Management of home garden in formal and informal settlement along riparian Ciliwung river in Bogor

D Kharisma1* and Kaswanto1
1 Department of Landscape Architecture, IPB University, Bogor, Indonesia 16680

*Email: kharis.dzu@gmail.com

Abstract. A lot of land-use conversion occur from open land areas to built-up areas, such as riparian that have been converted into settlement areas. The riparian is a buffer zone between aquatic and terrestrial ecosystems, which means that the riparian has many environmental roles. However, its ecological function and existence continue to be degraded due to settlement activities. The presence of settlements in the riparian cannot be simply eliminated; therefore an ecological approach is needed so that the presence of settlements does not always have a negative impact for the river. This approach can be seen through the management of Green Open Space (GOS) in the riparian area, ecologically GOS has many benefits in improving the quality of the riparian environment, and the GOS closest to the settlement is the home garden. This research was conducted in two types of settlements, namely Formal and Informal settlements, which are in the three riparian segments of the Bogor City Siliwung River, namely the upper, middle, and lower part. The purpose of this study is to analyzing the characteristics of the home garden in formal and informal settlements in the riparian area of the Ciliwung River in the City of Bogor, knowing the community’s perception of the existence of the home garden affecting the sustainability of the Ciliwung River and the results of this research is to provide recommendations for proper and sustainable home garden management in the Ciliwung River in Bogor Municipality.

1. Introduction
The population growth which continues to increase has implications for the increasing need for a place to live in society. There have been many land-use changes from open land areas to built-up land areas, such as riparian, which have been converted into settlement areas. Riparian has many environmental roles as a habitat for vegetation and animals, filtering pollutants and toxic substances, and providing water (water springs) and nutrients. However, its ecological functions and existence continue to be degraded due to activities from settlements. The Ciliwung River in Bogor is an example where the physical condition of the environment, water quality, and aesthetic quality of the river environment is negatively impacted by settlements on the riparian Ciliwung River. The presence of settlements on riparians cannot be simply eliminated; therefore it is necessary to take an unusual approach so that the presence of settlements does not always harm the river.

This approach can be made in various ways, such as by changing the perception of the community and government from a water back landscape to a waterfront landscape [1]. The waterfront landscape is a spatial planning concept that makes rivers or bodies of water, the main focus of developing the elements around them. The next approach can be made by managing of green open spaces located on riparian, the green open space closest to the settlement is the home garden. Home gardens can provide various types of very beneficial landscape services, from productivity and plant biodiversity, stored carbon content, management of water resources, to the beauty of the landscape [2]. Seeing the many benefits that can be provided by the home garden, and the location of the home garden that is close to the community settlement, it is possible to manage it more efficiently, and the benefits can be directly felt by the community itself.
This research was conducted in two types of settlement, namely formal and informal settlements, which are representing the three segments of the Ciliwung River, Bogor City riparian, that is the upper, middle, and lower parts. Comparison of home garden management in the two types of settlements is the basis for efforts to implement the concept of a sustainable home garden, and this concept is an alternative to efficient land use patterns that can restore the ecological function of the Ciliwung River riparian as a buffer for aquatic and terrestrial ecosystems.

2. Research objectives
The objectives of this study are to analyze the characteristics of home gardens in formal and informal settlements, to find out the perceptions and preferences of the community about the presence of their home gardens for the preservation of the Ciliwung River, and to provide recommendations for sustainable management of home garden on the Ciliwung River riparian.

3. Research steps and methods
The research steps that will be carried out include data collecting, data analysis and processing, and recommendations.

3.1. Data collecting
Data collected through interviews with respondents and questionnaires. As many as 60 respondents, were obtained in 6 settlements from formal and informal settlement types and represented the three segments of the Ciliwung River, Bogor City riparian (The upper, middle and lower parts) where each segment was represented by 20 houses that have a home garden (Figure 1). The settlement areas surveyed were in the Ciliwung River riparian or < 200 m from the river [3]. The method used in determining the respondents is the snowball sampling method. Snowball sampling is where research participants recruit other participants for a test or study.

