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Enhancing urban environmental quality through the development of green open spaces: An analysis of non-agricultural land use

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ABSTRACT
Background: Most areas in West Jakarta have fertile soil, making them suitable for a diverse range of urban vegetation. Urban vegetation communities offer numerous ecological, social, health, economic, and cultural benefits. The preservation of urban vegetation requires reliable data, one of which can be obtained through remote sensing using satellites. This data is crucial for informing the state and pressures on biodiversity in various urban areas. This study aims to analyze the distribution of vegetation on non-agricultural land to improve environmental quality and urban planning in West Jakarta. **Methods**: A qualitative approach was used, with secondary data and literature studies on several samples, assisted by Google Earth imagery for mapping the vegetation. **Findings**: The analysis reveals that non-agricultural lands are predominantly covered by alang-alang (Imperata cylindrica) grass, with these lands situated next to government and commercial centers. The findings suggest that there is potential for converting these areas into green open spaces *(Ruang Terbuka Hijau*/RTH), in accordance with the Regional Spatial Plan (*Rencana Tata Ruang Wilayah/*RTRW) for DKI Jakarta by 2030. **Conclusion**: The development of green open spaces from underutilized non-agricultural lands can contribute to improving environmental quality and enhancing the overall urban layout in West Jakarta. Additionally, the spatial structure of West Jakarta follows a sectoral model, where development focuses on specific land uses in distinct sectors. **Novelty/Originality of this article**: This article offers a novel perspective by integrating satellite-based remote sensing data with urban planning concepts, such as the sectoral model and green open space development.

KEYWORDS: landuse; non-agricultural land; vegetation.

1. Introduction

Life most of the human population on earth is concentrated in urban areas. More than half of the earth's human population lives in urban areas and in developing countries it is predicted that two out of three people will be living in cities by 2050. The existence of large cities with a human population range of 10-30 million is common these days. Conversion of green spaces occurs in many urban developments, turning the land into concrete and asphalt covered buildings that cause limited water absorption into the soil. Population growth in urban areas has caused environmental problems. Sustainable development is a middle ground that supports development that follows the sustainability of the landscape ecology. Green cities are cities that have moved towards and achieved long-term environmental sustainability. Future urban planners will face hurdles in choosing to protect green cities, urban economic growth, and social justice (Setiowati et al., 2019).

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Urban vegetation communities offer a variety of ecological advantages, including enhancements in air and water quality, mitigation of Urban Heat Island (UHI) effects, and the preservation of habitats and biodiversity. In addition to these environmental benefits, such green spaces also contribute to social, health, economic, and cultural well-being. Nonetheless, access to these advantages is not always equitably distributed among all population groups. Therefore, the planning and management of urban green spaces hold the potential to harmonize ecological goals with social considerations, particularly in fostering more inclusive and equitable access for marginalized communities (Rigolon, 2016). Emerging knowledge increasingly supports what many intuitively recognize—that humans have an inherent need for meaningful interaction with the natural environment. A growing body of research confirms that exposure to nature contributes significantly to mental health and overall well-being. This connection is particularly critical for younger generations, whose experiences of the natural world are increasingly mediated or diminished by technology. From an economic perspective, nature is also highly valued: properties with scenic views or proximity to natural amenities like trails command higher market prices, and businesses located along tree-lined streets often outperform those in less green urban areas. As awareness deepens regarding the essential role of nature in human life, there is a pressing need for policies to shift from solely conserving existing natural areas to actively integrating nature into the spaces where people live. Such an approach not only enhances the stewardship of natural resources but also promotes human well-being in a more holistic manner (Brown, 2016).

Preserving biodiversity, especially plant vegetation in urban areas, requires data. Effectively monitoring the status of natural resources and assessing the impacts of human activities is essential for formulating sound and efficient management strategies. This is especially crucial in addressing the complex challenges of global climate change. To do so, scientists require access to consistent, long-term, and globally representative data that capture both spatial and temporal dynamics. Such data must encompass the extent and intensity of direct and indirect human pressures on biodiversity, as well as changes in ecosystem distribution, structure, function, and integrity, alongside evaluations of management effectiveness. Over the past three decades, Satellite Remote Sensing (SRS) has increasingly proven to be a valuable tool in providing insights into biodiversity conditions and stressors across multiple spatial scales—from landscapes and regions to ecosystems, continents, and the global level (Pettorelli et al., 2014).

Indonesia is one of the developing countries in the world with the capital city of DKI Jakarta Province. DKI Jakarta is divided into five administrative cities and one administrative district, namely Central Jakarta, West Jakarta, East Jakarta, North Jakarta, South Jakarta, and Kepulauan Seribu. The total population in Jakarta is recorded at 10.61 million people, while the area of the province is only 664 Km^2. The population density in Jakarta reaches 15,978 people per Km^2, making Jakarta the most densely populated province in Indonesia and will continue to increase every year (Central Statistics Agency of DKI Jakarta Province, 2021). The condition of the densest population indicates the high mobility that occurs in Jakarta and this can have an impact on reducing environmental quality. West Jakarta City has a population of 2.4 million people with an area of 124.4 Km^2. According to research conducted by Cahya (2016), most of West Jakarta in the form of settlements and urban areas have soil conditions that are fertile enough to be a good growing medium for vegetation diversity in urban areas. Vegetation ecology has great potential to bring a new perspective to urban ecology because of its response and relevance to global human changes (Malanson et al., 2020). Therefore, the purpose of writing this paper is the distribution of vegetation on non-agricultural land to improve environmental quality and good urban planning in the city of West Jakarta.

