Application of Biophilia Concept on Greenery Layout Arrangement of Buperta Cibubur Tourism Landscape

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Abstract. The concept of Biophilia shows how humans have a fundamental desire to connect and depend on nature, providing healing and positive impacts on emotional change. DKI Jakarta Province population number has increased significantly from year to year so that the need for green open space increases. Buperta City Forest Area has enormous potential to facilitate the needs of the green space in the City of East Jakarta, but the development of existing natural tourism is still not optimal. The concept of Biophilia can be a solution to increase the attraction, user experience, and increase relaxation benefits for Buperta Cibubur user in sustainable way. The objectives of this research are: (1) Identifying and studying the characteristics of the site and its users, (2) Developing criteria for the utilization of the Biophilia concept in green open spaces, and (3) Developing greenery layout arrangement recommendations. Furthermore, direct observation, interview, and literature study were used comprehensively to collect the data. Data processed using Biophilia approach, through descriptive analysis and spatial method of analyzing the potential and constraints from the site. Detail recommendation developed on zones with strongest natural potential such as “Kempa”, Recreation Area, and Pine Forest, with each different approach of using Biophilia concept according to the environment and user characteristics. The output of the research is in the form of planting plan and site plan.

Key Words: Biophilia, Buperta Cibubur, Tourism Landscape

1. Introduction

Based on BPS data in 2015-2045 Indonesian Population Projection Results of the 2015 Revised Edition of the Inter-Census 2015 Population Survey [1], the projection of the population of DKI Jakarta can reach up to 10,891,900 in 2025 and increase to 11,239,300 by 2045, so the need for green open space as ecological and recreational functions will continue to increase.

The largest urban forest in East Jakarta is the City Forest of Bumi Perkemahan dan Graha Wisata Cibubur (Buperta) with an area of 210 ha. Buperta Cibubur has huge potential in the field of natural tourism and nature conservation because it has a large area. Buperta Cibubur has been used as a campsite, sports, and nature tourism, but the development of natural tourism in Buperta Cibubur has not been optimal because the management funds are insufficient, which only comes from entrance fees [2].

According to [3] a tourist area is a commercial area devoted to recreational activities. Recreation provides relaxation to the mind, provides a new eye view (new view) so as to renew the mind’s memory, forget about problems and relieve existing stress. Thus, with an approach, it can be said that the Buperta area to achieve the goals of recreation, needs to consider the arrangement that affects the mind of the user.

Over the past twenty years, studies have shown that there is a relationship between nature and increased productivity, increased healing value and even increased...
understanding of learning on a large scale [4]. The concept of Biophilia shows how humans have a basis to connect and depend on nature. These studies also state that the integration of the natural environment into the spaces where humans live can enhance healing and have a positive impact on emotional changes [5]. Empirical studies have reported that environmental experiences greater emotional recovery [6]. Consequently, the greenery layout arrangement and its optimization is crucial for the sustainability and benefit of Buperta Cibubur Landscape. The objectives of the study are recreating criteria of biohilia in Buperta Cibubur, analyze which area that potential to be optimized with biophilia concept, and make some recommendations in terms of concept in green layout arrangement. Therefore, the researcher wants to compile criteria and greenery layout arrangement using the principles of Biophilia concept as a way to increase the attractiveness of the tourist area of Bumi Perkemahan and Graha Wisata Pramuka (Buperta) Cibubur through the experience of the relationship between human and nature.

2. Methods

2.1. Study Site and Time
The research was conducted in the tourist area of Buperta Cibubur that shows on Figure 1 for 9 months from December 2019 to August 2020.

