Ecological Green Space Planning for Butterflies Habitat in Residential Area

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Abstract: Development a residential area cause fragmentation both green space and wildlife habitat as well. Moreover, the landscape design orientation in housing areas usually focusing on the aesthetic value and less attention to the ecological function as well as the health of the ecosystem. Butterflies are the indicators of environmental and ecosystem health. Areas rich in butterflies and moths indicate the richness of other invertebrates. These collectively provide a wide range of environmental benefits, including pollination and natural pest control. Therefore the presence of ecological orientation of green space in a residential area as a habitat for butterflies and other wildlife is one of the solutions. The purpose of this study is to create an ecological green space plan for a butterflies habitat in the residential area. The study was conducted consist of preparation, data collection, data analysis, synthesis and planning. The aspect analyzed in this study are biophysical aspect and quality of ecological aspect that contains butterflies diets and a host plants, proximity to the water resource, vegetation cover and the interspersion of habitat components. The result show that the butterflies on the site, qualitatively, indicate quite diverse lack of diversity of host plants and the vegetation for the butterflies diets. The as green space plan for butterfly habitat was arranged based on the development of the ecological space concept, the vegetation concept and the animal activities concept. Each green space unit (patches) has functions as sink and source and also as stepping stone and connecting corridor between sinks and source. A plant selection is proposed for each green space unit.

Keywords: butterflies habitat, ecological green space planning, residential, sink-source

1. Introduction

The development of residential areas, in particular, often cause in habitat fragmentation. Moreover, the orientation of landscape design in residential areas often focus on human need (anthroposentric), such as on aesthetic values, but does not pay much attention to the ecological function and wildlife habitat. Habitat is a living space where flora and fauna are existed, and animals look for feed and breed as well. Currently, a lot of residential developer ignored wildlife habitat in the region, or even the absence of animals such as birds, butterflies and other insects. According to the Butterfly Conservation Europe [1] butterflies are an indicator of environmental health and the health of ecosystems, butterflies help the process of pollination and as a natural pest control, besides it is also an important element in the food chain and is a prey for birds, bats and other insect eaters.

Many ecologists have used butterflies as an organism model to study the effects of habitat loss, fragmentation and climate change. According to Gilbert and Shelter in Brunet [2] the absence of butterflies also reflects the environmental impact on the development of urban areas. The application of pesticides in maintaining green space often kills butterflies. Although, the loss of habitat for flora and fauna in the region does not mean that the entire...
habitat is lost, but the alteration of the environment in which a population lives, causing habitat survival to decrease.[3] Developing residential area as mostly replacing the natural resources, such converting from woodland or agriculture land and to residential land. This conditions cause an imbalance of the ecological environment. Therefore it is very important to restore or inserting some of the previous natural environment into the new development areas.

The development of residential areas must be oriented towards sustainable development. Development of esidential units is not only related to social functions, but also related to the role of the residential environment in supporting ecological functions. Therefore it is necessary to increasing ecological capacity of the residential environment. One solution that can be applied is through the development of ecological green spaces in residential area. Those green space can be realized in the form of ecological green space as a butterfly habitat in residential areas. The objectives of this study are: to identify the butterfly potential habitats in green space, analyzing the suitability of green space as a butterfly habitat, and arranging the ecological green space plan as a butterfly habitat in study area.

2. Methodology
The study were carried out in two cluster, cluster of Tatar Tejakancana and cluster of Tatar Purbasari, of the residential areas in Parahyangan New Town, West Bandung Regency, West Java (Figure 1), from May to August 2016. The method used in landscape planning consists of the following stages, i.e.: inventory, analysis, synthesis and planning.

![Figure 1 Study site located in Tatar Tejakancana and Tatar Purbasari cluster, Parahyangan New Town, West Bandung Regency, West Java](image)

2.1. Inventory
This stage begins with a desk study, determining the location of the study, as well as taking data from the housing developer, relevant agencies and the local government. The survey was conducted by direct observation on the site and around the site to determine the condition of existing settlements, utilities and facilities as well as the ecological conditions of the settlements. In addition, direct verification is carried out on the existing condition. The data obtained is then compiled to produce preliminary base maps and derived as thematic maps.
2.2. Analysis and synthesis
The analysis was carried out on the structure, distribution and area of the existing green space based on Regulation of Minister of Public Work No. 5 of 2008. The analysis also conducted to determine suitability of green space area as a butterfly habitat. The ecological criteria for butterfly habitat suitability was compiled from various sources (Table 1). Using this criteria, the green space in study area can be evaluated. The range of values is calculated based on the difference between the maximum value and the minimum value of each criterion and divided by the number of classes. So that it can be seen the range of values for each ecological criterion. Calculation of the range of values and ecological classes is as follows:

\[
\text{Value range} = \frac{\text{The maximum value} - \text{The minimum value}}{\text{Classes}} = \frac{15 - 5}{3} = 3.3
\]