1.1 Environmental science theory

The environment refers to the external conditions, factors, energies, both biotic and abiotic, that influence living organisms or systems. Environmental science is an interdisciplinary field that combines knowledge from the physical sciences, such as biology, chemistry, and geology, with insights from the social sciences and humanities, including economics, politics, and ethics. This field aims to study how natural systems function and how humans interact with and respond to environmental challenges. It helps in understanding the delicate balance of Earth's systems and provides guidance on addressing the growing concerns related to environmental degradation. The interdisciplinary nature of environmental science enables comprehensive solutions to complex environmental problems. By examining both the scientific and social aspects, it plays a crucial role in shaping policies and practices that aim to protect the environment. Environmental science is essential for fostering an understanding of how human activities impact the planet and how to mitigate negative effects (Miller & Spoolman, 2018).

Sustainability refers to the capacity of Earth's natural systems, which support human life and societal structures, to endure and adapt to changing and uncertain environmental conditions. An environmentally sustainable society is one that meets the current and future basic needs of all individuals fairly, without compromising the ability of future generations to meet their own needs. Sustainable living involves efforts to reduce the exploitation of potentially renewable resources, ensuring that natural processes can replenish them over time. It also means avoiding excessive strain on the environment's capacity to renew and cleanse itself naturally. Sustainable practices are essential for long-term ecological balance and for minimizing the negative impacts of human activities. By adopting sustainable lifestyles, societies can help preserve the planet's resources for future generations. This concept is fundamental for ensuring that natural systems continue to support life while maintaining social equity and environmental health (Miller & Spoolman, 2018).

1.2 City structure theory

According to the DKI Jakarta Regional Spatial Plan (RTRW), the spatial pattern refers to the distribution of land use designations within a given area, encompassing allocations for both protected functions and cultivation purposes. In contrast, spatial planning is the process of determining spatial structures and patterns, which includes the formulation and formal adoption of spatial plans. The spatial structure of the city according to Law No. 26 of 2007 is defined as a description of the urban system of the district area and the district area infrastructure network developed to integrate the district area in addition to serving district-scale activities which include a transportation network system, an energy and electricity network system, a telecommunications network system, and a water resources network system, including all areas upstream of dams or reservoirs from the watershed.

The elements that make up the city's spatial structure consist of activity centers, activity areas, and road networks. A city or urban area can basically be viewed as a spatial system with its components and linkages. The city as a system/regional planning is a form of structure and pattern of space utilization, whether planned or not, which characterizes the area with important non-agricultural activities. The structural form of urban space utilization is the shaping elements of urban areas that are hierarchically and structurally interconnected and form the city's spatial layout. The structural form of urban space utilization is a hierarchy of service centers for urban activities, such as city centers, urban area centers, and neighborhood centers; road infrastructure systems such as toll roads, collector roads and supporting local roads. There are three theories that are often used in determining the structure of the city, namely concentric theory by Burges, sectoral theory by Hoyt, and multiple center theory by Harris and Ulman (Pontoh & Setiawan, 2008).

1.3 Sustainable urban development theory

Metropolitan cities with high population density and slum areas mostly have a negative impact on the environment. Environmental degradation that occurs in cities can be minimized by the development of green open spaces, good public transportation management, decreased crime rates, and increased bicycle use. This can be evidenced by the percentage of air pollution per day dropping from 50% to 20% (Miller & Spoolman, 2016). An environmentally sound development pattern that prioritizes natural resources as a component of the environmental order, the processing of a natural resource can produce a man-made environment so that various natural functions are taken over by man-made natural functions, and natural resources can be processed for various purposes. The development process can produce negative impacts in the form of pollution and environmental destruction as by-products. Natural resources and the environment must be cultivated to improve the welfare of present generations and also improve the welfare of future generations. Entrepreneurs and the entire community are invited to actively participate in developing environmentally sound industries so that people become more prosperous, and the environment is sustainable (Salim, 1986).

Urban development typically results in the removal of substantial portions of existing vegetation, the extent of which is influenced by factors such as climate, soil characteristics, and the historical land use of the area being urbanized. The pre-existing vegetation may consist of native primary forests, woodlands, grasslands, desert vegetation, secondary growth, or even invasive species. Generally, vegetation cover tends to decline as population density and/or development intensity increases within urban environments. The concept of urban density can be defined and quantified in various ways, depending on the focus or purpose of the analysis—for example, as the number of people, housing units, or employment opportunities per unit area, or in terms of total built floor area or available open space within a given area (Dovey & Pafka, 2014).