3.2. Analysis of home garden characteristics and structure
Analysis of the structure and characteristics of the home garden includes the size and area of the home garden, zone of the home garden, plant elements (diversity of plants height and functions), land use patterns of the home garden, elements of livestock and fish (related to types, number of livestock and fish), and supporting factors for plant fertility. Meanwhile, the value of the home garden biodiversity index is obtained through the Shannon-Wienner formula. The data that has been collected were analyzed quantitatively and descriptively and presented in tables and graphs [4].

3.3. Analysis of community perceptions and preferences
This analysis was carried out by distributing questionnaires to each respondent to obtain data on people's perceptions and preferences regarding the presence of their home gardens on the Ciliwung River’s
sustainability. Questionnaire results were calculated using the Likert scale method with the highest 5 and the lowest 1. The number of respondents, as many as 60 people, is multiplied by each score. The value obtained is entered into the criteria score to determine the results of the questionnaire data. The criteria score value is then converted into an assessment index, and produces a new rating before analyzing the questionnaire results, an analysis of the factors that influence people's perceptions and preferences were carried out using descriptive statistical methods, namely the Pearson Chi-Square correlation test.

3.4. Recommendation
The results of the analysis of the characteristics and structures of the home garden and the analysis of the perceptions and preferences of the community, will be the basis for making recommendations for proper and sustainable home garden management on the riparian of the Ciliwung River, Bogor.

4. Result and discussion

4.1. Site studies
Bogor is one of the cities in West Java Province, Indonesia with an area of 118.50 Km². The city is located 59 km south of Jakarta, and its area is in the middle of Depok and Bogor District. The city is administratively divided into six sub-districts, 68 urban villages, 790 hamlets, 3653 neighbourhood and based on the geographical layout of Bogor City is between 106° 48' East Longitude and 60° 26' South longitude, which means Bogor City is passed by the middle of the Ciliwung Watershed, so that several urban villages cross paths directly with the Ciliwung Watershed, including the Kedung Badak, Sempur, and Tajur urban villages [5]. Based on the results of digitizing satellite imagery at a distance of > 30 m from the body of the Ciliwung River in the three study locations, namely Sempur, Kedung Badak, and Tajur, it was found that land use in the upper and lower parts (Tajur and Kedung Badak villages) was still dominated by greenery structures, that is 3.73 ha (88.12%) and 2.75 ha (50.61%), while in the middle section, Sempur Village. The comparison of land use between greenery structures and built-up land has now been dominated by built-up land of 4.37 ha (55.05%).

4.2. Characteristics and structure of the home garden

4.2.1. Home garden area. There are 4 classifications of home garden sizes; there is small (<120 m²), medium (120-400 m²), large (400-1000 m²), and very large (> 1000 m²)[4]. Most of the home gardens in both types of settlements are still classified as small home garden sizes or <120 m², and when compared to the area of home garden between formal and informal settlements, most of the home garden in informal settlements are smaller. This is due to informal settlements on riparian that tend to be quite dense, causing limited land. Therefore, the community tends to choose to use most of their land for shelter needs and the remaining land for other purposes. (Table 1).

| Segments               | Formal Settlement | Informal Settlement |
|------------------------|-------------------|---------------------|
|            | Average Land Area (m²) | Average Home garden Area (m²) | Average Land Area (m²) | Average Home garden Area (m²) |
| Tajur Villages (Upper) | 345.6             | 70.6                | 121.2              | 33.9                  |
| Sempur Villages (Middle) | 315.4             | 70.2                | 194               | 70.2                  |
| K. Badak Villages (Lower) | 266.2             | 87.9                | 170               | 4                     |

4.2.2. Home garden Zoning. Based on the field survey results in formal settlements, most of the home garden zones are in the front of the house, as many as eight respondents (26%). In informal settlements, it was found that most of the home garden zones were located in front of houses, as many as 11
respondents (36%). Due to the density of the distance between one house and another, in the research location not many have side home garden, but the majority of each house has a home garden on the front. The front home garden is usually planted with ornamental plants, while the side or back is planted with vegetables, fruit plants, spices or even left empty without plants. If it is left empty without plants, the owner usually uses it for drying clothes, children's playgrounds, shelter, or fishpond.

