

## Conference Paper

# Management of “Pekarangan” in Informal Settlement of Ciliwung River Riparian Landscape

Jennie Jesica<sup>1</sup>, Regan Kaswanto<sup>2</sup>, and Hadi Susilo Arifin<sup>2</sup>

<sup>1</sup>Graduate Student of Landscape Architecture, Department of Landscape Architecture, Faculty of Agriculture, Bogor Agricultural University (IPB), Kampus IPB Dramaga, Jl. Raya Dramaga, Babakan, Dramaga, Bogor, Jawa Barat 16680, Indonesia

<sup>2</sup>Lecturer of Department of Landscape Architecture, Faculty of Agriculture, Bogor Agricultural University (IPB), Kampus IPB Dramaga, Jl. Raya Dramaga, Babakan, Dramaga, Bogor, Jawa Barat 16680, Indonesia

## Abstract

Riparian is undefined government land and can be converted to other utilization. Riparian areas have natural connections throughout the watershed; they are particularly sensitive and often degraded by human use. One of them is the informal settlement, such as the residential areas in the Ciliwung River riparian which changed the land function from a conservation area. This research conducted in three sites of the Ciliwung River riparian section that is represented by the upper part (Kelurahan Katulampa); middle part (Kelurahan Babakan Pasar); and the lower part (Kelurahan Kedunghalang). The purposes of this research are: 1) to analyze the riparian settlement yard in upper part, middle part, and lower part, 2) to figure out people’s motivation for the management of land yard, and 3) to calculate the potential of land as water catchment areas and to support household-scale agricultural production. The remaining of land in the informal settlement is upgraded to fulfill the riparian function and to improve local people’s welfare. Data were obtained by doing a literature review on previous research with a systematic literature review method; by analyzing the agroforestry land use; and by analyzing plant production. Plants production for agriculture concept in pekarangan in Ciliwung River riparian, Bogor Municipality have high potency. The result of the study of all sites is combined into an integrated agriculture concept as an alternative to efficient land use. These concepts offer some benefits from the ecological, social and ecological aspect. It can be used to convince the community for improving their welfare, as well as raising public awareness about the primary function of the riparian landscape.

**Keywords:** local people’s welfare, informal settlement, *pekarangan*, integrated agricultural landscape, riparian landscape

Corresponding Author:  
Jennie Jesica

Received: 24 May 2019  
Accepted: 25 July 2019  
Published: 4 August 2019

Publishing services provided by  
Knowledge E

© Jennie Jesica et al. This article is distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use and redistribution provided that the original author and source are credited.

Selection and Peer-review under the responsibility of the ISTEcs 2019 Conference Committee.

 OPEN ACCESS

## 1. Introduction

The growth of population in Bogor Municipality lead to land use and cover change. One of them is a residential building in a riparian zone of Ciliwung River that causes

a decrease in the function of riparian area. Riparian areas occur alongside waterways and water bodies; they provide valuable habitat for plants and animals and affect water quality. Bogor Municipality is the area passed by the Ciliwung watershed which empties into Jakarta City. The limited urban land condition has an impact on the conversion of protected land to built land such as in the part of the Ciliwung River. Housing development along a riparian river will lead to a problem. It is influenced by technological and cultural transformation, which is the ecosystem carrying capacity [1]. The extent of the residential area on the Ciliwung River riparian, Bogor Municipality, increased according to the need for land due to population growth. In 2016, the land occupancy on the upstream riparian of Ciliwung River was 41.20 ha (12.46%), the middle stream was 312.41 ha (37.11%), and the downstream was 215.31 ha (95.72%) [2]. Bogor Municipality is in the central stream section of Ciliwung River. The percentage of the building that stands on the intermediate stream Ciliwung River riparian in Bogor Municipality is 27% [3].

In many cities of developing countries, urban growth is informal and unplanned settlements. Informal settlements are unfinished projects that had been neglected by the agencies who produce it and poorly managed. In contrast, architect-produced architecture which emphasizes the physical form of the buildings, which are often at the expense of users [4]. The informal settlement is one of the poverty indicators of society. The enhancement of the quality of the settlement area affects social welfare through economic, social, and environmental development.