A study by Nowak et al. (1996), which examined 12 cities established in naturally forested regions of the United States, found that average tree canopy cover was greatest in parks and vacant land, moderate in residential zones, and lowest in commercial and industrial districts. Er et al. (2005) estimated that approximately 87% of forested land in Vancouver, Canada, was converted to urban use between 1859 and 1999. Interestingly, while urban expansion typically reduces vegetation within city boundaries, it can also indirectly lead to an increase in native vegetation in surrounding non-urban areas. For instance, forest cover on an island in Puerto Rico grew from 28% to 40% between 1991 and 2000, largely due to a demographic shift from rural to urban living, which resulted in the abandonment of agricultural lands and subsequent natural reforestation (Parés-Ramos et al., 2008). Urban tree planting initiatives, particularly in parks and along streets, can gradually enhance tree canopy cover in cities following development, thereby partially offsetting the loss of vegetation caused by urbanization. However, the species introduced are frequently non-native and do not restore the original native vegetation communities (Braun et al., 2017).

Cities are often founded in biologically rich regions characterized by favorable environmental conditions. However, the process of urbanization typically leads to the degradation of natural habitats, the displacement of native ecosystems, and the potential extinction of rare indigenous species. In urban environments, a significant proportion of land is covered by impervious surfaces such as roads and buildings, which limit opportunities for natural vegetation growth. Nevertheless, humans have engineered new urban landscapes and habitats that are now inhabited by a mix of native and non-native plant species. Increasingly, scholars are recognizing that urbanization, despite its ecological disruptions, can also contribute to biodiversity in certain contexts (Singh et al., 2018).

1.4 Urban habitats

Cities consist of a mixture of remnants of pre-existing habitats and new urban habitats. According to research conducted by Mckinney (2005) shows that urbanization drastically changes habitats, removing vegetation over large areas, leading to areas that are paved over and extensively modified so that the intensity of change exceeds habitat changes that occur due to logging or traditional agriculture. Zerbe et al. (2004) conducted a comprehensive habitat classification study for Cheonju City, located in the southwestern region of South Korea, detailing the proportions of land occupied by various habitat types. These include:

(1) built-up areas with mixed land uses, characterized by densely developed and enclosed zones in the city center and inner city; (2) historically old residential areas encompassing rural settlements in highland, plain, and hilly regions; (3) green open spaces and parks, including large city parks established in the 1980s exceeding 10 hectares, as well as smaller parks developed during the 1980s and 1990s ranging from 1 to 3 hectares; (4) commercial districts; (5) agricultural lands such as rice paddies, moorlands, and gardens; (6) aquatic environments including rivers, lakes, ponds, and their banks; (7) transportation corridors such as railways and highways; (8) public facility zones comprising campuses, hospitals, museums, and schools; (9) historical buildings; and (10) forested areas, which include natural broadleaf-dominated forests, mixed natural forests, natural coniferous forests, and man-made forests dominated by either broadleaf or coniferous species.

The biophysical processes associated with urbanization are not deterministic and urban habitats are often characterized by spatial variability or irregularity (Luck et al., 2004). However, this does not mean that environmental conditions at a site within the city are highly variable over time. Human disturbance of urban habitats is frequent and can lead to increased temporal variation in environmental conditions experienced by certain groups of species, such as grasses, plants or soil-dwelling arthropods (Sattler et al., 2017). Some environmental conditions may vary less in cities than in nearby rural areas. Climate change in cities associated with Urban Heat Island (UHI) effects and artificial watering of parks and gardens may reduce diurnal and seasonal variations in temperature, humidity and soil moisture (Malanson et al., 2020). In addition, seasonal variation in food availability for generalist species such as meat-eating birds, fruit-eating bats and scavenging mammals may be substantially lower in urban areas than in rural areas, leading to a suitable food supply throughout the year, thus higher population densities. The increased or decreased levels of environmental stochasticity experienced by various species following urbanization may contribute to the persistence or extinction of their populations over time (Parris, 2016).

Parks are recognized as a key habitat type within urban environments due to their role as reservoirs of plant biodiversity and their support for diverse human activities. Mathieu et al. (2007) classified parks in Dunedin, New Zealand, into three categories: dense and lush parks, where trees and shrubs cover more than 70% of the area; open parks with mixed vegetation—including trees, shrubs, hedges, and grass—with tree and shrub cover ranging between 30% and 70%; and grass-dominated parks with less than 30% tree and shrub cover. In Dunedin, approximately 46% of the residential area comprises vegetated parkland. Another critical urban habitat type is the ecological corridor, which links separate habitat patches. These corridors are essential for maintaining and enhancing urban biodiversity, as they, together with habitat patches, exert the strongest positive influence on vegetation structure and plant diversity by increasing species richness and improving habitat quality within the urban matrix (Beninde et al., 2015).