4.2.3. Diversity of home garden utilization. The home garden has a spatial pattern and filler elements that are not only plants, but there are other fillers even though they are mostly dominated by plants [4]. In formal settlements, most of the community, as many as nine people (30%) apart from being planted with vegetation, home garden land is also used as a place for raising animals and livestock. This is influenced by the fact that most houses in formal settlements have ample land and large maintenance capital. Then, in informal settlements due to economic factors and limited land, most of the people in informal settlements, as many as seven people (23%), tend to prioritize their home gardens apart from planting vegetation; alternative uses of warfare are used as a place for household needs such as clothespins.

4.2.4. Utilization of the Ciliwung river. Based on the interviews and direct surveys to the field, the close distance between the settlement and the Ciliwung River did not make the community have the desire to take advantage of the river directly, as many as 26 respondents (86%). The rest have used fishing activities and taken river stones as many as two respondents (7%). In informal settlements, direct use of the Ciliwung River is more diverse, even though most people have never used the river directly, namely 15 respondents (50%). The rest used fishing activities as many as 23% of respondents (23%), two respondents (7%) took the land, and six respondents (20%) took river stones.

4.2.5. Plant vertical diversity (level). Vertical diversity is created physically through the height of the plant, that is level I in the form of grass or herbs (< 1 m), level II in the form of shrubs (1 m - 2 m), level III are small trees (2 m - 5 m), level IV are medium trees (5 m - 10 m), and level V in the form of tall trees (> 10 m) [4]. Both types of settlement in each section are dominated by level I vertical vegetation structures, in formal settlements with an average of 68 species and in informal settlements with an average of 53 species. Most of the amount of vegetation is in level I and II or low level. This characterizes agricultural cultivation on limited land such as home garden.

| Table 2. Vertical diversity based on the number of plant species in each settlement segment |
|---------------------------------------------|
| Location          | Number of species |
|                 | I     | II    | III   | IV    | V     |
| Formal Settlement |       |       |       |       |       |
| Upper            | 59    | 21    | 10    | 4     | 1     |
| Middle           | 50    | 30    | 15    | 10    | 5     |
| Lower            | 94    | 22    | 12    | 3     | 1     |
| Average          | 68    | 24    | 13    | 6     | 3     |
| Informal Settlements |       |       |       |       |       |
| Upper            | 51    | 15    | 14    | 2     | 1     |
| Middle           | 50    | 25    | 13    | 4     | 2     |
| Lower            | 58    | 13    | 12    | 5     | 0     |
| Average          | 53    | 18    | 13    | 4     | 1     |

Information: I (< 1 m), II (1 - 2 m), III (2 - 5 m), IV (5 - 10 m), V (> 10 m)

4.2.6. Plant horizontal diversity (function). Horizontal diversity is classified according to the eight plant functions [4], that is ornamental plants, fruit plants, vegetable plants, spice plants, starch-producing plants, medicinal plants, industrial plants, and other functions (conservation, feed, handicraft, etc.). Ornamental plant species are the most common plant species found in both types of settlements. In formal settlements the average is 80 species, and in informal settlements, 56 species. This is because the people
in the research location still have a high enough desire to increase the beauty value of their home garden, and most ornamental plant species do not require intensive maintenance.