The agroforestry system in Ciliwung River riparian in Bogor Municipality has high potential plant production [5]. Agroforestry practices can provide better plants production, to ensure the stability and sustainability of society's income. The community near Ciliwung River riparian should be developed. The ecosystem that interacts with landscapes areas will lead to a sustainable settlement. Two main components were found for upgrading the living welfare in the regions: pekarangan potential and plant production. Pekarangan (Indonesian home garden), traditional biodiversity–low carbon system in Indonesia that establishes green procurement, promotes greening, species diversity, and biodiversity, and sets green guidelines, plays an essential role in sustaining the ecosystem at present (and will do in the future). Pekarangan is a standard smallholder agroforestry system used in Indonesia and throughout the tropics, from the rural to urban areas [6]. The community should consider appropriate pekarangan agroforestry practices rather than relying only on the cultivation of agricultural land [7].

This study was conducted in three landscape zones, which are the upper part, middle part, and lower part of Ciliwung River riparian that represent Bogor section. The upper

part is Kelurahan Katulampa, the middle part is Kelurahan Babakan Pasar, and the lower part is Kelurahan Kedunghalang. The purpose of this research is: 1) to analyze the riparian settlement yard in upper part, middle part, and lower part, 2) to figure out people's motivation for the management of land yard, and 3) to calculate the potential of land as water catchment areas and to support household-scale agricultural production. Data is obtained by doing a literature review on previous research. Spatial data of structure, function, and landscape dynamics at Ciliwung River riparian in Bogor Municipality were obtained from Ciliwung River riparian air image data in Bogor Municipality through aerial mapping process using Unmanned Aerial Vehicle (UAV). The data of plant species and combination of agroforestry were obtained from the existing landscape data in the field, i.e., data type, structure, and function of vegetation; data of existing vegetation landscape services; as well as the social, cultural, and economic conditions of the community. Also, the result is obtained from direct observation of the research sites.

## 2. Method

### 2.1. Study area

The research was conducted in informal settlement of Ciliwung River riparian's pekarangan in Kelurahan Katulampa, Kelurahan Babakan Pasar, and Kelurahan Kedunghalang (Figure 1). Riparian area of Ciliwung River in Bogor Municipality is part of Ciliwung River middle stream watershed. It is at  $106^{\circ}47'46''$  -  $106^{\circ}50'32''$  BT and  $6^{\circ}32'29''$  -  $6^{\circ}38'10''$  LS. Watershed width used the ministry regulation, PUPR No 28, 2015, and Indonesia's government regulation, PPRI No 38 tahun 2015, which is 15 m (inner city), and analyze ideal standard determination width of inner city Ciliwung River which is 50 m. Settlements near watershed will be examined because this is related to the society's welfare.

Watershed is an area of land that drains water, sediment, and dissolved materials to a collective receiving body or outlet. The area of land that flows into a stream is determined by the topography or "lay" of the land [8]. Site selection in the three segments (upper part, middle part, and lower part) is represented by the Kelurahan Katulampa, Kelurahan Babakan Pasar, and Kelurahan Kedunghalang. It is essential to determine the ratio of the availability of yard and the production potential of each segment. These three sites represent the result of differences in the height of the settlement sites on the Ciliwung River riparian, Bogor (Figure 2).