Werner (2011) defines patch areas as habitats comprising remnants of natural and semi-natural landscapes, parks, green open spaces, vacant lots, and other vegetated sites that collectively form the green infrastructure within urban environments. Additionally, Werner introduces the concept of the urban matrix, referring to all areas outside these patches, characterized by varying densities of building clusters and differing degrees of human disturbance. In older cities, walls represent a distinctive habitat type, serving as substrates for plant colonization and exhibiting successional changes in vegetation as the walls age. The importance of green spaces in cities has been recognized to varying degrees since the nineteenth century, when their value in providing a solution to widespread urban air pollution was a key driver in creating new parks and green spaces. However, in the last decade or so, there has been increasing interest and attention to the quality and quantity of green spaces in urban areas (Swanwick et al., 2003).

1.5 Urban microclimate

Climatic conditions in urban environments are greatly affected by the amount of construction activity and population, creating microclimates that result in cleaner air, less humidity, more or less rainfall compared to surrounding areas (Nikologianni et al., 2022). Vegetation is an important part of nature and urban ecosystems with various changes in their composition due to climate and environmental changes that result in possible threats to ecosystems. knowledge of the various climatic challenges in an area is considered important to set priorities for its conservation and restoration (Jennings & Harris, 2017). Urban heat island (UHI) is a phenomenon that first emerged in 1818, which refers to the condition of higher atmospheric and surface temperatures in urban areas compared to surrounding rural areas. UHI production in urban areas is caused by landscape changes due to reduced vegetation in urban areas, property development, urban geometry, heating due to human activities, weather, and location. Urban green spaces play an important role in mitigating UHI effects due to the presence of vegetation, such as forests, grasslands, and agricultural land (Estoque et al., 2017).

Vegetation is thought to have evaporative cooling effects that can lower ambient temperatures, including shading effects that can lower surface temperatures. An effective strategy to reduce the UHI phenomenon is to use reflective (high albedo) materials or increase the proportion of green space. Vegetation elements help regulate microclimate through evaporative cooling and the resulting shading effect (Müller et al., 2014). According to research conducted by Adityo (2016) through measurements of surface temperature, air temperature and humidity, as well as wind speed, the study of thermal comfort of road corridors shows the role of vegetation in maintaining the quality of the microclimate. Canopy on vegetation elements can reduce direct sunlight to the earth's surface, so that the surface temperature can be lowered.

1.6 Urban plant diversity

Plant diversity plays a crucial role in shaping overall ecosystem biodiversity. Urbanization is widely recognized as a significant driver of species extinction and is commonly linked to adverse effects on plant diversity. This process often leads to the replacement of native species by broadly distributed non-native species, thereby contributing to biotic homogenization. Variability in resource availability creates substantial spatial heterogeneity in plant diversity within urban landscapes. Notably, species richness can be high in cities due to the presence of diverse and heterogeneous habitats, some of which may be rare or absent in the surrounding rural areas (Godefroid & Koedam, 2007). A study by Aronson et al. (2014), which analyzed plant data from 110 cities globally, revealed that although the majority of urban plant species are native, the average species richness per square kilometer is substantially lower in urban areas—only about 25% of native species found outside cities are present within them. Furthermore, species density within cities is positively correlated with the extent of intact vegetation cover and the age of the city. Older cities and those with larger proportions of preserved vegetation tend to support higher levels of plant diversity.

Cities represent novel ecosystems characterized by fragmented and highly disturbed environments, dense built infrastructure, and extensive impervious surfaces that contribute to elevated heat retention. Within urban areas, habitats are predominantly anthropogenic, resulting in plant diversity patterns that often reflect underlying social, economic, and cultural factors. Urban expansion frequently drives the replacement of native plant species with introduced ones. Studies across 13 cities and towns on multiple continents have documented declines in native species richness ranging from 3% to 46% over periods of 50 to 150 years (Singh et al., 2018).

Two primary factors linked to urbanization that contribute to increased non-native species richness are the heightened introduction of non-native species by humans and the favorable habitat conditions within urban settlements that facilitate the establishment of these introduced species (McKinney, 2005). Urbanization often leads to biological homogenization because many cities host similar exotic species, resulting in plant communities that may be more alike across urban areas than in natural landscapes. However, if different non-native species are introduced and become established in different cities, biological differentiation rather than homogenization can occur (McKinney, 2004). Data analyzed by Aronson et al. (2014) indicate that although some exotic species are widespread across multiple cities, urban biotas have not become taxonomically homogeneous on a global scale and still reflect their respective regional biogeographic species assemblages. Moreover, cities can act as sources of non-native species dispersing into surrounding rural areas. Compared to rural habitats, urban environments tend to exhibit lower species diversity, less stable vegetation communities, increased patchiness, and dominance by non-native species.