Table 3. Horizontal diversity based on the number of plant species in each settlement segment

| Location     | Number of species |
|--------------|-------------------|
|              | A   | B   | C   | D   | E   | F   | G   | H   |
| Formal Settlemnt |     |     |     |     |     |     |     |     |
| Upper        | 76  | 7   | 2   | 7   | 0   | 2   | 0   | 1   |
| Middle       | 74  | 20  | 3   | 6   | 1   | 3   | 2   | 1   |
| Lower        | 89  | 22  | 6   | 6   | 4   | 3   | 1   | 1   |
| Average      | 80  | 16  | 4   | 6   | 2   | 3   | 1   | 1   |
| Informal Settlements |     |     |     |     |     |     |     |     |
| Upper        | 57  | 17  | 3   | 9   | 1   | 4   | 0   | 0   |
| Middle       | 55  | 18  | 4   | 10  | 2   | 2   | 2   | 1   |
| Lower        | 62  | 14  | 2   | 5   | 1   | 2   | 1   | 1   |
| Average      | 58  | 12  | 3   | 8   | 1   | 3   | 1   | 1   |

Information: A: Ornamental, B: Fruit, C: Vegetable, D: Seasoning, E: Producing Starch, F: Medicine G: Industry, H: Other functions (conservation, feed, handicraft, etc.)

4.2.7. Biodiversity index. Using the Shannon-Wiener formula, it was found that the biodiversity index value in the home garden in formal and informal settlements was obtained from 60 samples (Table 4). The results show that the lowest score of 4.07 is in informal settlements and the highest is 4.50 in formal settlements, both of which are relatively high in biodiversity. The average biodiversity index value in formal settlements is 4.35 and in informal settlements is 4.21. The highest Shannon-Wiener index value is found in the lower part of formal settlements; this is due to the factor of most the home garden in formal settlement have an large area size, as well as urbanization factors, which mostly occur in the lower part. The understanding of urbanization as a real population displacement and concentration has an impact on its relationship with a new society that is motivated by social, economic, political and cultural factors. This factor makes the plants in the downstream part more diverse because they are supported by the culture brought by the migrants.

Table 4. Shannon-Wiener (H') diversity index of homestead land use in each settlement segment

|                | Shannon-Wiener Index | Category |
|----------------|----------------------|----------|
| Formal Settlemnt |                      |          |
| Upper          | 4.27                 | High     |
| Middle         | 4.29                 | High     |
| Lower          | 4.50                 | High     |
| Average        | 4.35                 | High     |
| Informal Settlemnt |                    |          |
| Upper          | 4.26                 | High     |
| Middle         | 4.30                 | High     |
| Lower          | 4.07                 | High     |
| Average        | 4.21                 | High     |

4.3. Correlation between respondent characteristics and perception questionnaire results
Based on the results of the Chi-square Pearson correlation test on formal settlements, internal factors that have a high positive correlation value include the variable of community professions towards understanding the importance of managing the Ciliwung River as a whole from upstream to downstream (comprehensive) of 0.68, then the profession variable on the importance of Ciliwung River hygiene also has a correlation, which is positive for 0.44. The majority of community professions in formal settlements are retirees, housewives, and entrepreneurs, as many as 25 respondents (83%). This shows that respondents who have professions with more free time, increasingly agree with the perception of
the importance of protecting the Ciliwung River’s environment. The variables of the length of stay and age of the community with an understanding of the importance of managing the Ciliwung River comprehensively are 0.60 and 0.58, respectively. Most of the formal settlements on the Ciliwung River riparian are old settlements, which means that many predecessors have lived for 21-60 years, as many as 25 respondents (83%). This shows that the longer the community lives on the riparian, the greater the community understands that the management of the Ciliwung River can not only be done in one part or segment of the river.

In informal settlements, a negative correlation was found between community professions variables and river hygiene of -0.34. Although most of the community professions in informal settlements are the same as in people in formal settlements, namely as housewives, retirees, and others (household members, labourers, coolies, etc.) as many as 21 respondents (70%). Thus, it shows a differences in perceptions between informal and formal settlement communities regarding the importance of river hygiene. Besides, a negative correlation was found between professions variables and the desire to participate in the management of the Ciliwung River riparian through home garden development, namely -0.74. This indicates a need to increase awareness and education for informal settlers regarding the importance of the Ciliwung River.