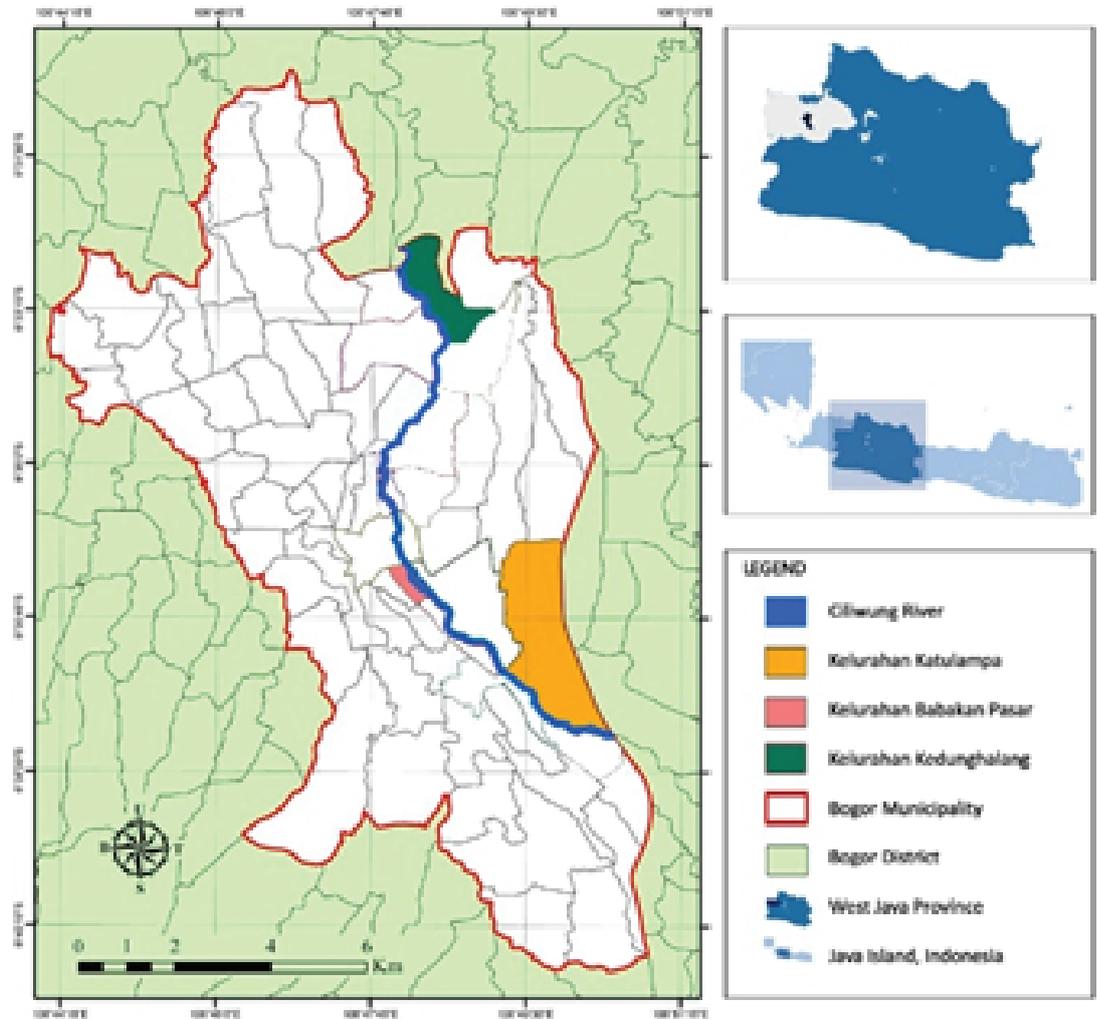


Figure 1: Study area of Ciliwung riparian in Bogor Municipality.