Singh et al. (2018) report that as urbanization intensifies, certain species well-adapted to urban environments tend to become widely distributed and locally abundant across cities, leading to biotic homogenization. The occurrence and frequency of species in urban areas are influenced by their proximity to different types of urban land uses. The loss of native species and the successful colonization of exotic species represent dynamic and ongoing processes within urban plant communities. Urbanization-driven extinctions may be species-specific; for instance, geophytes, hemicryptophytes, and species dispersed by wind or ants are particularly vulnerable. Additionally, urban soils tend to be alkaline—partly due to the widespread use of alkaline building materials—which favors species adapted to such conditions. Species richness along rural-to-urban gradients varies depending on the taxa considered; while animal species richness typically declines with increasing urbanization, plant species richness often increases toward city centers. To support biodiversity and enhance the well-being of urban residents, the establishment of urban nature reserves should be integrated and mandated within urban planning frameworks.

2. Methods

This study employs a qualitative approach, utilizing secondary data and literature review, as well as observation of current field conditions with the assistance of Google Earth. The research location is situated in the Administrative City of West Jakarta, as shown in Figure 1. According to data from the West Jakarta City Statistics Agency/*Badan Pusat Statistik* (BPS), this area lies between coordinates $106^0$22’42” E–$106^0$58’18” E and $5^0$19’12” S–$6^0$23’54” S, covering a total area of 129.54 km^2 with an elevation of approximately 7 meters above sea level. West Jakarta comprises eight districts: Cengkareng, Grogol Petamburan, Taman Sari, Tambora, Kebon Jeruk, Kalideres, Palmerah, and Kembangan. The city is bordered by North Jakarta to the north (Penjaringan District), Central Jakarta to the east (Gambir District), South Jakarta and Banten Province (Tangerang City) to the south, and Banten Province (Tangerang City) to the west. The administrative map of West Jakarta City is presented in Figure 1.

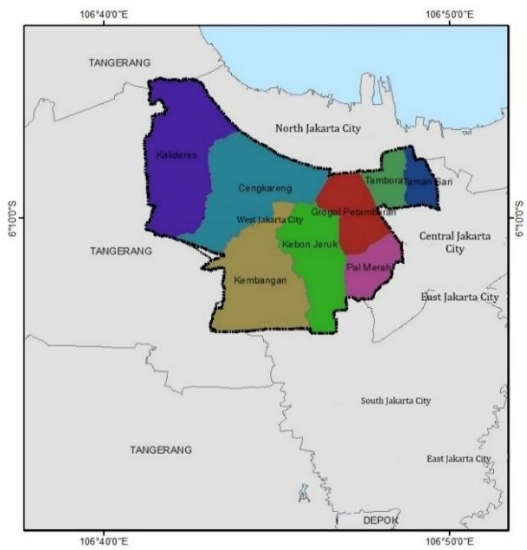

Fig 1. The administrative map of West Jakarta City

Vegetation observation data on non-agricultural land was obtained by comparing the results of the land use analysis map and the agricultural land distribution analysis map in West Jakarta with the actual conditions at the location obtained through Google Earth. Samples taken in the form of images of the condition of non-agricultural land vegetation areas at several points in West Jakarta obtained from Google Earth. Samples obtained from Google Earth are at two points, namely, the West Jakarta mayor's office area and the West Jakarta Samsat area.

3. Results and Discussion

3.1 Spatial distribution of vegetation on non-agricultural land

Vegetation mapping based on the phytosociological classification of vegetation according to the Zürich-Montpellier school of phytosociology (Braun-Blanquet) began in the 1920s. Maps of natural vegetation were made in the context of phytosociological research on vegetation in limited areas, for example in France, Czechoslovakia and Poland. Natural vegetation was mapped in locations where it actually existed. At the same time, small-scale schematic maps with widely understood vegetation units in larger areas were published. Natural vegetation is the best reflection of the natural habitat conditions of an area. After World War II, a new approach to natural vegetation mapping in the field began, with this approach, the natural vegetation of the entire area covered by the map sheet was mapped, regardless of the type and where the natural vegetation actually existed. This meant that phytosociologists began to map natural vegetation also in locations where there was no natural vegetation. This mapping was done in the field based on detailed investigations of the entire area and large-scale topographic maps (1:25,000–1:100,000) were used to outline the vegetation maps. The mapping units are derived from the classification units of natural or semi-natural plant communities that actually exist, delimited and described. The units do not strictly correspond to any particular syntactic rank. The choice of syntactic rank for the mapping units depends on (1) the syntactic knowledge of the natural vegetation; (2) the map scale; (3) the possibility of reconstructing the mapping units in locations without natural vegetation; and (4) the extent of the area that can be depicted at a given map scale (Moravec, 1998).