4.4. Correlation between respondent characteristics and preference questionnaire results
In formal settlements, the internal factor which has the highest positive correlation with Chi-square Pearson is the variable of profession on the understanding that there is greenery around the house which can increase comforts, which is 0.59. The community, who are mostly housewives and retirees, spend a lot of their spare time by managing plants in their home garden, and they understand and feel the impact that is greening around the house can increase the comforts. Then the length of residence variable on the understanding that there is a need for a place for activities outside the house building also has a positive correlation of 0.41. This informs that the length of time the community has lived affects the desire of the community to have a place for activities outside the home, such as gardening, exercising, and others. A positive correlation related to this variable was also found in informal settlements, although it was entered into a low correlation of 0.24. Besides, it was found that a negative correlation in informal settlements between the variable age and understanding of the home garden can be used for agricultural development of -0.22. The local community does not yet have an understanding of the importance of commodity diversity in their home garden.

4.5. Community perception of the preservation of the Ciliwung river
The results of the interviews and the questionnaire showed that the overall community in the two types of settlements had the perception that rivers were an important aspect that needed to be maintained and preserved, because people felt the benefits of the Ciliwung River. Although, people in formal settlements argue that even though the benefits are felt indirectly (0.80), such as being a water catchment area when it rains, and the sound of splashing river water is considered to give a comfortable and beautiful impression to the settlement. Meanwhile, in informal settlements, more people use the river directly (0.83), such as fishing or collecting river stones. Besides, informal settlers tend to use rivers as their Waterback Landscape. Based on the degree of importance regarding the management of the Ciliwung River, the community in both types of settlements shows that the Waterfront Landscape concept is useful to apply (0.83 and 0.78), if the quality of the Ciliwung River is good, it is because the community is afraid of flooding which often results in landslides.

4.6. Community preference for home garden
Based on the results of interviews and filling in the preference questionnaire, it was found that the community assessment index of home garden development was good, especially in the desire to social and aesthetic needs (0.93 and 0.95). However, in general the community does not yet know that a home garden can be developed into agriculture that can meet family food needs independently (subsistence) and can contribute to environmental sustainability on the Ciliwung River riparian.
4.7. Strength, weakness, opportunity and threat analysis

4.7.1. Strength. The biodiversity index of the home garden in the two settlements on the riverbank is good. The community has a positive response to the presence of their home garden.

4.7.2. Weakness. The desire to participate in the management of the Ciliwung River riparian through the development of the home garden is still weak. Knowledge and information regarding home garden development have not been spread evenly among the community. The community has not realized that the home garden can provide benefits for them and the river environment. Community awareness and concern for the Ciliwung River hygiene is not yet right. The buildings around the Ciliwung River still have their backs to the river body.

4.7.3. Opportunity. There is a Ciliwung Care Community (KPC) in Bogor. There are already programs from the government related to home garden development.

4.7.4. Threat. Settlers with a low economy. Floods and landslides often occur.

4.8. Recommendation

4.8.1. Home garden Utilization Policy / Program. The home garden development program to support the fulfilment of family food needs independently (subsistence) has been carried out a long time ago, such as Food and Nutrition Diversification (DPG), the Women's Home garden Optimization Movement (GPOP), and the program currently being intensified by the Ministry of Agriculture is the Sustainable Food House Area (KRPL). However, the implementation is still very difficult to implement because of many factors, including the socio-cultural conditions in which the community has not cultivated an intensive garden development culture, then a lack of funds, personnel, and intensive assistance. In addition, the conditions of resources and the environment are less supportive. There are several key factors need to be considered in order to achieve the success and sustainability of the home garden development program, including:

- Actively involving community leaders or local group leaders in all processes starting from the very beginning in program planning, implementation and evaluation.
- Creating a container for the availability of seeds or seeds, processing produce from the home garden, and marketing.
- Conducted counselling the concept of integrated livestock crop systems.
- Creates guidelines regarding diversification models that can fulfil the needs of food groups (tubers, fruits, oils and fats, animal foods, nuts, sugar, and vegetables).
- Strong commitment and participation from local governments as support and facilitating the implementation of the home garden development program, it's very impactful.

