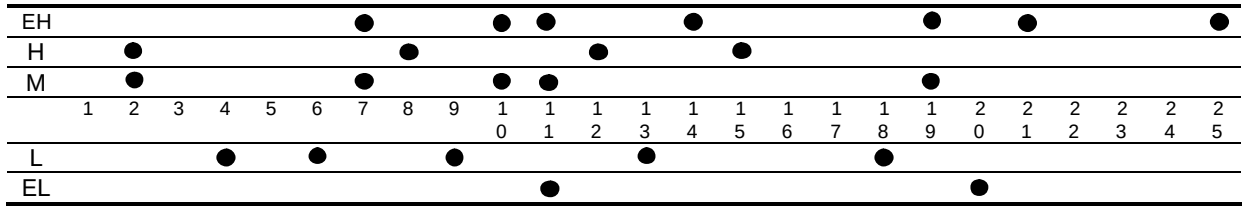
Grouping variables of landscape character quality values into factors formed (RC1)



Where: EH: extremely high; H: high; M: moderate; L: low; EL: extremely low; 1,2,3, ...n: semantic differential value.

Table 6

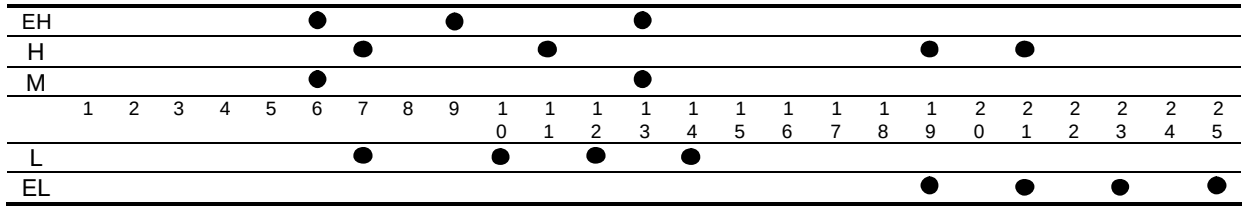
Grouping variable values of landscape character quality into formed factors (RC2)



Where: EH: extremely high; H: high; M: moderate; L: low; EL: extremely low; 1,2,3, ...n: semantic differential value.

Table 7

Grouping variable values of landscape character quality into formed factors (RC3)



Where: EH: extremely high; H: high; M: moderate; L: low; EL: extremely low; 1,2,3, ...n: semantic differential value.

Protection and modification of landscape visual aesthetic characters. According to the dispersion of landscape visual aesthetic character scores, there is considerable potential to develop ecotourism. The wide-spread landscape characters have generated the dispersion of visual aesthetic scores which had extremely high, high, moderate, low and extremely low visual effects on the users (Booth 1983). The development of ecotourism on the basis of landscape characters encouraged actions to protect and to modify (Kusumoarto et al 2017). Several things needed to be done according to Starke & Simonds (2013) were protecting the visual and aesthetic characters of a landscape, eliminating inappropriate elements, accentuating natural shapes, crushing natural shapes, altering landscape formation, conducting intensification, promoting visual quality intensively (Table 8).

Table 8

Protection and modification of the character of the Pongkor mining landscape

No.	*Land covers*	*SBE values*	*Values of landscape characeters quality*	*Visual aesthetics protection of landscape character*	*Elimination of unsuitable elements*	*Accentuation of natural forms*	*Change the form of landscape*	*Intensi-fication*	*Intensive visual quality improvement*
1.	Mix plantation area	SBE > 60 (extremely high)	attractive, strong, comfortable, harmonious and smooth	v	v	v		v	v
2.	Vegetation area			v	v	v		v	v
3.	Road networks			v	v	v	v	v	v
4.	Rivers			v	v	v		v	v
5.	Thicket area	20 < SBE < 60 (high)		v		v		v	v
6.	Dry Land area			v		v		v	v
7.	Paddy field area			v		v		v	v
8.	Residential area	-20 ≤ SBE ≤ 20 (moderate)	bright, rather shady, wide, open, rather safe, and rather simple		v	v	v	v	v
9.	Bush area					v		v	v
10,	DAM irrigation channel					v		v	v
11.	Taling storage facilty area	-60 ≤ SBE < -20 (low)	not attractive, less strong, uncomfortable, less harmonious, and not smooth nor rough			v	v	v	v
12.	Maining buildings area					v	v	v	v
13.	Open land area					v	v	v	v
14.	Grassland area					v	v	v	v
15.	Fish pond area	SBE < -60 (extremely low)			v	v	v	v	v

a. Protecting of visual aesthetic landscape characters. Seven types of land covers with extremely high and high SBE scores found in research location should be protected for their visual aesthetic characters. Those seven landcovers are mixed plantations, vegetation areas, street networks, rivers, bush land, farm land, and rice fields. The protection against visual aesthetic characters of a landscape is seriously needed to develop ecotourism on the basis of landscape characters. The scenery nature landscapes should be presented as optimally as possible by protecting biodiversity and avoiding the obstacles. Protection should be performed to land covers subjected to calamities, such as erosions that could cause changes in the land. Protection should also be given to areas experiencing land changes in order to reshape the land covers into their previous shape and to replant local vegetations. Furthermore, visual and aesthetic protections should be performed against river basins and the shape of watersheds.