![Figure 1](image)

**Figure 1** Study Sites: (a) DKI Jakarta Province (b) Jakarta Timur City (c) Buperta Cibubur (Source: Google Earth Pro)

2.2. Study Methods
In this study, the overall process of methods are using Biophilia patterns by [6] as a consideration. In general, there are three platforms, comprising of nature in space, analogue of nature, and nature of space. Furthermore, there are seven patterns (P1-P7) in nature in space, three patterns (P8-P10) in analogue of nature, and four patterns (P11-P14) in nature of space. The detail of each pattern can be seen as follow:

| 14 Patterns of Biophilia |
|--------------------------|
| Nature in Space          |
| P1  Visual Connection with Nature |
| P2  Non-Visual Connection with Nature |
| P3  Non-Rhythmic Sensory Stimuli |
| P4  Thermal and Airflow Variability |
| P5  Presence of Water     |
Nature in space describing the patterns of the natural existing conditions and the connections among nature and human activities. In addition, analogue of nature is the pattern that transform all appearance of the elements into natural shape. Nature of space is describing the non-physical patterns of natural phenomena that can be plugged in the development areas.

2.2.1. Preparation
In the preparation stage, the researcher conduct a research about the location and research topic then prepares permits for the research location manager, prepares material tools and compiles technical details of the research.

2.2.2. Inventory
At the inventory stage, the researcher looks for the information needed for the analysis stage. The information obtained includes location, climate, topography, hydrology, visual, circulation, facilities, land use and activities, and vegetation. Information is obtained through visits to research sites, interviews with site managers, related stakeholder, and publications.

2.2.3. Analysis
The analysis stage in this study is divided into two approaches, spatial analysis and descriptive analysis. Descriptive analysis formulates potentials and constraints as reference materials for the application of the concept using general site condition data with Biophilia patterns as material for analysis. Then conducted a study with a spatial analysis approach to determine the zone with the strongest natural potential by vegetation and visual analysis.

Vegetation potential was assessed using the Normal Difference Vegetation Index (NDVI) method to see quality of the greenery on the overall site which uses the normalized difference between the near red and infrared reflectance values due to the reflection by [7]. The NDVI analysis technique measures the quality of vegetation using a Landsat 8 map with an accuracy of 30x30m, then categorized based on the vegetation quality:

\[ NDVI = \frac{(NIR - RED)}{(NIR + RED)} \]

NIR = Band that has a near infrared length (band 5)
RED = Reflection in visible red band (band 4).

Visual potential is assessed using the Scenic Beauty Estimation (SBE) method, which is an assessment through a questionnaire on photos taken based on a grid and the presence of a biophilia pattern to get a comprehensive representation of the entire site and capture the biophilia potential on the site. Data were collected by researchers directly and assessed by
landscape architecture students. This technique uses criteria based on [8] where landscapes including low visual quality have an SBE value of <-20, landscapes include moderate visual quality if they have an SBE value between -20 to 20, and landscapes including high visual quality have an SBE value> 20 with calculations:

\[ SBEx = (ZLx - ZLs) \times 100 \]

- \( SBEx \) = SBE value of x-scene
- \( ZLx \) = Average z value of the x-scene
- \( ZLs \) = Average z value of standard scenes

SBE consists of three steps, namely survey and selection of landscape representations, taking questionnaires, and analyzing data. There are 30 landscapes presented using photos. Photos were presented using the online QuestionPro form with each photo given 8 seconds to grade on a scale of 1-8. Respondents who assess the visual quality of the landscape presented are students of the Department of Landscape Architecture IPB semester 8 who according to [8] are part of the community who are considered critical and care about their environment. The number of respondents who assessed was 30 people.

The results of the descriptive analysis are displayed in the form of a green arrangement recommendation table, while the results of the spatial analysis are displayed in the form of a map of potential zones classified in 5 classes, from low to high values according to the dominance of the analysis value in each zone.

2.2.4. Synthesis

The results of the NDVI and SBE analysis at this stage are overlaid, validated by assessment of potential biophilia patterns on each land use zone, then three zones with the most potential from the entire site are determined. The three selected zones then determined the sub-concept of the biophilia concept based on the table of recommendations for green arrangement that was made in the descriptive analysis stage.

2.2.5. Recommendation

The recommendation process is processing the sub-concepts that have been created at the synthesis stage and determining the alternative green layout arrangement designs for each site development. These recommendations are presented in the form of a concept and site plan.

