Green open space of riverbanks in Bogor City as a potential location for development of urban agriculture

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Abstract. Bogor City is one city that has a history as a green city. To meet food security, green cities are not only directed at planting trees or ornamental plants. However, currently the green city is more directed at the development of productive plants so that the people of Bogor City can use it in meeting food needs. One alternative to conversion of urban agricultural land is in the river area. One of the structures of the Green Open Space (GOS) in Bogor City is referred to as the GOS river bank. Riverbank GOS is one of the potential locations for the development of urban agriculture, so this study aims to identify potential locations on river banks for the development of urban agriculture. The method used in this study is GIS analysis. The analysis process is done by overlaying the hydrological map (river), GOS land use map, and land slope map, which then produces the riverbank GOS thematic map. This data analysis technique is followed by an initial inspection process to check the correct location of potential points. The results of this study indicate potential location points of riverbank GOS that can be used for the development of urban agriculture in Bogor City.

1. Introduction

Departing from desire to restore Bogor City as a Green City, the city government began to think about how to develop urban agriculture. Urban agriculture is defined as any agricultural activity that grows, increases, processes and distributes agricultural products regardless of the size of the land and the amount of human resources in cities and cities [1]. Urban agriculture contributes to increasing sustainability in cities by improving the quality of building environments [2]. UA has ample potential to yield positive social, economic and environmental returns for cities and their citizens and has been noted and received attention from city planners, policymakers, and scholars [3]. A survey of UA practices across the globe indicates that factors like urban ecosystems remain connected to urban planning, design, and management for resilience [4], urban landscape [5], land use preferences [6], water management practices [7], innovative forms of green urban architecture practices [8], quality of governance [9] legal-technical, policies, bureaucratic rules and procedures [10], and are highly supportive for sustainable development of UA.

Regarding the statement above, urban agriculture carried out sustainably will present a regular activity. This is because farming activities are synonymous with regularity, an activity that has a definite process, must be done in a sequence and consistent. With the presence of urban agriculture, the city will
be more ‘alive’, more organized and beautiful. In fact, urban agricultural areas not only function as a place for providing food for the urban community, but also can be a center for agricultural education activities for the younger generation, and become a recreational vehicle for all urban communities. This of course will overcome some social problems, will open employment, and make the city more dynamic in a pleasant everyday atmosphere. Sustainable urban agricultural activities show an increased awareness and real appreciation of the city environment which is indicated by the atmosphere of a green and beautiful city.

Urban agriculture is part of a local food system where food is cultivated and produced in urban areas and marketed to consumers in the urban area. Urban agriculture can also include livestock (for example breeding and maintenance livestock), apiculture, cultivation (eg fish farming), aquaponics (for example integrating fish farming and agriculture), and non-food products such as producing seeds, cultivating seeds, and growing flowers. This can be characterized in terms of the geographical proximity of producers to consumers, sustainable production and distribution practices [11]. Because urban agriculture moves towards activities that generate income or produce food, it is important to develop a plan to start and operate a business regardless of whether it is intended to be a business or non-profit business profit [11].

Organizing urban agriculture can be carried out on private land and public land owned by the government. At the practical stage, of course it requires an urban agriculture plan that is integrated with the Urban Planning. It is also good for the Urban Agriculture plan to be seen in the Urban Land use Plan, especially urban agricultural activities planned on public land or government-owned land. Bogor City has significant economic growth. This causes more land to be built so that the green land continues to decrease in number. In 2016, green land is decreasing and remaining only around 320 ha. Of course, with that condition it will not be possible to return to a time when agricultural production was massive with extraordinary food security. The most appropriate concept to keep making a green city and supporting food security is urban farming.

Urban agriculture in Bogor City has been carried out since the last few years. Some programs have been applied such as KRPL (Kawasan Rumah Pangan Lestari) namely urban farming in the yard, demonstration garden or known as demplot that uses public land, toga gardens or medicinal plant gardens, and several other programs. The development of urban farming in Bogor City is initiated by the city government through related agencies such as the Agriculture Official and the Food Security Official. However, one of problem that occurs according to develop urban agriculture is lack of green open space so that it requires identification of potential green open space for its sustainability [12].