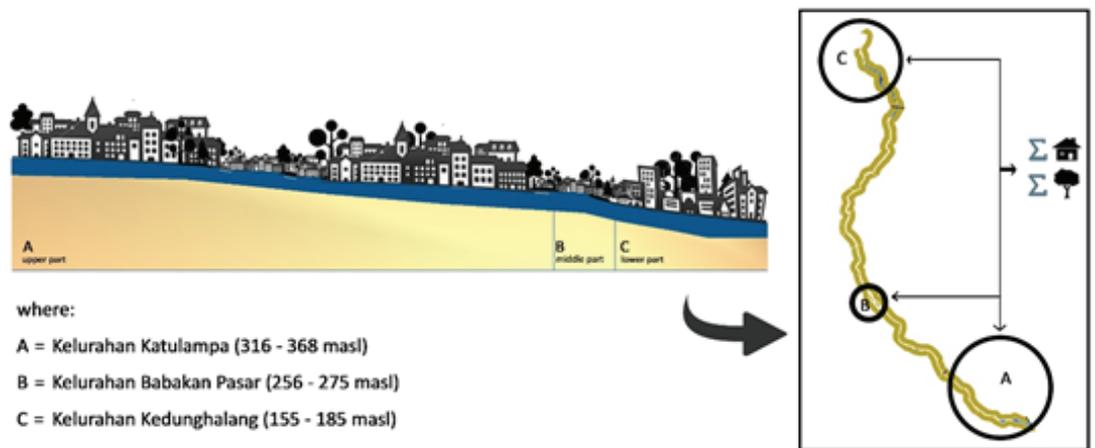
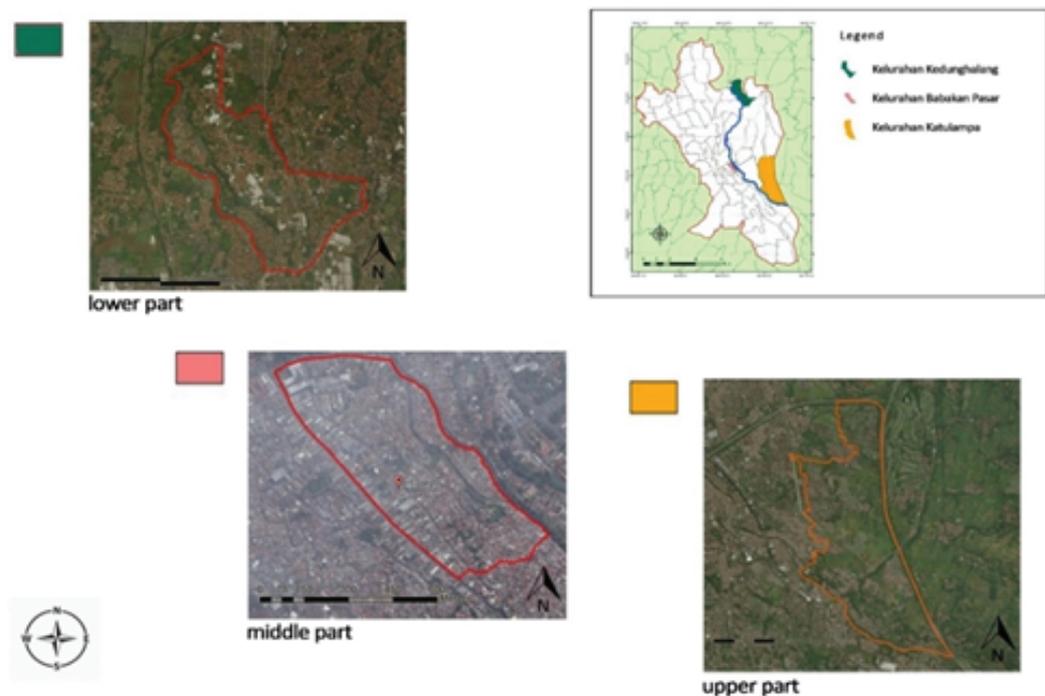


Figure 2: Illustration of the topographic differences from three segments of Ciliwung River riparian in Bogor Municipality.

See Figure 3, the locations of the three *kelurahan* is represented by each segment. Each *kelurahan* has a different area. The Upper part is Kelurahan Katulampa, the middle section is Kelurahan Babakan Pasar, and the lower part is Kelurahan Kedunghalang. This research analyzes the land stock and landscape owner preference as well as the watershed benefit for society's welfare. The analysis that will be conducted in the upper part, middle, and lower part watershed biophysics, community preference, and land availability that can be used for informal settlement near the watershed.



**Figure 3:** Three *kelurahan* that represent each segment of Ciliwung riparian in Bogor Municipality.

## 2.2. Data analysis

All data were analyzed based on agroforestry land-use and plant production analysis. Spatial data used is a map of land use Ciliwung River riparian in Bogor Municipality from classification result using Unmanned Aerial Vehicle (UAV) image with resolution 15 cm/pixel. The agroforestry land use analyzed in this research is *pekarangan*. The land use classification process was performed using ArcMap 10.3 software with World Mercator as a coordinate system. Visual observation of land use is done by digitizing the image of UAV on the screen of the monitor (on-screen digitizing) into polygon form based on the classification of land use class. Plants production calculated only for the perennial and annual plant that contained in sample plots (adapted from Prastiyo 2017). Production of plants is harvested plants, which include fruits, seeds, vegetables, and

tubers. The total area of the yard in each *kelurahan* is divided by one sample of the yard [5]. Plant production per hectare is calculated using the following formula:

$$\text{Production (Mg/ha)} = (P/1000) K \quad (1)$$

where  $P$  is the production of a plant species (kg), and  $K$  is the number of individuals of a plant species in the sample plot area (ind./ha).