3. Result and Discussion

3.1. General Site Condition

Bumi Perkemahan and Graha Wisata (Buperta) Cibubur has an area of 210 hectares, located in Pondok Ranggon Village, Cipayung District, East Jakarta City. After being classified based on the land use and activity, the Buperta area can be divided into 14 zones, i.e. main access, arboretum, sports area, support area, agricultural area, tourist area, lake, tourist house, pine forest, men’s camp (Kempa), women’s camp ("Kempi"), airport, main field, and swamp. The aspects that are inventoried are location, climate, topography, hydrology, visuals, circulation, facilities, zones and activities as well as green systems.

3.2. Descriptive Analysis

3.2.1. Location, Site Boundary and Accessibility

Buperta Cibubur has a strategic location. The site is the main access for the Cibubur T-junction which is right in front of the Jagorawi toll exit from the direction of Jakarta and the entrance door is too close to the Trans Jakarta and Angkutan Kota (Angkot) bus stops so
that the vehicle intensity that occurs is high during busy hours. Consequently, due to the existing conditions the pollutants in the study area are high and need to be considered to minimize the pollutants.

One of the Biophilia approaches that can be applied is Refuge (P12) [6] by separating the site from the surrounding area. Its implementation in green system arrangement can be in the form of utilization of vegetation which can reduce pollutants and noise.

3.2.2. Climate
The air temperature in DKI Jakarta province reaches a maximum temperature of up to 29.7°C with an average of 28.8°C, while the average air humidity is 74.4% [9]. According to [10], the relative comfort temperature in the tropics is 27-28°C and the ideal humidity is between 40% -75%. In other words, Buperta Cibubur is not in the ideal human comfort and In the Buperta Lake area, air humidity is higher due to the presence of water bodies.

Biophilia patterns that can be applied is Thermal and Airflow Variability (P4) and Refuge (P12) [6] can be applied in several areas that require more comfort and high intensity of use. The implementation of this principle is in the arrangement of green systems, namely planting shade vegetation and ground cover to reduce surface temperature and adding a number of vegetation with wide crowns in order to reduce surface temperature without reducing the area of space or activity.

3.2.3. Topography
Using the modified criteria of Hardjowigeno and Widiatmaka (2007) in [11], for urban forest recreation, a land slope of 0-15% is a very suitable land characteristic, a slope of 15-25% is quite suitable, a slope of 25-45% is marginal, while a land slope greater than 45% is not suitable. Most of the land in Buperta has a slope of 0-15%, which mean flat and sloping so that the overall topography of the Buperta area is very suitable.

By using the Biophilia approach, this potential can be exploited by greenery layout arrangement with a combination of Prospect pattern (P11) and Mystery (P13) [6] in areas with a slope category of 0-25%, applications in green arrangement can be by highlighting the contour using vegetation.

3.2.4. Hydrology
The good condition of Lake Buperta and the surrounding environment which is environmentally preserved have the potential to become a source of clean water and a house with ideal conditions for animals, as well as being a model lake that can support the development and management of other water bodies in DKI Jakarta province. Most of land cover in Buperta Site is bare land and grass, so the water absorption rate at the site is high, and drainage is well distributed so that the potential for flooding is very small. Potential inundation can be found in areas with bare land cover, such as parking lots.

When associated with the Biophilia approach, we can increase the diversity and sanitation Lake Buperta Complexity and Order (P10) [6], mimicking the concept of natural water cleansing by vegetation. In addition, to overcome the inundation problem in parking lots, it would be better if provided pavement material is permeable or with a good slope.

3.2.5. Visual
A recreational urban forest must fulfill several facilities such as parking lots, security posts, hygiene facilities, toilets, water installations, electrical installations and drainage systems [12]. In general, the quantity and completeness of the facilities at the Buperta Cibubur site is quite complete. Some of the facilities with high usage intensity on the Buperta Cibubur site are well maintained, while some of the facilities with low intensity usage are poorly maintained.
With Biophilia approach, pattern that can be used is Mystery (P13) and Risk (P14) can be applied to provide a user experience to the site, with Prospect (P11) to guarantee its safety. Patterns of Non-Visual Connections with Nature (P2) can be added to interesting experiences and create connection patterns with natural systems [6]. In summarize, there are three patterns that can be used to optimize the visual context at the study area.

