Birdie..birdie.. come and let’s share our city

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Abstract. Humans have been dominating the urban areas with their abilities and unfavourably tend to have affected other living creatures. This paper directed how to acquire a place in the cities for creating opportunities for birds that live in the cities to live together with us. Several methods were applied emphasizing on Urban Rapid Biodiversity Assessment (RBA) which was adjusted for tropical environments. Vegetation structure, Domain value and the diversity of vascular plants are components determining the quality preference for birds. Results indicated that stream corridors were the best accommodating spaces with an average number of vascular plants was 27; the average number of existing vegetation structures amounted up to 7.00; the average of the total Domain values of all vegetation structures excluding buildings was 24.00 and the average of the total Domain value of all trees was 11.00. Furthermore there were as well empty fields, road corridors, institutional space, green spaces for the public, urban farms and wetlands. The quality of spaces for city birds could be more specific by adding additional filtering of size, ownership, and a development plan. Networking with natural areas would be more feasible if more space were included. Available spaces would be greater when the state of ownership was not limited, despite public spaces were much easier to manage.

1. Introduction

1.1. Urbanization

Urban development is a worldwide phenomenon, resulting from the change of both physical and demographical aspects due to urbanization where for Southeast Asia, up to 11% are now metropolitan areas [1,2]. As the main inhabitant of urban areas, humans are the most responsible creatures for driving the course of this change, whether their egocentric approaches, focusing only on their matters or concerning other creatures who were the original inhabitants of these areas which turned to be more urban. Urbanization causes pressures to cities in terms of their ecosystem ecology, physical changes which results to disruptions and threats to the natural state [3] and overall imposing pressures on space utilization which compete with other members of the urban ecosystem [4], and thus affect them inauspiciously. As a consequence, the existence of other species that inhabits the urban area has been decreasing. The issue of creating an urban environment as a home for humans and habitat for species’ has become a popular discussion among planners, environmentalists and policy makers. Emphasizing the importance of the existence of particular species could lead to the assessment of their needs for their habitat, the distance and values required for further analysis [5]
1.2. Species that become urban target species
Assessment on urban space ecology could be more intensive by considering a specific species as the primary target or indicator. This refers to a species which has important values to the landscape and is subtle to changes in the landscape, furthermore requires special treatment [6]. In the scope of the urban context, the identification of these desirable species is significant as their interaction with human beings have been intense and thus the effect is ostensible [7]. Among the species that have received large attention are urban birds [3], concerning their value to human beings [8]. Birds are considered to be an important member of the ecosystem in cities [3] and their presence and conditions have often become a parameter of environmental change in the urban areas [7]. Relating it with other urban environmental issues such as the ecological network and greenways, optimizing urban spaces as a habitat which have become the objective for the conservation program [9]. Furthermore, they could be an important indicator for the biodiversity in the environment [10] as they represent the viability and the quality of habitat in the urban areas [11] especially as the food chain where birds have been a consistent component [12] as their presence in a variety of habitat types and environment [11].

1.3. Habitat Preferences
A variety of previous researches stressing on urban birds emphasised the preferences for birds habitat within the urban environment. Many of them stressed the importance of the vegetation structure and richness of the plants [13], some also included the significance of the area [12], and the abundant amount of insect [14], also the specific type of urban patches [9,15] as well as the stage of urban corridors [16]. The quality of the area potential enough to become the habitat for urban birds has become the object of observation and tend to focus on the anthropological effect which causes threats, disturbances, disruption and results the fragmentation of these features [15]. One thing in common referring to the features of the habitat is the significance of vegetation as the ecosystem’s main component. Vegetation structures specifically, according to [17] the information relating to this structure will lead to the comprehension of the ecological value of habitat for wildlife.

This article tries to find a solution to assess areas in the cities which are considered to be suitable as a habitat for birds who live in the city in one city in Indonesia which has been developing, which one of those is Makassar. The primary observation was the vegetation structure of various types of areas in the cities, as within the urban environment, the ecosystem functions across biological and non-biological aspects [18], or natural and artificial [4] features, those commonly discovered in the urban environment.