The calculation of land productivity based on Land Equivalence Ratio (LER) value. LER is the ratio of plant yield between the agroforestry planted system to the monoculture planted system at the same level of management. Plant production data with monoculture system is obtained based on horticultural plants production from Statistics Center Bureau (BPS) of Bogor Municipality, National BPS, and some research on horticultural plant production. Here is the LER equation:

$$LER = \sum_{i:1,2,3..}^n \frac{hi}{Hi} \quad (2)$$

where  $hi$  is plant production in an agroforestry system,  $Hi$  = plant production in monoculture system, and  $i = 1, 2, 3, \dots, n$  is plant species.

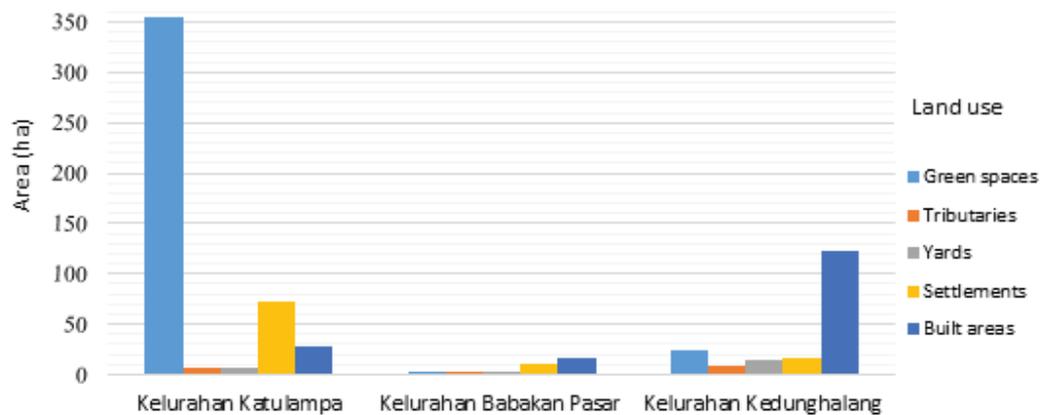
### 3. Result

The main focus on this study is *pekarangan* in the informal settlement of Ciliwung River riparian. The riparian areas of Ciliwung River have gently sloping areas of 0-25%. They can provide better plants production.

#### 3.1. Landscape dynamic

Kelurahan Katulampa has a landscape of ecological structure, which is dominated by natural structures (tributaries, yard, and green spaces) of 366.17 ha (78.58%), while artificial structures (settlements and built areas) are 99.83 ha (21.42%). Kelurahan Babakan Pasar has an ecological structure of landscape that is dominated by artificial structures (settlements and built areas) of 26.36 ha (77.52%), while its natural structure (tributaries, yards, and green spaces) is only 7.64 ha (22.48%). Kelurahan Kedunghalang has an ecological structure of landscape dominated by artificial structures (settlements and built areas) of 139.44 ha (74.57%), while its natural structure (tributaries, yard, and green spaces) is only 47.56 ha (25.43%). Figure 4 shows that most of the land in each *kelurahan* has been occupied by artificial structures (built land). This is particularly evident in the

changing use of the Babakan Kelurahan landscape and the Kelurahan Kedunghalang. On the contrary, Kelurahan Katulampa is still dominated by the natural landscape.