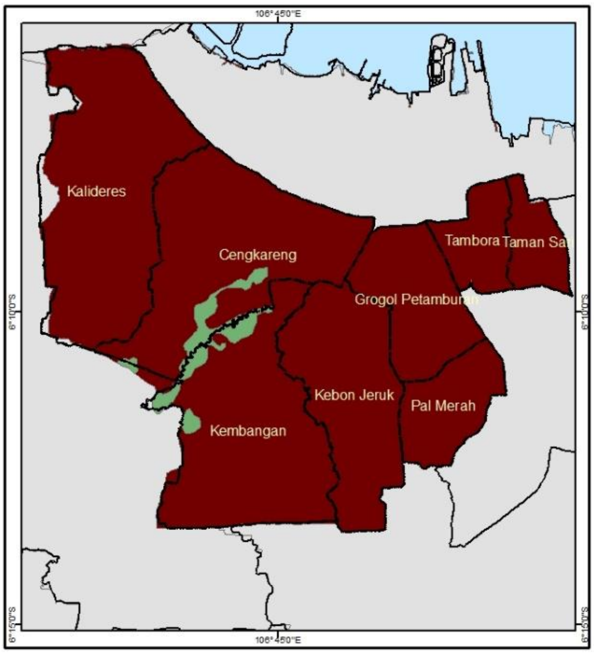

Fig 2. Land use map of West Jakarta City

The West Jakarta Population and Civil Registration Office/*Dinas Kependudukan Dan Pencatatan Sipil* (DISDUKCAPIL) in 2021 reported that the population of West Jakarta was 2.59 million people with a population density of 19.98 people/Km^2 spread across 8 sub-districts with an area of 26.54Km^2 in Cengkareng Sub-district; 9.99Km^2 in Grogol Petamburan sub-district; 30.23 Km^2 in Kalideres sub-district; 17.98Km^2 in Kebon Jeruk sub-district; 24.16Km^2 in Kembangan sub-district; 7.51Km^2 in Palmerah sub-district; 7.73Km^2 in Taman Sari sub-district; and 7.73Km^2 in Tambora sub-district. According to previous research conducted by Cahya (2016) in one of the urban villages in West Jakarta, namely in Duri Kosambi, the land is fertile enough to be suitable for agricultural activities. The land use map of West Jakarta City can be seen in Figure 2.

Based on the land use map of West Jakarta City in Figure 2, it can be seen that the land use division of West Jakarta City is divided into built-up areas and agricultural land. Agricultural land listed on the map is located in Cengkareng and Kembangan sub-districts. BPS West Jakarta City in 2019 reported that the rice harvest area in West Jakarta City was 27.27Km, which decreased from the previous years, namely 2018 of 73Km^2 and 2017 of 213Km^2. The author suspects that the decrease in the area of agricultural land from the harvest area is due to the conversion of land into built-up areas as shown in Figure 2, where the entire West Jakarta area is dominated by built-up areas.

There is a difference in data between the maps in Figures 2 and 3, where the map of the distribution of vegetation on non-agricultural land has more complete data, this is possible because the data source used is more recent. The division of vegetation distribution on non-agricultural land consists of shrubs, wet forests, and alang. Based on Figure 3, it can be seen that the distribution of vegetation is dominated by the presence of land filled with reeds. Alang-alang is a plant classified as a grass weed with the Latin name Imperata cylindrica. Map of Vegetation Distribution in Non-Farm Land in West Jakarta can be seen in Figure 3.

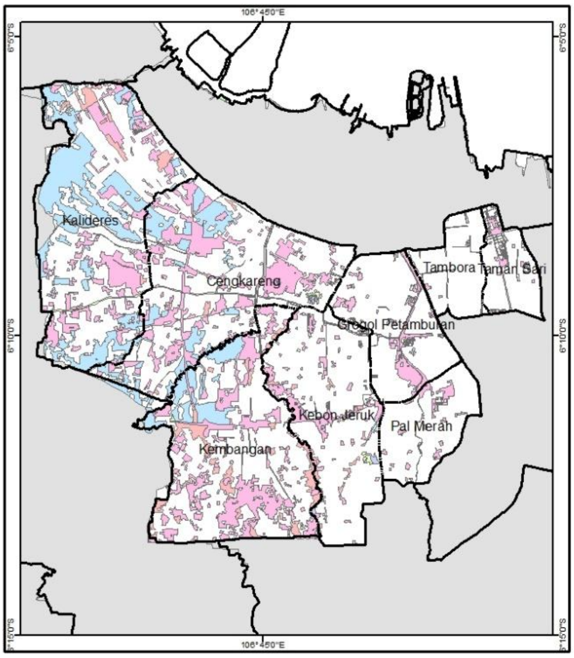

Fig 3. Map of Vegetation Distribution in Non-Farm Land in West Jakarta

The presence of alang-alang dominating non-agricultural areas in West Jakarta may occur because according to Lundholm & Marlin (2006) urban vegetation is dominated by weed species that have adapted to human disturbance, for example, the wall flora in some cities is dominated by species from rocky habitats such as cliffs and embankments. Urban plants are predominantly ruderal and have often been defined as synanthropic (associated with humans or human habitation), anthropophytes (whose presence is associated with human activities), or hemerobes (associated with areas impacted by humans).