Where:
- High Ecological Suitability = 11.7-15.0
- Medium Ecological Suitability = 8.4-11.7
- Low Ecological Suitability = 5.0-8.3

Synthesis is carried out by compiling a space requirement program that can be used as a habitat for butterflies. The synthesis is an alternative of green space type that can be developed in accordance with the characteristics of the residential landscape and the types of butterflies that have the potential to be attracted.

| No | Components of butterfly habitat | High (3) | Medium (2) | Low (1) |
|----|----------------------------------|----------|------------|--------|
| 1  | Caterpillar feed [4][5]          | - There are ≥ 10 plants which are caterpillar feed which have characteristics of large, hard leaves and high shoot density and diversity of host plants. | - There are 5-7 plants which are caterpillar feed have characteristics of large leaves, smooth and with a canopy density and diversity of host plants. | - There are <4 plants which are caterpillar feed having fine leaf characteristics, with low crown density and diversity of host plants. |
| 2  | Butterfly feed                   | - There are ≥10 nectar-producing plants. | - There are 5-9 nectar-producing plants | - There are <4 nectar-producing plants |
| 3  | Water resources                  | - Place the park <5 m from the water body. | - Place the park 5-10 m from the water body. | - Place the park >10 m from the water body. |
| 4  | Canopy Opening [4][6]            | - Stratified heterogeneous vegetation | - Heterogeneous Vegetation | - Homogeny Vegetation |
|    | Adult butterfly ≥ 90% canopy opening | - Adult butterfly 60-90% canopy opening | - Laying of eggs 30-60% canopy cover | - Adult butterfly <60% canopy opening |
|    | Egg laying ≥60% canopy cover     | - Laying eggs <30 canopy cover |
| 5  | Interspersion of habitat components [7] | - The existence of caterpillar and butterfly feed is diverse, with stratified vegetation, proximity to water sources, and having vegetation cover for protection. | - The existence of caterpillar and medium butterfly feed, with stratified vegetation, close enough to water sources, and has vegetation cover for shelter. | - The existence of caterpillar feed and butter fly feed is small, separate and sparse, with homogeneous vegetation, away from water sources, and has low vegetation cover. |

2.3. Planning
At this stage the planning concept was developed. The concept consist of basic concept, spatial concept, vegetation concept and activity concept. The final results of this study was performed
as green space planning as a butterfly habitat along with the various factors that support the butterfly habitat was considered.

3. Results and Discussion

3.1. Site Biophysical Conditions

Parahyangan New Town which is located in the West Bandung Regency and covers Padalarang District and Batujajar District has an area of 1250 ha. Administratively, the location of Parahyangan New Town is bordered by Jaya Mekar Village to the North, Pangauban Village to the South, Cipangerang Village to the west and Kerta Mulya Village to the east.

Based on data from Bappeda (Agency for Regional Development), the type of soil found in this study location is alluvial and red yellow podsolic. Monthly average rainfall ranges from 116.9 (mm) - 156.4 (mm), with average daily humidity ranging from 53.25% - 74.67%. The study area is located within the water catchment area that flows into Saguling Reservoir [8]. Most of the rivers flowing on the site are part of the catchment area of the Saguling reservoir, including the Cilesang River, Cikondang River, Cireundeu River, Cisudi Mampir River, Cihaur River. The drainage infrastructure in the residential area of Parahyangan New Town was built as open and closed drainage system.

Vegetation found in the Purbasari and Tejakancana clusters is dominated by exotic vegetation. Qualitatively, species diversity of exotic plant, consist of 29, 14 and 8 (eight) species of trees, shrubs and ground covers, respectively. Animals found in residential areas consist of reptiles, birds and insects. Qualitatively, by direct observation in the site for butterfly, in particular, the types of butterflies that are mostly found in the study site consist of 4 (four) families, namely Pappilionidae, Pieridae, Nymphalidae, and Lycaenidae.

3.2. Analysis and synthesis

3.2.1. Analysis of Green Space for Residential Area

There are 286 households within the two clusters in residential area of study. The total green space area within those two clusters are 54,687.33 m², including thematic community parks, thematic neighborhood parks, home gardens and backyard gardens, and pocket park. Based on Minister of Public Works Regulation No. 5 of 2008, the existence of community and neighboring parks within the settlement area have fulfilled the provisions, while the home garden still does not meet the minimum area specified.