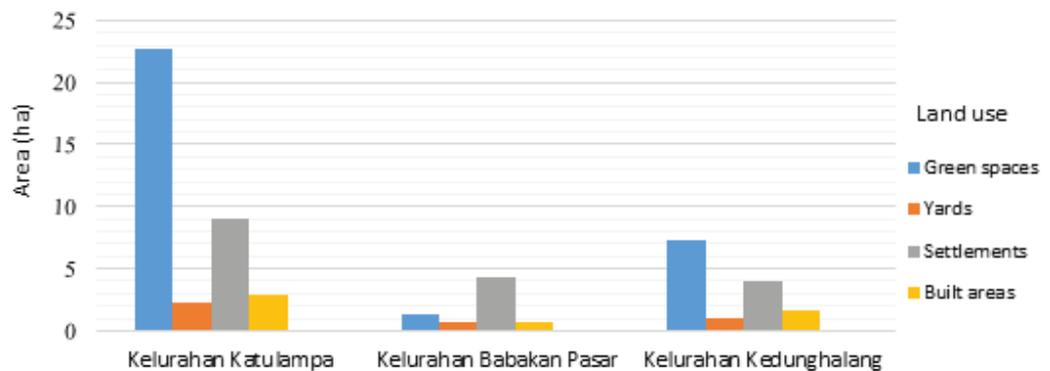


**Figure 4:** Graph of ecological structure of landscape in the whole area of three *kelurahan*, Bogor Municipality.

Beside the data of *kelurahan*, there are data of landscape dynamic in Ciliwung River riparian, which is 50 m from the river. Kelurahan Katulampa has a view of ecological structure dominated by natural structures (yard and green spaces) of 24.97 ha (67.49%), while artificial structures (settlements and built areas) are 12.03 ha (32.51%). Kelurahan Babakan Pasar has a landscape of ecological structure that is dominated by artificial structures (settlements and built areas) of 4.97 ha (70.97%), while its natural structure (yards and green spaces) is only 2.03 ha (29.03%). Kelurahan Kedunghalang has a landscape of ecological structure dominated physical structures (yard and green spaces) of 8.30 ha (59.32%), while artificial structures (settlements and built areas) are 5.70 ha (40.68%). See Figure 5, and the data represents the riparian landscape in Babakan Kelurahan has been occupied by artificial structures (built land). It has a high amount of informal settlement along the riparian river. On the contrary, Kelurahan Katulampa and Kelurahan Kedunghalang are still dominated by the natural landscape. This condition can be caused by the location of the middle part riverine in the central municipality and it has a small area for population carrying capacity.

### 3.2. Pekarangan benefit

Agroforestry can provide many ecosystem services. It is a suitable tool for landscape restoration because it can enhance physical, chemical and biological soil characteristics, thereby increasing soil fertility, controlling erosion and improving water availability [9]. Different strata of plants in the yard can harvest solar energy and effectively absorb



**Figure 5:** Graph of ecological structure of Ciliwung River riparian, Bogor Municipality.

carbon, protect soil and water systems, and provide the beauty and comfort of the local environment. Agroforestry can enhance livelihoods in rural communities by providing a variety of food, fodder and tree products, which increase food and nutrition security, generate income and alleviate poverty [9]. Farming in the yard if managed intensively following the potential of the yard, also, to meet the needs of household consumption, can also provide income contribution to the family. Home gardens provide nutrition in various forms such as food crops, fruits, vegetables, livestock, aquaculture, wild plants, and animal products. Different weed species have been used as fodder, compost, medicine, and roofing material; a few species are also used as food [10]. Home gardens play a crucial role in providing nutritional and diet security to households by ensuring a steady supply of necessary vegetable proteins, carbohydrates, vitamins, and minerals [11], particularly during lean periods when other food supplies are inadequate. The animal waste provides manure required to maintain soil fertility and production sustainability [10]. Production of plants of agroforestry land use in *pekarangan* in Ciliwung River riparian, Bogor Municipality has high land productivity (Table 1). The average value of LER is from a home garden sample of each *kelurahan* [5], which is 2.93 that includes the high category. The amount of LER can know the productivity of land planted in monoculture and intercropping. If the results of the analysis of obtained NKL value is higher 1 ( $> 1$ ), this indicates that intercropping cropping pattern is more productive than monoculture. Plants have an enormous role in suppressing soil erosion and surface flow rates. Results of crop production with agroforestry system can be sold and the availability of investment funds for the owner [12].

The landscape services potency of plants production produced by *pekarangan* in Ciliwung riparian, Bogor Municipality is high (Table 2). Kelurahan Katulampa with the area of 5.88 ha and average plant production of 80.56 Mg/ha [5], has total plant production potency reaches 1894.89 Mg (Author's work). Kelurahan Babakan Pasar

TABLE 1: Example of home garden plants production in Ciliwung riparian in Bogor Municipality.

Location sample (Kelurahan)	Number of harvest species	LER
Katulampa	7	1.48
Babakan Pasar	9	1.26
Kedunghalang	1	0.19
Average	5.67	2.93

Notes: low (LER<1.0), moderate (1.0<LER<1.2), and high (LER>1.2)

with the area of 2.04 ha and average plant production of 38.70 Mg/ha, has total plant production potency reaches 269.89 Mg. Kelurahan Kedunghalang with the area of 14.76 ha and average plant production of 2.32 Mg/ha, has overall plant production potency reaches 857.89 Mg. It proves that the agroforestry system can be the basis of the management of informal *pekarangan* in Ciliwung River riparian landscape that is sustainable.