3.2.6. Land Use and Activity
The types of tourism activities in the Buperta area can be broadly divided into several main types of activities, namely camping, picnics, sports, education with small to large scale user groups. The effectiveness and visitor attractions have the potential to increase if the site arrangement is adjusted to the intended use and activities carried out on the site.

Using the Biophilia approach, the zone with camping activity can apply the pattern of Analogues of Nature, Complexity and Order (P10). Zone with picnic activities, can apply the Prospect (P12) which aims to create the feeling of comfort and safety needed in picnics while still maintaining the existing view. Zone with sports activity can apply Material Connection with Nature (P9) pattern on trails and activity areas to increase the fun aspect of recreational sports. Whereas in the education zone, Mystery (P13) can be applied because it can cause a sense of exploration or curiosity about what will happen or what will come afterwards [6]. Above all, there are four patterns that can be added in the study area to improving activities of recreation to nature.

3.2.7. Greenery Layout Arrangement
The diversity of vegetation types that exist in the Buperta area is a potential, however the vegetation is still arranged without a clear pattern, the large number of untreated weeds in some northern camping areas also make it less comfortable to be used for camping. As a result, the impression that created is that the site is not neatly arranged. Referring to these potentials and constraints found, patterns of complexity and regularity can be applied (P10) [6] by adding variation of complexity on greenery arrangement considering the purpose, also adding vegetation with a different shape from existing vegetation, and vegetation leading the view towards a good view found on the site.

3.3. Vegetation Potential Study
Buperta Cibubur site as one of the largest urban forests in East Jakarta has enormous potential in the aspect of vegetation. In developing the area it is necessary to take advantage of the potential of this vegetation, the Vegetation Potential Study functions to determine zones with the strongest vegetation potential for further development. This study uses the Normalized Difference Vegetation Index (NDVI) analysis technique.

In the results of this analysis, the lowest data obtained was -0.07 and the highest data was 0.52. The quality of vegetation in the Buperta area as a whole is dominated by high category with a percentage of 66.6% with an area of 139.86ha, followed by medium category at a percentage of 15% with an area of 31.5ha, high category at a percentage of 7.1% with an area of 14.91ha, and low category with a percentage of 6.6% with an area of 13.8ha, and very low category with a percentage of 3.9% with an area of 8.3ha.

3.4. Visual Potential Study
The Buperta Cibubur area as a tourist area, in order to increase the attractiveness of the area apart from utilizing its potential in the vegetation aspect, it is also necessary to consider its natural visual potential. Visual Potential Study serves to determine areas with the strongest visual potential for further development.
In the results of this analysis, the lowest data obtained was -0.07 and the highest data was 0.52. The visual quality of nature in the Buperta area as a whole is dominated by very high category with a percentage of 37.7% with an area of 79.17ha, followed by medium category at a percentage of 37.3% with an area of 78.33ha, high category at a percentage of 21.3% with an area of 44.73ha, and low category with a percentage of 3.5% with an area of 7.34ha, and 0.2% very low category with an area of 0.42ha.

3.5. Biophilia Pattern Potential Scoring
The assessment of potential Biophilia patterns on existing sites can help complement research in assessing the strongest natural potential that can be used for Biophilia concept’s site development. In addition to determining the strongest natural potential, Biophilia pattern potential scoring can also be used to determine patterns that can be prioritized in site development.

Result of this pattern potential scoring shows that arboretum zone categorized as a very strong potential on Biophilia pattern, followed by lake zone categorized as a strong potential, kempa zone, “Kempi” zone, tourism area zone with moderate potential, main field, sport area, and main access with low potential, and lastly sport area, agriculture area, and air field with very low potential.