3.2.2. Biophysical Analysis

3.2.2.1. Soil Analysis

The soil type in the study area predominantly an alluvial type. This soil type has a high nutrient content. High nutrient content in this soil will give opportunity and provide a variety of choices of plants that can be planted in the green space.

Moreover, as the study areas located adjacent to the Saguling reservoir, this make the area has potential to be developed as an ecological green space, especially for butterfly habitat. Some types of butterflies have the behavior of absorbing minerals from wet or mud puddling soils [7]. The availability of wet soil around the bank of the reservoir can attract more butterflies to visit the green space.

3.2.2.2. Climate Analysis

The climate characteristics base on Schmidt and Ferguson [6], West Bandung regency is classified as in C type climate with a bit wetter. The climate characteristics, such as intensity and not too frequent of rain, average daily temperature between 25.43° C to 33.69° C, and the average daily humidity ranges from 53.25% to 74.67% very suitable for the development of ecological green space as butterfly habitat and breeding area Speight in. [10]
3.2.3. Green Space Analysis Based on Ecological Criteria as Butterfly Habitat

Analysis to determine butterfly habitat was conducted by assessing the availability and quality of butterfly habitat based on ecological criteria for butterfly habitat suitability (Table 1) for each ecological analysis unit. The ecological analysis unit is a green space unit which available in the study area. Although green space unit in the study area, predominantly has a low ecological value (Table 2), but has the potential to be developed as green space for butterfly habitat. Although, the source of nectar plants and host plants for butterflies are still lacking and the quality of plants is not so good, through the improvement of the quality of available green space can provide opportunities for the movement (migration) of butterflies originating from outside (resource pool) into residential area. This is due to the types of butterflies found in this region are quite diverse and abundance of each type, especially, for Lycaenidae family.

| No | Green Space Unit | Type Name | Suitability Class | Area (m²) |
|----|------------------|-----------|------------------|-----------|
| 1  | Community Park   | Taman Grand Amphitheater | ✓ | 5855 |
| 2  | Neighborhood Park | Saron Park | ✓ | 702.02 |
|    |                   | Gong Park | ✓ | 1236.1 |
|    |                   | Suling Park | ✓ | 744.11 |
|    |                   | Calung Park | ✓ | 797.21 |
| 3  | Pocket Garden     | East Perimeter | ✓ | 196 |
|    |                   | West Perimeter | ✓ | 1223.29 |
| 4  | Green corridor    | Berm       | ✓ | 3268.442 |
|    |                   | Median     | ✓ | 813.558 |
|    |                   | Traffic island | ✓ | 56.25 |
|    |                   | Pedestrian | ✓ | 280.02 |
| 5  | Home Garden       | 200-300 m² | ✓ | 5379 |
|    | (Front yard)      | 400 m²     | ✓ | 2591.44 |
|    |                   | 500-600 m² | ✓ | 4058.86 |
|    |                   | 700 m²     | ✓ | 2314.2 |

Therefore it need to improve the quality of green space as a butterfly habitat. The improvements of quality of green space can be done in this study area by provide the source, sink and corridor. Contextually, in larger scale, the green space area acts as butterfly habitat patches which are connected as large scale sink-source relationship. Those relationship connected as butterflies movement from resources pool (resources) beyond the site to the paches (sinks) of green spaces in the site. On a micro scale, the relationship between sinks as feed providers for adult butterflies and sources as hosts for plants, occurs through connecting structures in the form of stepping stones and corridors between sinks. The results of evaluation of green space as butterfly habitat can be proposed as planning program (Table 3).
| No | Green Space Unit | Site conditions based on biophysical analysis and habitat components | Proposed Planning Program |
|----|------------------|------------------------------------------------------------------|---------------------------|
| 1  | Community Park: Grand amphitheatre | - Caterpillar feed/host plant: Caterpillar feed is quite diverse  - Feed the butterfly: Minimal  - Vegetation cover: Trees, grass, groundcover  - Water / nutrition: Very close to water | - Maintain appropriate vegetation  - Addition of nectar-producing plants, from various strata and various types and sizes of flowers |
| 2  | Neighborhood Park | - Caterpillar feed / host plant: Caterpillar feed is quite diverse  - Feed the butterfly: Minimal  - Vegetation cover: Trees and ground cover plants  - Water / nutrition: Close to water sources | - Hosts plant are not added, planning is focused on planting nectar-producing plants, with different types and sizes of flowers. Adding a small pond containing wet soil |
| 3  | Pocket Garden | - Feed caterpillars / host plants: Minimal  - Vegetation cover: Trees and grass  - Water / nutrition: Quite far from water sources | - Planting nectar-producing plants, with various types and sizes of flowers.  - Adding a small pond containing wet soil |
| 4  | Green Corridor | - Feed caterpillars and butterflies: Minimal | - Addition of nectar-producing plants with various strata and types of flowers |
| 5  | Home Garden (Front yard) | - Caterpillar feed / host plant: There are 8 types of host plants in 4 house samples  - Butterfly feed: Minimal type of vegetation | - Planting nectar-producing plants, with various types and sizes of flowers. |
| 6  | The whole area | - Average daily temperatures range from 25.43 °C-33.69 °C, with average daily humidity ranging from 74.67% -53.25%, climate type C, with Alluvial soils | Addition of trees and shrubs and ground cover for micro climate modification |
| 7  | Reserved Area | - Planted by bamboo vegetation as a barrier.  - Dominated by weeds, there are several wet puddles | - Planning is focused on planting host plants. |