2. Methodology

2.1. Area of Study
This study was done in the capital of the Province of South Sulawesi i.e. Makassar, a city in the Eastern part of Indonesia which is described as a fast-growing city in Indonesia, a developing country. Urbanization in this city is intense and has caused problems in the quality of urban environmental [19], affecting all biotic factors which includes human beings and wildlife.

2.2. Identifying the Urban Area
In order for the assessment to be more manage-effective and well-structured, the areas of this study were classified based on the function, physical condition and other affecting qualities. Such classification could be completed through observation by assessing images of both aerial and the surface. This study benefited the typology of areas spaces which have been developed [20]. The areas in Makassar were classified into several patches and corridors. The patches were: inter-housal space, commercial space, unbuilt space, empty fields, institutional space, public fields, open public /green space, wetland, fish ponds and urban farms. Whereas corridors which consisted of road corridors (primary, secondary and tertiary), river corridors, stream/canal corridors and in-property corridors [20].

2.3. Determining birds’ preferences according to local resources or certain similarities
Several studies which have been done in other Indonesian cities have been taken as benchmarks for determining the environment preferred by birds. As Makassar has been developing, urban birds tend to become scarcer to find, and no information acquired about their stage regarding no location has been provided to conduct specific research about this city. Therefore several research which have been held in other cities such as Jakarta [21], Padang [22], Kudus [21] and other unspecified location in Java [21] or unspecified cities in Indonesia [23] were taken to formulate aspects of observation based on fulfilling the needs for birds mentioned in those studies. Based on the only studies in Indonesia, it would not be sufficient enough to formulate the standards of several variables of the birds’ preferences. Therefore, general studies emphasizing on urban birds were also discussed to verify the factors such as trees [24], patches’ or the types and sizes of the corridors [12,25].

2.4. Observing all the typologies of the areas regarding their vegetation stage, structure and types

Tzoulas and James in their research in the UK [26] have introduced a method for urban biodiversity assessment with a tool known as the Rapid Biodiversity Assessment (RBA). This UK-based research was adopted [4] in order to be applied in developing contexts. Part of the method is applicable for this study as an assessment on vegetation which includes the qualities that are used in the variable of this study. The assessment of the vegetation structure was performed by scoring the Domain value of each structure. The structure here refers to both the soft (vegetation structure) and the hard built structure). The structure of vegetation defines the composition and height of trees, shrubs, forbs and grasses in an area [26] whereas the Domain value is a number used in quantifying the dominance of a structure over a particular land coverage. The scaling ranges from 0 to 100 percent which is divided into 10 classes with smaller graduations nearer to the lowest part of the scale [27 p.45]. Figure 1 illustrates the list used in the vegetation assessment.

| Typology of space (representation of habitat type) | Height | Domain value |
|--------------------------------------------------|--------|--------------|
| Intra-house space | ≥ 10 m | 10 |
| Un-built spaces | 5 - < 10 m | 9 |
| Institutional space | 1 - ≤ 5 m | 8 |
| Public open/green space * | 20 cm - ≤ 1 m | 7 |
| Fish pond | 5 cm - ≤ 20 cm | 6 |
| Primary roads | ≤ 5 cm | 5 |
| Tertiary Roads | Aquatic | 4 |
| Stream/Canal | Built | 3 |

**Domain value**
1: ≤ 4% cover with few individuals;
2: ≤ 4% cover with several individuals;
3: ≤ 11-25% cover with many individuals;
4: 11-25%
5: 26-33%
6: 34-50%
7: 51-75%
8: 76-90%
9: 91-100%

**Notes**
*: includes cemetery
**: includes sport fields and grounds

Figure 1. Field record sheet (source:[26])

Stages of observing the vegetation are explained as mentioned below:

2.4.1. **Defining a Visual Horizon.** A Sampling site that represents all typologies which have been surveyed by allocating sample points in the area. The number of sampling points depended on the size of the area of the site. In each sampling point a sampling circle has been set. The function of this circle was to define the visual horizon of each point. (As seen in figure 2)
2.4.2. Recording dominance of different vegetation structures. This stage was performed by visual observation by estimating the land cover dominance and writing it into a field work sheet. Figure 3 indicates how this method was performed. The researcher observed all the existing structures (vegetation or built), starting from the circle's center to the border of the sampling circle. This was carried out to all directions (A-A’ and B-B’ of figure 3A). If there was a blocking object, then the observer would walk around the sampling area (as in figure 3B).
2.4.3. Recording vascular plants. The previous step produced eight radii, each two unidirectional radii which were combined into a transect of long line, hence four transects were formed. The length of the line depends on the size of the sampling circle. This study used a 60m radius circle, therefore, the length of the two combined radii was 120m. This line furthermore used as a midline of the transect (see figure 4). Each transect was then made as a 10-meter-wide path (5 meters to each side of the line). Each path was then walked at least 2 times to record all vascular plants that exist inside the path. This recording refers to the type or species that exist, not the number of plants.
Figure 4. Transect set up and vascular plants recording.

Taking all the preferences for the accommodation of city birds’, and all information that could be observed and recorded through the research method, where there were several variables that were taken as standards for scoring as seen in table 1.

Table 1. Preference variables for creating accommodating space for birds.

| Birds’ preferred conditions based on studies of urban birds | Translation of the preference regarding condition of observed spaces in the Makassar study (based on the approach of vegetation structure assessment) |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| A More diverse vegetation structures [12]                  | 1 Existence of all vegetation structures (with or without built structures)                                                      |
| B Dense coverage of vegetation (high vegetation cover) [21]| 2 High domain value of vegetation structures (the higher the better) and also, high average Domain value of all non-built structures |
|                                                           | 3 More vascular plants exist in the area                                                                                           |
| C Areas with big and high trees [24,28]                     | 4 The existence of trees in the area                                                                                            |
|                                                           | 5 High Domain value of high trees                                                                                               |
| D Conserved and protected areas (minimum human activities) [11] | 6 Absence or minimum existence of built areas                                                                                  |
3. Results and discussion

3.1. Results

Domain Value of each typology group is presented on table 2.

**Table 2.** Domain value (DV) of various vegetation structures of different typology groups.

| Typology group     | High Trees DV | Low Trees DV | Bushes DV | High Grass DV | Low Grasses DV | Ground Flora DV | Aquatic Flora DV | Built DV | Average Number of Vascular plants | Average of Total Domain values of all vegetation structures excluding built areas | Average of Total Domain value of all trees |
|--------------------|---------------|--------------|-----------|---------------|----------------|----------------|-----------------|----------|-----------------------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------|
| Empty field        | 4.64          | 3.82         | 6.55      | 3.18          | 4.73           | 3.27           | 1.09            | 3.55     | 31.55                             | 6.64                                                                                             | 27.27                                     | 3.78                                      |
| Fish pond          | 0.33          | 0.33         | 3.00      | 1.33          | 1.00           | 1.00           | 5.33            | 0.33     | 8.67                              | 6.00                                                                                             | 12.33                                     | 0.67                                      |
| Institutional space| 6.21          | 4.57         | 4.00      | 2.21          | 6.50           | 3.64           | 0.07            | 4.86     | 41.93                             | 6.50                                                                                             | 27.21                                     | 6.64                                      |
| Inter house space  | 2.33          | 2.00         | 4.00      | 0.00          | 3.00           | 4.00           | 0.00            | 9.00     | 35.67                             | 6.00                                                                                             | 15.33                                     | 10.79                                     |
| Primary road       | 6.00          | 1.00         | 1.00      | 1.00          | 2.00           | 1.00           | 0.00            | 10.00    | 10.00                             | 7.00                                                                                             | 12.00                                     | 8.45                                      |
| Public field       | 5.00          | 0.00         | 1.00      | 0.00          | 9.00           | 1.00           | 0.00            | 4.00     | 17.00                             | 5.00                                                                                             | 16.00                                     | 4.33                                      |
| Public open/green space | 6.70  | 3.30         | 2.80      | 1.00          | 5.40           | 1.80           | 1.00            | 4.20     | 29.30                             | 6.80                                                                                             | 22.00                                     | 9.00                                      |
| Secondary road     | 3.67          | 5.33         | 4.67      | 3.33          | 4.67           | 3.00           | 0.33            | 9.33     | 33.33                             | 7.33                                                                                             | 25.00                                     | 4.60                                      |
| Stream/canal       | 6.00          | 1.00         | 5.00      | 6.00          | 0.00           | 5.00           | 1.00            | 6.00     | 27.00                             | 7.00                                                                                             | 24.00                                     | 11.50                                     |
| Tertiary road      | 7.00          | 4.50         | 3.00      | 0.00          | 3.00           | 1.50           | 0.00            | 9.00     | 41.00                             | 6.00                                                                                             | 19.00                                     | 7.00                                      |
| Un-built space     | 2.40          | 2.20         | 5.00      | 0.40          | 7.60           | 1.20           | 0.20            | 2.60     | 20.80                             | 6.40                                                                                             | 19.00                                     | 5.00                                      |
| Urban farm         | 4.18          | 2.45         | 3.09      | 3.09          | 4.91           | 3.27           | 1.64            | 1.45     | 26.55                             | 7.09                                                                                             | 22.64                                     | 7.00                                      |
| Wetland            | 1.78          | 2.00         | 2.44      | 2.67          | 3.11           | 1.78           | 6.33            | 2.33     | 21.89                             | 7.33                                                                                             | 20.11                                     | 10.00                                     |
| Grand Total        | **4.45**      | **3.09**     | **3.85**  | **2.12**      | **4.86**       | **2.66**       | **1.58**        | **3.96** | **29.58**                         | **6.72**                                                                                           | **22.62**                                 | **7.54**                                  |