3.6. Synthesis
Figure 3.a describes dark green means very high in natural condition, figure 3.b. shows that the dark pink means very high quality of visual, figure 3.c describes the dark turquoise means the area has more indicator of Biophilia patterns. In the overlay analysis results (Figure 3.d), it was found that most of the sites had a moderate category at a percentage of 50.2% which is 105ha, then followed by high category at a percentage of 38.4% with an area of 80,64ha, very high visual and vegetation potential with a percentage of 6.5% with an area of 13,65ha and low category with a percentage of 4.8% with an area of 10,08ha, while the very low category is not found. Areas with the highest visual and vegetation potential categories are mostly found in the Arboretum, followed by Pine Forest, Tourism Area, Sport Area, “Kempa”, and “Kempi” zones.

According to [6] Biophilia design patterns must be adapted to the surrounding environment and the predicted user population for the space. Each space will present different design challenges depending on programming, user types and dynamics, climate, culture, and various physical parameters, as well as existing or required infrastructure. To determine the 3 zones to be developed, the result of weighted overlay on figure 3.c is limited, considering land use zone, the type of environment and user characteristics, “Kempa” Zone, Tourism Area and Pine Forest are selected to be developed into the recommendation stage as seen of figure 3.d.
Based on the results of the descriptive analysis that has been conducted by considering the potentials and constraints on the site, the application of the Biophilia concept in greenery layout arrangement in each zone can be applied through the following sub-concepts as seen on Figure 4.

**3.6.1. Pine Forest: Wild Curiosity Trail**

Wild in this concept describes the atmosphere to be achieved in the pine forest zone by this recommendation using a Non-Visual Connection with Nature (P2) pattern and Risk (P14), while Curiosity describes the impression to be achieved to support the educational function in the pine forest zone using Mystery (P13) pattern. The design of the activity area in the pine forest zone will be designed in the form of a trail, this path can be used by tourist visitors on foot or by bicycle and academics to be able to explore the pine forest associated with the arboretum, without destroying the existing vegetation. The design concept is applied in an organic form to make the experience more natural.

**3.6.2. Recreation Area: Green Urban Miniature**

Green in this concept is carried through the vegetation from outside the site (P1) which is obscured by the boundaries into the site by creating a vegetation buffer (P7), the vegetation that was previously dense outside the site when brought into the site is getting less and less. Meanwhile, the urban atmosphere is brought about in the connection between buildings and their respective areas to one another through the pedestrian circulation path which is built continuously.

**3.6.3. "Kempa": Systemic Forest Camp Site**

Systemic forest is a hierarchical and diverse system that exists in most forests in tropical areas, which has a random pattern and high diversity, consisting of various types of
vegetation with different shapes and heights (P10). This concept also emphasizes that this zone is a camp site where safety (P12), comfort (P11), space and the existence of facilities must be considered, so that combining the two concepts, Systemic Forest Camp Site will create a safe, comfortable and free camp area, without losing the forest-like atmosphere which is one of the main goals of camping.

3.7. Greenery Layout Arrangement Recommendation
Green planning recommendations are made based on the results of the analysis and synthesis that have been carried out on the Bumi Perkemahan and Graha Wisata Cibubur areas. The vegetation types recommended on the site are partly vegetation types that are already in the Buperta area so that a connection with the natural system is formed (P7), and all of them can have a significant influence in the application of the formulated biophilia concept.

3.7.1. Pine Forest
In implementing the Wild Curiosity Track sub-concept, three types of circulation paths will be formed; pedestrian, bicycle and car lanes (existing). The bicycle path is formed around the entire site and has a dangerous character to support the wild atmosphere that you want to achieve in the form of obstacles, while the pedestrian path is made effective by considering the view that will be obtained.

In this recommendation, the recreation room is divided into sky (upper) and land (lower) recreation, taking into account the difference in the potential view to be achieved, the activities in the lower recreation room are in the form of picnics and camping, while in the upper recreation room in the tree house, namely sight seeing activities. The vehicle parking space is also planned to use a permeable pavement to avoid potential puddles that arise with land cover.