Based on the amount of non-agricultural land dominated by alang-alang, it can be concluded that the land is unused or less productive, so it can be allocated for the development of cultivation areas. This allocation can be done on both government and private land, in accordance with the 2030 Regional Spatial Plan of DKI Jakarta. In the Regional Spatial Plan, the development of cultivated areas in the West Jakarta Administrative City area includes several types of areas, including cultivated green open areas, housing areas and their facilities, park housing areas and their facilities, and office, trade, service and mixed areas. In addition, there are also office, trade, service, and mixed park areas, government areas which include local government areas, and blue open areas. Other areas included in the Regional Spatial Plan are agricultural areas, industrial and warehousing areas, public and social service areas, and tourism areas.

Biodiversity in general emphasizes that understanding the mechanisms related to interactions between local and regional species distribution patterns remains a challenge and that studies on the inter-active effects of various mechanisms at various scales are needed and this is especially true for cities. The spatial heterogeneity and dynamics of urban landscapes are the result of complex interactions of abiotic and biotic processes at different scales, making simple starting points and explanatory pathways impossible. On the other hand, our knowledge is not completely unbiased. There are three examples of this; (1) we have a limited view because many published studies present results from regions in Central Europe and North America; (2) our scientific knowledge and general perception of urban biodiversity is mainly determined by two taxonomic groups-higher plants and birds; roughly estimated, more than two-thirds of all published studies are related to these two groups; (3) comparing floristic maps of European cities, we can see that the cities that show higher species diversity are those with universities and associated biologists (Werner, 2011).

The relationship between urban areas and their surroundings seems to need to show two aspects. First, it requires an ecological description of a city compared to its surroundings that is more globally interpreted than is commonly done. Mastering this will allow for better comparisons between the results of local investigations from different cities. Second, regional species assemblages must be understood as broad and dynamic. This means that regional species assemblages should not be reduced to limited cross-sections of species living in natural or semi-natural habitats and unchanging species configurations (Werner, 2011).

3.2 Distribution of vegetation in several points of non-agricultural land

Observation of the actual distribution of vegetation on non-agricultural land was carried out through data obtained from Google earth. Observations were made at two points in the government area in West Jakarta, namely around the West Jakarta Mayor's Office and the West Jakarta Samsat Office. Figure 4. shows the area around the West Jakarta Mayor's office through Google Earth satellite imagery.

Fig 4. Area around the West Jakarta Mayor's Office

The West Jakarta Mayor's Office is located at *Jalan Kembangan Raya No.2, RT.5/RW.2*, South Kembangan, Kembangan District. Other institutions near the location of the West Jakarta Mayor's Office are the West Jakarta Attorney General's Office and the Lippo Mall Puri shopping center. Non-agricultural vegetation land is found at two points around the West Jakarta Mayor's office. The first point is in the south of the mayor's office, precisely on Jalan Puri Ayu and in the north precisely on Jalan Puri Permai which is listed in Figure 5.

Fig 5. Vegetation on non-agricultural land around the West Jakarta Mayor's Office. (a) Puri Ayu Road in the south. (b) Puri Permai Road

As can be seen from the results of Google Earth satellite imagery in Figure 5, both non-agricultural vegetation lands around the West Jakarta Mayor's office have been installed with signboards indicating land ownership. The land to the south, on Jalan Puri Ayu, is owned by Mr. Budi Rahardja and is not for sale. Vegetation on the land is dominated by grass category weeds and there are also patterns of agricultural activities, the author sees in Figure 5 part a there are two beds of horticultural crops and on the edge there is a cassava planting, then the rest is filled with weeds.

The land to the north of the West Jakarta Mayor's office, precisely on Jalan Puri Permai is owned by the DKI Jakarta government and the plan is to build a regional revenue management unit (UPPD) office for the Kembangan area. The author sees in Figure 5 part b that the vegetation on the land at Jalan Puri Permai is dominated by grass category weeds and there are also lush trees. Another point that was observed was in the area around Samsat West Jakarta, located on Jalan Daan Mogot KM. 13 No.130, East Cengkareng, Cengkareng District which is shown in Figure 6. To the north of the West Jakarta Samsat is the Mookervaart Channel or Kali Mookervaart which connects the Angke River with the Cisadane River. The land to be observed is located to the northwest of the West Jakarta Samsat office, more precisely on the Mookervaart River Inspection Road.

Fig 6. The area around the West Jakarta Samsat Office

Based on the results of Google Earth satellite imagery in Figure 7, the location of vegetation on non-agricultural land located on the northwest side of the West Jakarta Samsat office is more clearly visible. The land on Jalan Kali Mookervaart is owned by PT Elite Prima Hutama and is located to the north of Kali Mookervaart which is only limited by Jalan Kali Mookervaart. Based on Figure 7, the author sees that the entire land is almost covered by alang-alang (Imperata cylindrica) grass category weeds.