Water play a critical role in agriculture. This is a consideration for green open space close to water bodies to be a potential location for urban farming development. Bogor City has two large rivers and several tributaries. Efforts to develop urban agriculture in Bogor City have good opportunities. Urban agriculture that will be carried out on the riverbanks can later be a practice of cultivation, processing, distribution of food, and other supporting activities. This research was made to identify green open spaces on riverbank in the Bogor City as a potential location in the development of urban farming.

2. Method

2.1. Study Site

This research was carried out in Bogor City. This research was conducted in the area of Bogor City, West Java. The Bogor City is located between 106°48’ E longitude and 6°26’ S latitude, the geographical position of the Bogor City in the middle of the Bogor Regency area and its location is very close to the National Capital. The location of the study was conducted in the Bogor City area, covering six sub-districts, namely North Bogor District, South Bogor, Central Bogor, East Bogor, West Bogor, and Tanah Sareal (Figure 1). The total area of Bogor City is 11,850 Ha.
2.2. GIS analysis

GIS is a computer system used to collect, examine, integrate, and analyze information relating to the surface of the earth [13]. Basically, the term geographic information system is a combination of three main elements, namely system, information, and geography. Thus, understanding the three main elements will be very helpful in understanding GIS. By looking at the main elements, it is clear that GIS is an information system. GIS is a system that emphasizes geographic information elements.

This research method includes several stages. At the data collection stage, the data needed is a combination of some of the data collected to be processed and implemented in the system, there are data needed including, Bogor City administrative map data obtained from Regional Planning Department with hydrological map, green open space map, and land slope map.

At the stage of the system needs analysis, it is determined how data, processes, and information technology can be connected to each other. With the analysis of a system it is hoped that it can be described in its entirety into basic components with the aim of identifying, evaluating problems and expected needs, and this analysis is also carried out to ensure that the system is built according to the needs of the object of research. Data processing can be seen in Figure 2.

In this data processing stage, an overlay of a hydrological map (a map showing a water body), a map of green open space, and a land slope map are carried out. This map then becomes a suitability map. After becoming a composite map, a suitability analysis of potential is carried out with three factors that determine suitability. The three factors are based on accessibility with a water body, slope and the area are a green open space for cultivation or sleeping land not a protected area. The last process carried out is the ground check stage, which is checking the actual state of the system. This ground check process is carried out by observation on Google Earth and documenting at potential location points generated. The final result of this spatial analysis with GIS is a map of the distribution of green open space that has the potential to develop urban agriculture.
3. Result and discussion

Gardening activities in the city, or what is known as urban farming, now seems to be a new trend for people living in urban areas, including the Bogor City. The history of Bogor City is a green city full of plants. Therefore, the past history of Bogor City which is full of trees and various types of plants including horticulture will try to be resurrected. The current constraints are that it is not easy because green land or space, is now diminishing and leaving only around 320 hectares, of course, with that condition it will not be possible to return to a time when agricultural production was massive with extraordinary food security. So, the concept that is felt most appropriate for green city goals and supports food security is urban farming.

3.1. Urban Agriculture in Bogor City

The vision and mission of developing urban farming in the Bogor City is to develop a food security system based on regional characteristics and diversity of food sources to ensure the availability of safe and nutritious food, realize environmentally sound and competitive urban agribusiness by increasing production and productivity through optimizing the use of resources agricultural power, encourage the availability and sustainable food security, and increase the added value of agricultural products through the development of systems and agribusiness. Its applications include breeding fruit trees, mushroom cultivation training, aquaponic / hydroponic cultivation training, and others. This is supported by the food resources of 168 farmer groups consisting of: Kelompok Wanita Tani/ Women Farmers Group (KWT), Kelompok Tani Dewasa / Adult Farmers ‘Groups (KTD) and Kelompok Tani Ternak/ Livestock Farmers’ Groups (KTT), and has forty-one Gabungan Kelompok Tani/ Joint Farmer Group (Gapoktan) which are spread in Bogor City [13].