### 3.2.4. Concept Development

The basic concept in this study is to develop an ecological green space as a butterfly habitat within residential areas. Based on ecological suitability analysis of green space as a butterfly habitat, the Tejakancana and Purbasari Clusters can be developed into a source and sink area for various types of butterflies.

#### 3.2.4.1. Space Concept

Conceptually, the neighborhood park and community park was developed as a sink area. It has function to provide various types of feed sources for adult butterfly. The greenway and home...
garden was developed as a corridor that also provides a source of feed. Whereas in the West Perimeter’s pocket park and reserved area was developed as a source area that provides a source of host plants. Those space concept was arranged by considering proximity of the planning area to user activities and the residential area.

3.2.4.2. Vegetation Concept
The concept of vegetation for butterfly habitat is planned to have functions as a sink of feed (sink as nectar provider), a place to play and rest, provide nest and egg laying (source as host provider). The plant selection criteria is directed at multi-strata vegetation which is nectar-producing vegetation and as host plant as well (Figure 2).

3.2.4.3. Concept of Activity
Activities developed within the site are focused on butterfly movement. The movement of butterflies is not directed but rather providing attraction of the feed sources, so that butterflies that come can move freely in the planning area because of the availability of abundant feed sources. Egg laying activities can be carried out by butterflies in the area that has been planned and focused on that area.

3.2.5. Green Space Plan
Green space planning of as a butterfly habitat in this residential area is related to the space that has function as sink-source. The green space in this residential area is more like patches that serve as stepping stones for the movement of butterflies. Whereas on a micro scale, there is a relationship between sink as feed providers for adult butterflies and source as plant for laying eggs or plants host, while the greenbelt of road becomes the connecting corridor between the sink and source area. Base on concept development can be arranged the ecological green space plan for butterfly habitat (Figure 3).

3.2.5.1. Planting Plant
The planting plan for butterfly habitat is developed in order to be able to provide opportunity have a function as a host provider, playing and resting, shelter and eggs laying place. Specifically, the characteristics of vegetation for the sources as host plant provider are selected the dense vegetation with a large and hard leaf, while the vegetation characteristics as sink provider for adult butterfly should have nectar-producing flowers which is available.
throughout the year. Table 4 show planting plant base on location and green space unit, vegetation function, type and characteristic.