b. Eliminating the inappropriate elements. Elimination of inappropriate elements is conducted in plantation areas, vegetation areas, street networks, riverbanks, and residential areas. The alteration in the use of certain areas, and the alteration of land cover of some areas bring about unsuitable landscape elements. Those elements can grow naturally, or may be constructed by either the management of the area, or the surrounding community. Generally, the eradication of inappropriate elements gives impact on facilitating the area visual aesthetic quality that will be utilized to improve the ecotourism destinations. The eradication of inappropriate elements is performed provided that they are against the natural landscapes. Among them are man-made environment constructed in mixed plantation areas, mining constructions in the middle of vegetation areas and on the river banks, houses which are developed in vegetation areas and on pedestrian at one of mixed plantation areas. Moreover, there were modern structures built in residential areas. These elements adopt colours, textures, and shapes that did not offer the perception of unity and harmony with the natural characters of landscapes.

c. Accentuating of natural shape. The emphasis on natural shapes enabled to reach the maximum development of ecotourism destinations. In all areas of land covers, the emphasis of natural shapes can be developed and improved by eradication negative elements and by promoting positive qualities. In order to improve landscape quality, accentuation is needed to be conducted to shape natural landscape characters optimally. Eye-catching displays and new exciting experiences can be offered to tourists by optimizing the accentuation of natural landscape characters through colours, textures, shapes and spaces.

d. Changing natural forms. The changes of natural landscapes occur on landscape characters of street networks, residential areas, tailing construction areas, mining construction areas, bare land areas, areas of savannah, and fish pond areas. Tailing structures, street network surface, house shapes in vegetation area and residential area have altered the nature of landscape characters. In addition, the changes of shapes of the land occur in the areas of bare land, on savannah, and in the areas of fish ponds. These changes will certainly generate damages on landscape characters when the land becomes barren, bare land and unproductive. It can absolutely cause negative effects on the landscape or the security landscape under it, for example in forms of erosion and flood. The restriction of the expansion of constructed areas and bare-land areas in order to develop natural landscape areas should be conducted, and this nature of landscape areas can be served as parts of landscape elements which can be utilized to develop areas for ecotourism destinations. The changing of landscape characters should become the effort to maximize the functions while maintaining the balance and preservation of the existing landscapes.

e. Intensification. Landscape characters can be intensified by strengthening the landscape characters. Nearly all land cover characters should be strengthened. The alteration from man-made landscape characters to natural landscape characters, for certain land covers are the effort to carry out intensification. The natural landscape

characters in the presented land covers follow the original landscape character profile; they are not eradicated of changed. Moreover, the intensification can be applied on the environment created by abolishing constructions which destroy the natural landscape characters. The intensifications were conducted by applying borders with natural landscape elements, developing constructions to avoid erosions and landslides, building a retaining wall to avoid damages of tailing constructions and surface water runoff. The intensifications were conducted by balancing the colours, weights and distances of natural landscape elements.

f. Improving visual qualities intensively. The visual qualities of the entire land covers in research locations can be improved intensively developing the areas to become ecotourism destinations. The entire land covers should contribute to the visual qualities that prioritize on achieving the attribute of beauty. The presented landscape elements should have harmony and beauty of landscape characters. The protection of natural landscape characters, namely vegetation and river areas offered the intended unity and harmony. In the areas of bare land, landscape character profiles, especially the shape of landscape characters was maintained and intensified. The landscape elements were presented to offer unity and harmony with the surrounding natural landscapes. The visual qualities of landscapes that were developed could be improved by carrying out plan and creating designs that allow satisfying scores for unity and harmony in colour, shape, balance, weight and distance to surrounding landscapes. Contrasts which were not dominant were presented within the limits of reaching conformity, unity and harmony in the surroundings where these elements were constructed.

Conclusions. Pongkor post-mining area holds a vast variety of land covers, landforms, and landscape characters. The variety of landscape potentials have visual aesthetic value for ecotourism. Land covers with exceedingly high SBE scores are dominated by vegetations, natural rivers, well-managed landscapes namely mixed plantations and street networks. In the circumstances, land covers with low and exceedingly low SBE scores are dominated by constructed landscapes, plain/flat landscapes, less well-managed and not well-managed landscapes, neglected landscapes that become abandoned areas.

Landscape characters with exceedingly high SBE scores are dominated by vegetations situated in convex landform, concave landform, and valley landform, natural river landscape, well-managed landscapes, such as mixed plantation situated in valley landform and street networks located in flat/plain landform. Landscape characters with low and exceedingly low SBE scores have been dominated by constructed landscape characters situated on convex landform, concave landform, plain/flat landform. Moreover, they have been dominated by open landscape characters situated in convex landform, plain/flat landform, valley landform and mountain ridge landform. Furthermore, they have been dominated by landscape characters that are less well-managed and not well-managed situated on concave landform, convex landform, plain/flat landform, valley and mountain ridge landforms; neglected landscape character which become abandoned spaces located in concave landform, convex landform, plain/flat landform, valley landform and mountain ridge landform.

Land covers with extremely high and high SBE scores hold the value of character quality which are captivating, powerful, pleasant, harmonious and refined. Land covers with moderate SBE scores hold the value of landscape character quality which are relatively distant, bright, fairly shady, vast, open, relatively safe and simple. Land covers with low SBE scores hold the value of landscape character quality which are unimpressive, less powerful, not pleasant, less harmonious, and neither refined nor rough.

Focusing on visual aesthetic characters, several areas of land covers should be protected and modified in order to develop those areas for ecotourism destinations. Several areas of land covers, such as mixed plantations, vegetations, street networks, rivers, shrubs, farmlands, and rice fields need protection of landscape visual aesthetic characters. Modification have been carried out nearly on the entire land covers.

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