One urban farming program currently running in Bogor City is KRPL. KRPL or Sustainable Food House Area is a house of residents who intensively cultivate yards to be used with a variety of local resources wisely which ensures the continuity of supply of quality and diverse household food ingredients. If the RPL is developed on a broad scale, based on hamlets (villages), villages, or other possible areas. In addition, KRPL also includes efforts to intensify the use of living fences, village roads and other public facilities (schools, houses of worship, etc.), green open land, and develop processing and marketing of products.

The basic principles of KRPL are: (i) utilization of land that is environmentally friendly and designed for food security and independence, (ii) diversification of food based on local resources, (iii) conservation of food genetic resources (plants, livestock, fish), and (iv) maintain sustainability through village nurseries towards (v) increasing income and welfare of the community. KRPL if managed properly and sustainably or sustainably, will be a solution in overcoming problems of hunger and poverty. Even the World Food and Agriculture Organization (FAO), which has the aim of improving nutritional standards of the world community, has adopted the KRPL Program to overcome hunger and poverty by the name "Family Farming" (Head of West Java Province BKPD Food Consumption and Safety and 2014 Agricultural Research). In the implementation of Bogor City, it has made around several development points for KRPL in several sub-districts. The sub-district with the most point is the South.
Bogor Sub-District, this sub-district also has the highest poverty rate in the 2017 Bogor BPS figures [14]. The development points of KRPL in Bogor City include Ciwaringin, Rancamaya, Pasir Jaya, KedungBadak, Puspasari, Cibuluh, Tanah Baru, Mekar Wangi, and Tanah Sareal.

For the overall program of urban farming according to the Agriculture Office of the Bogor City, among others: (1) development of nurseries, (2) development of demonstration plots or sample gardens, (3) development of farmer member yards, (4) development of school gardens, and (5) supporting healthy food consumption patterns, B2SA or Diverse, Nutritious, Balanced and Safe Food. To support B2SA, urban farming can be a part of providing local food from upstream to downstream in order to support food security.

3.2. Riverbank as a potential location for developing urban agriculture

Green Open Space (GOS) has an ecological function as water catchment and water basin [15] [16]. In addition, river border areas also function as water and nutrition sources, vegetation and animal habitat, and filters for pollutants and toxic substances [17] [18]. The riverfront GOS has diminished due to development, even though this can be used as an ecological function. In addition, the border of the river can also be used as a productive GOS by developing urban agriculture. Water flowing from the river is one of the natural potentials available and is a major supporter of the sustainability of urban agriculture.

Bogor City is currently crossed by two major rivers, the Ciliwung River and the Cisadane River. The length of the main stream of Ciliwung river is almost 120 km with its catchment area (watershed) covering an area of 387 km² while the Cisadane River also has almost the same length 126 km with its catchment area (watershed) covering an area of 1546,54 km². Besides the two main rivers, Bogor City also has quite a number of tributaries, among others, (1) Ci Apus, (2) Ci Budik, (3) Ci GedeKulon, (3) Ci GedeWetan, (4) Ci Jeruk, (5) Ci Karet, (6) Ci Keuneuh, (7) Ci Leungsir, (8) Ci Leuwibangke, (9) Ci Liwung, (10) Ci Luar, (11) Ci Lulumpang, (12) Ci Milis, (13) Ci Omas, (14) Ci Pakancilan, (15) Ci Paku, (16) Ci Picung, (17) Ci Pinanggading, (18) Ci Rawakalong, (19) Ci Sadane, (20) Ci Seuseupan, (21) Ci SindangBarang, (22) Kali Angke, (23) Kali Baru 2, dan (24) Kali Demang. The entire river can be seen on the hydrological map of Bogor City (Figure 3).

3.2.1. Suitability Analysis Map

In determining the level of land suitability carried out by the scoring method. The land suitability classification was carried out following the FAO 1993 classification [19], where suitability follows a level of suitability for certain uses. According to FAO (1993) the suitability classification standard is famous for land suitability analysis. The standard establishes whether a land is highly suitable or not suitable. It is split into five suitability ratings. This case study used three of the important ratings of land suitability ratings to generate the results. The three ratings are high suitability, moderate suitability, and low suitability (Table 1).