This shows that to realize the success of programs related to home garden development, active participation from the community is needed, and is supported by a strong commitment from the local government. In addition, it is necessary to do it with a group approach so that the home garden development program can be well-coordinated so that it can be developed, which does not only make use of private home gardens, but can also be developed on village-owned lands, road edges and supporting facilities with a variety of vegetation so as to provide also a positive contribution to the environment such as on river boundaries.

4.8.2. Home garden model. The concept of a home garden development model in formal and informal settlements must prioritize fulfilling family needs independently (subsistence) and ecological functions. In addition, home garden is a plot of land on which there is a settlement building and has a functional relationship, both economic, biophysical, and socio-cultural with its residents [6]. So that social functions such as aspects of improving the physical and spiritual welfare of the residents of the house also need to be considered. In order to create an ecological home garden, making a home garden model
must be based on the size of the home garden, the diversity of plant strata and functions, zoning of the home garden, and the critical minimum size. The model of the smallest home garden will be made with a size of 100 m² following with the required minimum size of the ecological home garden (Figure 2).

Figure 2. (a) recommendation for formal home garden model (b) recommendation for informal home garden model

The houses in informal settlements the front and sides will be made wider, because this section will function as a gathering area and a service area. The gathering area is an area where the house can fulfill their social needs. The vegetation to be planted in the gathering area is vegetation with ornamental and shade functions. Meanwhile, the service area is an area where the house can carry out activities to meet household needs, such as a place to drying clothes or produce in the home garden. In this area, a verticulture planting pattern can be applied, which is a plant cultivation pattern in a stratified or tiered way. The vegetation to be planted is vegetation with a production function. Then, the effect is mostly on informal settlements turning their backs on river bodies, at the back of the home garden a conservation area. This area has a function to support the preservation of the river environment. Vegetation that is planted in the conservation area is that which has a function as a barrier and ecology. In formal settlements, the size of the home garden model follows the medium ecological size, which is 259.96 m². As a result, most of the formal settlements on the riverbank were facing forward towards the river. Therefore, in addition to this, it will be used as a gathering area and an ecological area. The vegetation planted in this area is a mixture of ornamental and ecological functions that will contribute to the riparian environment. On the side, it becomes a service area where the planted vegetation has a production function. The back home garden becomes a production area, because of the dominance of vegetation with production functions in the area such as planting areas. Then due to the wider land area at the back, fish ponds can be added to be placed close to the production area to make it easier to reach water sources, as well as chicken or goat drums.

5. Conclusion
Formal and informal settlements have different typologies of home garden. Most of the aspects of home garden area size, biodiversity index value, diversity of plant structure and function in formal settlements are higher than in informal settlements. This is influenced by various factors including natural
conditions, socioeconomic status, and cultural background. The public’s perception of the importance of preserving the Ciliwung River is quite good. This is indicated by the existence of several communities who carry out their household waste management independently. Although, in informal settlements, there are still some people who do not comply with the regulations, who dispose of their waste into the river, especially those who are positioned right next to the river. Then, Community preference for home garden development is good, especially in the desire to meet social and aesthetic needs. However, in general the community does not yet know that home garden can be developed into agriculture that can meet family food needs independently (subsistence) and can contribute to environmental sustainability on the Ciliwung River riparian.

Programs/policies regarding home garden development to support the fulfillment of family food needs independently (subsistence) have been in place for a long time. However, implementation is still very difficult to implement due to many factors including socio-cultural conditions, lack of resources, and less intensive assistance. Meanwhile, the recommendation for the concept of home garden development prioritizing of fulfilling family needs independently (subsistence) and ecological functions, while still adjusting to the typology of the type of settlement.

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