TABLE 2: Plant production potency of *pekarangan* in Ciliwung riparian, Bogor Municipality.

No	Kelurahan	Area (ha)	Plant production (Mg/ha)	Plant production potency (Mg)
1	Katulampa	5.88	80.56	1894.89
2	Babakan Pasar	2.04	38.70	269.89
3	Kedunghalang	14.76	2.32	857.89

The most significant percentage of the income of settlement residents along the Ciliwung River riparian is in the range of 2,000,000 IDR to 3,000,000 IDR and the smallest rate of 3% in the field of 10,000,000 IDR to 11,000,000 IDR [13]. For example, the contribution of the business land income derived from the comparison between the business income of the yard and the total income during the planting period.

#### 4. Recommendation

Optimization of *pekarangan* in Ciliwung River riparian is needed to improve the welfare of the community and to preserve the watershed area. In general, the number of plant species per yard is also influenced by the average size of the yard. The more extensive the yard is, the more diverse the plants are. Agricultural biodiversity in the yard serves to support food security and accelerate the diversification of food consumption. *Pekarangan* provides benefits in the form of production and services. The benefits of production are subsistence (fruit, vegetables, spices, medicine, staple food, stimulants, timber, and fodder) and commerce (cash income). The benefits of services are socio-culture (gifts, sacrifices, pride, pleasure, aesthetics, employment, socializing)



## 5. Conclusion

Land use changes in riparian rivers are more prevalent in Kelurahan Babakan Pasar. The riparian area should be free from buildings. Babakan Pasar is one of the slum areas in Bogor Municipality. There is 70.97% land along Babakan Pasar riparian that has been occupied. The fact is that riparian zones are considered part of a territory and are subject to property rights. From the perspective of this study, yards management can help to fulfill the riparian function and to improve the local people's welfare. Improvement of the household scale can make a real contribution to the health of the settlement community. Kelurahan Katulampa, Kelurahan Babakan Pasar, and Kelurahan Kedunghalang have the potential to improve their yards utilization. The highest potential production value of the yard is a riparian upper part, Kelurahan Katulampa of 1894.89 Mg. The smallest potential is in the middle section, Kelurahan Babakan Pasar because it has a small urban area (2.04 ha). Therefore, the type of plants in each Kelurahan must be adjusted to the carrying capacity of land and the community interest.

The local community tends to choose ornamental plants that serve as displays. The yard is also used as a border of after a fence or wall adjacent to the Ciliwung River. The yard tends to be shaped like a residential garden, usually located in front of the house with different sizes. The dominant community uses the yard for public recreation and relaxation [16]. The yard can be managed as a buffer area for pollution before heading to the river, especially in the settlement position in riparian streams. The types of plants that generate more profit are fruits, vegetables, spices, and medicine. This information can be applied by the local community to manage their yards for positive impact on ecosystem services and local community welfare.

The yard has the potential to support riparian function as a recharge area and water reservoir for river water recycling. The development of the yards in the informal settlement can be approached with the organic farming practices model. The fruit plants recommended are kuwani (*Mangifera odorata*), papaya (*Carica papaya* L.), banana (*Musa* sp.), Soursop (*Annona muricata*), guava (*Psidium guajava*), rambutan (*Nephelium lappaceum*), and avocado (*Persea Americana*). Local communities have planted these fruit plants. It shows that these fruit plants can provide the benefits of the yard's owner and sustainable for planting. Most of them are the perennial plant. It is a long-lived plant and does not require intensive care. These plants create a permanent network of roots that help stabilize the soil and prevent erosion.