There are two stages of scoring carried out after overlaying the hydrological map of the GOS. This overlay is done to see the proximity of the GOS to the river bank. GOS chosen as a potential location for urban agriculture development is GOS with a distance of 0-50m from the river bank. The first scoring was carried out on the green space distribution map that based on the function factors stated in the Bogor City spatial plan (2011-2031) [20] (Figure 4).
Figure 3. Hydrological Map of Bogor City

Table 1. Explanation of the land suitability ratings used in the study (Source: FAO, 1993).

| Low Suitability | Moderate Suitability | High Suitability |
|-----------------|----------------------|-----------------|
| S3              | S2                   | S1              |
| Land with limitations so severe that benefits are reduced and/or the inputs needed to sustain production are increased so that this cost is only marginally justified | Land that is clearly suitable but which has limitations that either reduce productivity or increase the inputs needed to sustain productivity compared with those needed on highly suitable land | The land can support the land use indefinitely and benefits justify input |
In the Spatial Plan map, GOS function is divided into several criteria, including (1) Agricultural cultivation zones, (2) urban green open areas, (3) Public Cemetery, (4) Urban Forests, and (5) Germplasm Protection Areas. Land suitability scoring based on function can be seen in the table of the score for the development of urban agriculture (Table 2).

**Table 2. GOS Land Suitability Scoring for UA development**

| Suitability Categories | Type of GOS                                |
|------------------------|--------------------------------------------|
| S1                     | Highly Suitable Agricultural Cultivation Area and Green Open Space of City |
| S2                     | Moderately Suitable Public Cemetery         |
| S3                     | Marginal Suitable Urban Forests and Germplasm Protection Area |

The agricultural cultivation area and urban green open space are rated in the S1 category or are very suitable because of their supporting functions as the development of UA. For public cemeteries it is categorized in the S2 class regarding social values. Public cemetery is assessed as land which is still limited by ethics that must be maintained and not used for intensive activities such as UA. However, public cemeteries can still be negotiated with certain restrictions through local government policies.
Urban Forests and Germplasm Protection Areas are in the marginal suitable category, due to very heavy restrictions. This limit is not on social values but on environmental values. In type of GOS with S3, it is almost impossible to develop UA in the context of this GOS purpose to maintain the sustainability of environmental ecology such as supporting groundwater storage, preservation of germplasm, etc.

The second stage of the scoring was carried out on the overall land slope map of the Bogor City (Figure 5). Land Slope map is needed in consideration of applying the UA. Scoring value is based on% slope which can be seen in the slope scoring table that is suitable for the development of UA (Table 3).

| Suitability Categories | Slope       |
|------------------------|-------------|
| S1 Highly Suitable     | 0-15%       |
| S2 Moderately Suitable | 15-45%      |
| S3 Marginal Suitable   | >45%        |

Table 3. Scoring Land suitability for slope

Figure 5. Land Slope Map of Bogor City

3.2.2. Thematic Map of potential location for UA

Based on the results of land suitability analysis using the scoring method, the map will be overlayed so that the thematic maps are needed. Thematic maps of potential locations for the development of UA are generated from the overlay of the identification results which are equated with the unit values. Overlayed maps are maps of identification of hydrological maps, GOS maps, and land slope maps. The overlay results can be seen on the composite map (Figure 6).
The final stage in this study is to produce a potential thematic map in the riverbank of Bogor City. Then on this thematic map potential points of location will be used to develop UA. To test the truth on a map produced from spatial analysis with GIS, a ground check process was carried out. Observation at location points is done by looking at and documenting it. There were 17 potential locations for the development of UA on the river bank with an overall area of 287.6 ha (Figure 7). This potential point is in Tanah Sareal District (4 locations), West Bogor District (4 locations), Bogor Central District (4 locations), South Bogor District (4 locations), and East Bogor District (1 location).
4. Conclusion
This study produced a map of potential points on the river bank for the development of agricultural urban. In the resulting map Required 17 locations found. This research is expected to contribute to the development of the city by making the river as one of the centres of agriculture for the urban community. This research will also encourage cities that have rivers to develop their river areas as productive green areas. The development of the river area as an agricultural area will increase the area of productive green open space for the city, and also produce a green 'city face' with a neat and beautiful environment. For its implementation, further research is needed regarding the model for transforming activities, from non-agricultural activities to agricultural activities for a healthy lifestyle.

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