The results of observation on the vegetation structure as illustrated in table 2 made it possible for the assessment of all typologies in order to evaluate their compatibility with the conditions required by urban birds as an effort for giving more space for them in Makassar (table 3). Table 4 illustrates the compatibility of the translated conditions required by urban birds with the observed and assessed condition of spaces in the city. The number range of the Domain value which were used to classify the parameters into ‘high’, ‘medium’ or ‘low’ were all based on equal distribution of the maximum and minimum Domain values for all variables.
Table 3. The transformation of the required conditions into classifying the Makassar study research parameters.

| Required condition | Observable Research Parameters |
|--------------------|-------------------------------|
| A Various vegetation structures | 1. The Number of Vegetation structures Low Med High 2. The Domain value of all structures Low Med High 3. The Number of Vascular Plants Low Med High 4. The Total Domain value of trees Low Med High 5. The Domain value of high trees Low Med High 6. The Domain value of built structures Low Med High |
| B Dense vegetation (high vegetation cover) | 12.00-17.10-22.20-8.67-19.77-30.87-17.09 22.19 27.27 19.76 30.86 41.93 |
| C Areas with big and high trees | 0.67- 4.29- 7.90 4.28 7.90 11.50 0.33- 2.56- 4.79- 7.91- |
| D Areas protected or with minimum human activities | 10.00- 67.67- 3.54- 6.78 3.55- 0.33- |

Note: shaded areas show high range as the preferred values.

Table 4. The Matrix of compatibility to meet preference for accommodation of urban birds.

| Required condition | Empty field | Fish pond | Institutional space | Inter house space | Primary road | Public field | Public open/ green space | Secondary road | Stream/ canal | Tertiary road | Un-built space | Urban farm | Wetland |
|--------------------|-------------|-----------|---------------------|------------------|--------------|-------------|--------------------------|----------------|--------------|--------------|----------------|------------|---------|
| A1                 | ü         | ü       | ü                 | ü              | ü          | ü         | ü                      | ü            | ü          | ü          | ü            | ü        |
| B2                 | ü         | ü       | ü                 | ü              | ü          | ü         | ü                      | ü            | ü          | ü          | ü            | ü        |
| B3                 | ü         | ü       | ü                 | ü              | ü          | ü         | ü                      | ü            | ü          | ü          | ü            | ü        |
| C4                 | ü         | ü       | ü                 | ü              | ü          | ü         | ü                      | ü            | ü          | ü          | ü            | ü        |
| C5                 | ü         | ü       | ü                 | ü              | ü          | ü         | ü                      | ü            | ü          | ü          | ü            | ü        |
| D6                 | ü         | ü       | ü                 | ü              | ü          | ü         | ü                      | ü            | ü          | ü          | ü            | ü        |

Note: shaded areas fulfilled 3 or more requirements, hence considered preferable

3.2. Discussion

The compatibility matrix (table 4) enables us to see the fulfilment of the capacity of the condition of each typology prior to providing more space for the birds. Among all the typologies, only the stream/canal corridors fulfilled most of the requirements i.e. 4 (four) requirements. Institutional space, empty fields, primary and secondary roads, public green space, urban farms and wetlands equally shared 3 (three) fulfilment of the requirements.