Figure 3. Ecological Green Space Plan for Butterfly Habitat

Table 4. Propose Plant Selection for Green Space as Butterfly Habitat

| No | Location                      | Functions                  | Propose Vegetation Type and Characteristics                                                                 |
|----|-------------------------------|----------------------------|-------------------------------------------------------------------------------------------------------------|
| 1  | Tatar Tejakancana & Purbasari | Sink Nectar Provider       | Community Park, Grand Amphitheater and Median. Propose vegetation type and characteristics include trees, vines, shrubs, shrubs and small flowering ground cover. Such as Cassia sp., Caesalpinia pulcherima, Lantana camara, Cuphea sp., Ixora sp., Cleodendron sp., Antigonon leptopus. |
| 2  | Tatar Tejakancana             | Sink Nectar Provider       | Gong Park. Propose vegetation type and characteristics include trees, shrubs and shrubs cover large, small and large flower. Such as Bauhinia purpurea, Cassia sp., Ruellia sp., Gardenia sp., Widelia biflora, Mirabilis jalapa, Impatiens sp. |
|    | Sink as Nectar Provider       | Saron Park                 | Propose vegetation type and characteristics include trees, shrubs, shrubs and shrubs. Such as Lagerstromia speciosa, Caesalpinia pulcherima, Pseudoranthemum reticulatum, Cuphea hysopifolia, Lantana camara, Ixora sp. |
|    | Traffic Island                | Traffic Island             | Propose vegetation type and characteristics include shrub and small flowering ground cover. Such as Pseudoranthemum reticulatum, Cuphea hysopifolia, Lantana camara, Ixora sp. |
|    | Home Garden                   | Home Garden               | Propose vegetation type and characteristics include trees, shrubs and flowering ground cover. Such as Bauhinia purpurea, Cleodendron sp., Gardenia sp., Ixora sp. |
|    | Sources as host provider      | West Perimeter            | Propose vegetation type and characteristics include trees and shrub, Family Papilionaceae, Caesalpiniaceae, Rutaceae dan Annonaceae |
|    | Sink as Nectar Provider       | Pedestrian Median         | Propose vegetation type and characteristics include conifer tree and shrubs, and flowering ground cover. Such as Agathis amara, Cleodendron sp., Lantana camara, Ixora sp. |
| No | Location          | Functions                      | Propose Vegetation Type and Characteristics                                                                 |
|----|-------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------|
|    |                   |                                 | Road Line 1 and 2 Combine among Conifer tree and shrubs, and flowering groundcover. Such as Agathis damara, dan Lagerstomia speciosa, Cuphea hyssopofila, Widelia biflora. |
|    |                   |                                 | Road Line 3                                           Combine among Conifer tree and shrubs, and flowering groundcover. Such as Agathis damara, dan Lagerstomia speciosa, Cleodendron sp., Gardenia sp., Ixora sp., Impatients sp., Widelia biflora. |
| 3  | Tatar Purbasari   | Sink as Nectar Provider         | Calung Park Tree, shrub and flowering ground cover. Such as Calistemon citrinus, Nerium oleander, Zephyrantes sp., Cuphea hyssopofila, Gardenia sp., Ruellia sp. |
|    |                   |                                 | Suling Park                                           Tree, shrub and flowering ground cover. Such as Bauhinia purpurea, Cassia sp., Ruellia sp., Gardenia sp., Widelia biflora, Mirabilis jalapa, Impatients sp. |
|    |                   |                                 | East Perimeter Tree, shrub and flowering ground cover. Such as Cassia sp., Calistemon citrinus, Nerium oleander, Ruellia sp., Widelia biflora, Cuphea hyssopofila, Ixora sp. |
|    |                   | Sink as Nectar Provider         | Pocket Park Small tree, shrub and flowering ground cover. Such as Caliandra., Pseuderanthemum reticulatum, Cuphea hyssopofila, Lantana camara, Ixora sp. |
|    |                   |                                 | Home Garden Tree, shrub and flowering ground cover. Such as Bauhinia purpurea, Cleodendron sp., Gardenia sp., Ixora sp. |
|    |                   | Souces as host provider         | Reserved area Tree and shrub of the Family Bambusaceae, Euphorbiaceae, Rubiaceae, Apocynaceae, Papilionaceae, Caesalpinaceae, Rutaceae and Annonaceae |
|    |                   |                                 | Road Line 1 and 2 Combine among Conifer tree and shrubs, and flowering groundcover. Such as Agathis damara, dan Lagerstomia speciosa, Cuphea hyssopofila, Widelia biflora. |
|    |                   |                                 | Road Line 3                                           Combine among Conifer tree and shrubs, and flowering groundcover. Such as Agathis damara, dan Lagerstomia speciosa, Cleodendron sp., Gardenia sp., Ixora sp., Impatients sp., Widelia biflora. |

4. Conclusion
Although, the vegetation found in study site dominated by exotic vegetation, the butterflies found in the site are quite diverse. There are four butterfly families, namely Pappilionidae, Pieridae, Nymphalidae, and Lycaenidae. The family of Lycaenidae are found quite abundance in study area.

Base on analysis of ecological criteria for butterfly habitat suitability in each ecological analysis unit of green space structure in the study area, predominantly, have low ecological quality (value). Eventhough, the source of nectar plants and host plants for butterflies are still lacking and the quality of plants is not so good, but it has the potential to be developed green spaces for butterfly habitat. It is due to the types of butterfly family
found in this region are quite diverse and abundance. This can be occurred through butterfly migration from outside, because it is possibility that there is a resource pool outside the area.

Ecological green space planning as a butterfly habitat in the residential area of Parahyangan New Town can be arranged based on the development of the ecological space concept, the vegetation concept and the animal activities concept as outlined in the sink area as a feed/nectar provider for adult butterflies and the source area as a provider of host plants, as well as corridor that connects the sink and source.

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