Fig 7. Vegetation on non-agricultural land around the West Jakarta Samsat Office

Mapping global vegetation density, Crowther et al. (2015) identified an inverse relationship between vegetation density and anthropogenic land use, highlighting that human activities directly compete with natural forest ecosystems for space. Similar negative correlations between human population density and vegetation cover have been observed in cities such as Baltimore, MD; Tampa, FL; and Montreal, Canada, while a positive relationship between population density and residential vegetation cover was reported in Raleigh, NC. Consequently, Troy et al. (2007) suggest that human population density alone does not fully explain the spatial distribution of urban vegetation, particularly tree canopy, and that additional factors must be considered. Increasing research interest focuses on the mechanisms shaping the abundance and distribution of urban vegetation, examining not only population density but also social stratification—including spatial mobility, neighborhood turnover, access to power, and luxury effects—as well as lifestyle and social group behavior. Furthermore, the significance of time lags and historical landscape changes is increasingly recognized in understanding urban vegetation patterns.

3.3 Structure of West Jakarta City

Based on the map of the distribution of vegetation on non-agricultural land in West Jakarta in Figure 8, it can be seen that agricultural and non-agricultural land vegetation is spread throughout West Jakarta. It has been mentioned in the analysis conducted in the previous section, the location of vegetation is located side by side or around government centers and commercial centers. Based on this, the author argues that the results of the previous analysis can also be obtained from the spatial structure in West Jakarta City, namely the sectoral model developed by Homer Hoyt. Hoyt's sectoral model can be seen in Figure 8.

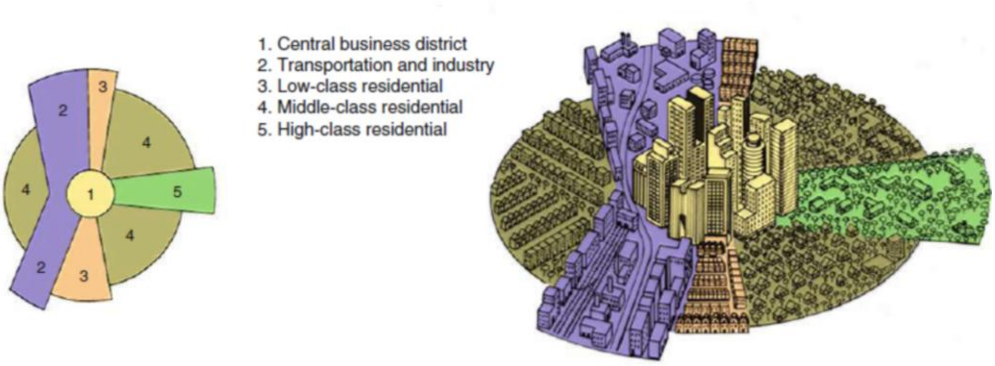

Fig 8. Sectoral model
(Rubenstein, 2020)

The sectoral model of urban structure theory, coined by Homer Hoyt in 1939, proposes that cities develop in sectoral rather than concentric circles. Different sectors within a city become more attractive for certain activities initially due to environmental factors or chance. As the city develops, activities spread outward within a sector, starting from the city center. When an upscale residential district is built, the most expensive new housing is built on the outer boundary of the district, away from the city center. As a result, the most desirable housing is located along a corridor that runs from the city center to the outer edge. Industrial and retail activities tend to appear in other sectors, often near transportation routes. The sectoral model can be seen as a refinement of the concentric zone model rather than a complete change from it. Hoyt examined different cities in the United States at different times, mapped the areas with the highest rents, and showed that the districts inhabited by the highest social classes generally remained within the same sector, although they increasingly shifted outward. The model relies on assumptions, such as wealthy individuals who have higher financial means choose the most desirable locations; wealthy residents, who can afford private vehicles or transportation costs, tend to live away from industrial areas but close to major highways; similar types of land uses tend to attract and concentrate in certain areas and discourage others (Beauregard, 2007).

4. Conclusions

Land use in West Jakarta City is divided into two main categories, namely agricultural land and built-up land. Agricultural land can still be found in this area, but the majority of non-agricultural land is dominated by alang-alang vegetation. The extensive presence of alang-alang indicates that much of the land is not being used optimally, which indicates that the land does not yet have a clear productive function. As a result, these lands could potentially be diverted or utilized for the development of cultivated areas, in line with the existing Regional Spatial Plan (RTRW). One alternative to utilizing such land is to convert it into green open space (RTH), which can provide benefits to the surrounding environment and improve air quality and urban comfort. The development of green open spaces can also improve the aesthetics of the city and provide recreational areas for the community. Therefore, it is important to plan and manage such abandoned non-agricultural land so that it can make a positive contribution to the development of the city.

The development structure of West Jakarta City tends to take the form of a sectoral model, where the city area develops separately in certain sectors. Each sector has distinctive characteristics and development that is more focused on certain types of land functions, be it housing, industry, or commercial areas. This sectoral model can be seen in how development in West Jakarta is divided according to the needs and potential of each sector. Although it has the advantage of directed development, this model also demands careful management to avoid overlapping land functions and uses. Therefore, a more integrated and balanced spatial planning and utilization is necessary for these areas to develop sustainably. On the other hand, the development of green open spaces in the context of this sector can also support a more environmentally friendly spatial concept. Thus, efficient land use management is essential to improve the quality of life in West Jakarta.

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