This fact would lead to accepting the fact that stream corridors are more preferred by urban birds. We can also see that other corridors (primary and secondary roads) are preferred and this fact confirms the results of studies in other cities in Indonesia that corridors with green features shelter more numbers and types of urban birds compared to a more common form of green spaces such as urban parks [22]. However, it gave a clue that it is important to keep those corridors green with plantings of trees and other types of vegetation.

When a narrower and less natural corridor (i.e. stream/canal) in this study have been proved to be a better place for birds to stay, it can be concluded to presume that the wider and more natural the corridors are such as rivers the more preferred they are. Especially, rivers do not have many humans’ activities. It is interesting to see that spaces and corridors tend to be more affected by human interaction (such as tertiary roads, inter-house space, un-built space), are less preferred by birds. This study did not assess human activity as a direct variable of observation, yet the existence of built structures represented the existence of humans (with all their intervention).

Concerning other studies in other context/cities, not only green corridors have been taken as study target. [29,30] have performed identification studies of urban birds in the campus environment. In this study, it belongs to the typology of institutional space. In general, campus grounds in Indonesia have a wide vegetation area with big trees as the main structure of vegetation. It is also verified in this study.
that the campus environment (institutional space) is the ideal space to be developed for the birds to stay.

The column of trees alongside the road corridors is the key components that help makes a place to stay for the birds during their migration or even as refuging sites. Therefore, the condition of the trees and other vegetation as well as the width of the corridor is significant to consider and improve, especially as Hernowo & Prasetyo [12] emphasized the significance of the width of green corridors, according to them even a 15m corridor could probably become a house for two types of birds only.

Learning from this study therefore, the most ideal corridors (of roads/stream) would be ones, which are more than 15 m wide. However, for Makassar, the consistent width of corridors is difficult to identify as the corridors in this city entirely are in the form of series of small patches alongside either natural or cultural corridors. Despite the discontinuity, the distance between those patches are close enough to form a sort of ‘corridors’, hence the width of the corridor would be the same as the patches’ width.

Regarding the patches for birds, the vegetation condition and composition is more important than the size, therefore despite the guidelines of USDA regarding the preferable patch size for vegetation i.e. 2.02 hectares [31] this should not filter out smaller spaces especially if the condition of the vegetation in the site is already good or potentially improvable.

Land ownership always becomes an issue in the topic of urban space. In many cases it could be an obstacle in the inclusion of spaces to green development programs [19]. It is indeed much less complicated to manage public and state-owned spaces, however considering land status as a filter for selecting birds’ preferable spaces will result in less space available for this purpose as only public space, state owned-land and institutional spaces that are included. As a consequence, disregarding land status will provide more available spaces significantly. It is very possible to include remote areas, considering the most important components of the patch/corridors for the birds are the trees, and there are many ways to improve their condition and composition without too much changing or interfering the current land use and status.

4. Conclusions
Stream corridors become the best place for birds to stay and most popular. Then empty fields, road corridors, institutional space, public green spaces, city farms and wetlands which are equal in attracting birds’. The quality of spaces that may attract urban birds can be more specific by adding additional filtering by the inclusion of size, ownership, and development plan as a consideration. However, concerning the linkage to a more natural setting in the sub urban areas, a network would be more feasible if there were more space. One thing certain is that the number of space would be even greater when land ownership is not limited, despite the fact that public spaces are more manageable.

This study focused only on vegetation, making further thorough study concerning other variables become necessary for a comprehensive and more details for studies on city birds. However, this study would help further research to use the vegetation stage as the foundation filter for more sophisticated studies and analysis on the species of city birds and communities.

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