## References

- [1] Arifin, H. S. (2014). *Revitalisasi Ruang Terbuka Biru sebagai Upaya Manajemen Lanskap pada Skala Bio-Regional. Risalah Kebijakan Pertanian dan Lingkungan* Vol. 1 No. 3: 172-180.
- [2] Noviandi, T. U. Z., Kaswanto, R. L., & Arifin, H. S. (2017). Riparian Landscape Management in The Midstream of Ciliwung River as Supporting Water Sensitive Cities Program with Priority of Productive Landscape. *IOP Conf. Ser.: Earth Environ. Sci.* 91 012033.
- [3] Mosyaftiani, A., Kaswanto, R. L., & Arifin, H. S. (2018). Ecological Engineering of Ciliwung Riparian Landscape in Bogor City. Institut Pertanian Bogor: Bogor. (In Indonesian).
- [4] Kellett, P. (2008). *Constructive Journeys: Dwelling Consolidation and Social Practices in a Squatter Settlement*. Department of Anthropology. Durham, University of Durham. MA in Socio-Cultural Anthropology.
- [5] Prastiyo, Y. B., Kaswanto, R. L., & Arifin, H. S. (2017). Management of Agroforestry Landscape as Landscape Services Improvement Strategy on the Riparian of Ciliwung River in Bogor Municipality. Institut Pertanian Bogor: Bogor. (In Indonesian).
- [6] Arifin, H. S. (1998) Study on vegetation structure of Pekarangan and its changes in West Java, Indonesia. (Unpublish doctor dissertation) The Graduate School of Natural Science and Technology, Okayama University. Japan.
- [7] Kaswanto, R. L.. & Nakagoshi., N. (2017). Management of Landscape Services for Improving Community Welfare in West Java, Indonesia: Landscape Ecology for Sustainable Society. (Eds. Sun-Kee H and Nobukazu N). *Springer International Publishing AG*, part of Springer Nature. Pp 251 – 270.
- [8] U.S. Environmental Protection Agency's Watershed Academy Web. (2009). Distance Learning Modules on Watershed Management. Introduction to Watershed Ecology. <http://www.epa.gov/watertrain>.
- [9] US - Food and Agriculture Organization. (2017). *Agroforestry for landscape restoration: Exploring the potential of agroforestry to enhance the sustainability and resilience of degraded landscapes*. Rome.
- [10] Mohri, H., Lahoti, S., Saito, O., Mahalingam, A., Gunatilleke, N., Irham, Hoang, V. T., Hitinayake, G., Takeuchi, K., & Herath, S. (2013). Assessment of ecosystem services in home garden systems in Indonesia, Sri Lanka, and Vietnam. *Elsevier: Ecosystem Services* 5, e124–e136.

- [11] Abdoellah, O. S. (1985). Homegardens in Java and their future development. Paper Presented in the International Workshop on Tropical Homegardens. Held at the Institute of Ecology, Padjadjaran University, and Bandung, Indonesia.
- [12] Bahrin, A. B. D. H., Chozin, A., Arifin, H. S., & Darusman D. (2012). An Eco-Physiological Study of Seasonal Crops that Form Agroforestry in Some Agroclimate Zones on the Upstream Watershed of Ciliwung. Institut Pertanian Bogor: Bogor. (In Indonesian).
- [13] Paramitha, M., & Kaswanto, R. L. (2018). Analysis of Society Perception on Ciliwung River Waterfront City as A Provider of Landscape Beautification Service in Bogor City. Institut Pertanian Bogor: Bogor. (In Indonesian).
- [14] Kehleinbeck, K., Arifin, H. S., & Maass, B. (2007). Plant Diversity in Homegardens in A Socio- economic and Agro-ecological Context in The Stability of Tropical Rainforest Margins: Linking Ecological, Economic and Social Constraints (Eds. T. Tschardtke, C. Leuschner, M. Zeller and E. Guhardja). *Springer Verlag Berlin, Germany*. pp 297-319.
- [15] Arifin, H. S. (2012). *Manajemen lanskap pekarangan bagi ketahanan pangan keluarga. Dalam Pangan Rakyat: Soal Hidup atau Mati 60 Tahun Kemudian*. (Eds. Fariyanti A, Rifin A, Jahroh S, dan Krisnamurthi B. Departemen Agribisnis FEM IPB & PERHEPI). ISBN: 978-979-19423-6-3. p. 147-171.
- [16] Putri, M. W., & Kaswanto, R. L. (2018). Analysis of Public Perceptions and Preferences of Ciliwung River's Riparian Management as Landscape Biodiversity Services in Bogor. Institut Pertanian Bogor: Bogor. (In Indonesian).