![Figure 5 Pine Forest Greenery Layout Arrangement Recomendation](image)

(a) Block Plan (b) Site Plan

The recommendation for green arrangement that is added to the existing green layout of the pine forest zone is the addition of shrubs with different textures on most sites (P10), such as *Imperata cylindrica* with a fine texture and *Nephrolepis exaltata* with a coarse texture, and a bold color as a texture enhancer and differentiator between activity and non-activity spaces, except in the lower recreation room and parking space where activities are carried out above it. In addition, around the parking space there is vegetation *Terminalia Mantaly* which plays a role in limiting the view (P13).
3.7.2. *Recreation Area*

The Green Urban Miniature concept emphasizes the connection between each part of the site, and also on the connectedness of the activity area with the surrounding natural environment. The tourism zone is divided into several zones, namely a prayer zone, a traffic garden zone, a guest house, and other tourist spaces (swimming pool, scouting education, and a hall). The connection system is implemented in the form of pedestrian circulation through plazas and pedestrians. At the center of the activity, a shared parking space is formed that is associated with the entire site.

Most of the green planning recommendations that are added to the existing green layout of the tourist area have the aim of creating an integration of the surrounding environment into the activity area (P7). Most of the existing vegetation is of medium height so the added vegetation is of high and low elevation to create diversity (P10). Vegetations with high crowns were *Ceiba petranda*, *Swietenia mahogany*, *Samanea saman* and *Filicium decipiens*, and low canopy vegetation were *Carex morowii*, *Nephrolepis exaltata* and *Pennisetum rubrum*. *Terminalia Mantaly* was added to add an urban accent to the site.

![Figure 6](image1.png)

**Figure 6** Recreation Area Greenery Layout Arrangement Recommendation
(a) Block Plan, (b) Site Plan (b)

3.7.3. “*Kempa*”

The Systemic Forest Camp Site concept focuses on a camping experience that resembles a camping experience in a natural forest, but is guaranteed safety and security. Therefore the felt zone is divided into three types of space, namely closed and open individual campsites that can be used for families and individual, group campsites, and display rooms. However, open areas can be used during the day and closed areas with protection are more comfortable to use at night. The group campsite is for large groups, while the display space will be used and formed as a borrowing view of the surrounding camp spaces. While the green arrangement adapted the concept of camping arrangement by [13] as seen on figure 7.

![Figure 7](image2.png)

**Figure 7** Camp Site Greenery and Tent Layout Arrangement
(a) Close Individual Camp 1 (b) Close Individual Camp 2 (c) Open Individual Camp (d) Group Camp
Source: [13] modification
Recommendations for the arrangement of green layout in group campsites focus on the formation of vocal points as a way of giving a little texture (P10) to the site using *Samanea saman* and *Erythia fusca* vegetation because they have a firm branch shape. Green planning recommendations for group campsites focus on the establishment of privacy (P11) using *Erythina fusca* vegetation because it has low branches but does not cover the view and *Necrolephis exaltata* because it includes vegetation that already exists on the site and can limit movement without close view. Meanwhile, the recommendation for green arrangement in the display room focuses on establishing a hierarchy of vegetation height (P10) using *Ceiba pentandra* and *Polyathia longifolia* vegetation because the canopy is high enough to be seen from a distance.

![Figure 8 “Kempa” Greenery Layout Arrangement Recommendation](image)

(a) Block Plan  (b) Site Plan

4. Conclusion
In an effort to overcome obstacles and take advantage of existing potentials, this study uses the concept of Biophilia. In a site which already dominated by vegetation, the concept of biophilia or the formation of a relationship between humans and nature can be achieved not only by adding natural material to the site, but also can be achieved in the form of applying characters of nature to the site. Its application in green arrangement can take into account the shape of the canopy, height and texture of each vegetation and its influence on human feelings so that it can create natural environment characteristics. The concept of biophilia in its application in three zones with the highest visual and vegetation potential in the Buperta Cibubur area is broken down into three sub-concepts, Wild Curiosity Track in Pine Forest Zone, Green Urban Minature in Tourism Zone and Systemic Forest Camp Site in “Kempa” Zone. The three sub-concepts are determined based on the types of activities that are often found in the zone and aim to systematically maximize the potential that exists in the zone.

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