

RESEARCH ARTICLE

Impacts of Population Density for Landuse Assessment in Cengkareng, West Jakarta, Indonesia

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Abstract

Economic development in Jakarta has been influencing physical and social characteristics of urban area significantly. For recent years, burgeoning population growth occurs as a result of urban development and contributes to the landuse dynamics in a certain area. Cengkareng, is one of the most developed urban areas in Jakarta and has been experiencing such population and landuse dynamics. Its strategic location has turned this area become densely-populated. Increasing population density increase land demand, shapes the settlement pattern, and changes the landuse of the area. A study conducted in Cengkareng District has been done to describe how the population density impacts the landuse features for landuse assessment. The method implemented in this study combines quantitative and qualitative to process statistics and satellite imagery to produce data of population density, landuse change, and settlement pattern of the studied area. The study aims to determine the impact of increasing population density on determining the right landuse for urban areas. It can be use as the reference for the local government in designing regional spatial plans that are adjusted to the conditions of the population. The study resulted that Cengkareng has experienced such significant landuse change which is dominantly converted into settlement and offices due to rising of population density. Nucleated settlement pattern has taken more area regarding to increased land need over land supply. It becomes serious problem for Cengkareng such as slum settlements, flood problems, and land subsidence.

Keywords: Landuse Change; Population Density; Settlement Pattern

1. Introduction

Jakarta used to be Batavia, which was the capital of Dutch East Indies. Massive development has been started in the colonial era and has led to rapid economic growth until nowadays. It turns Batavia, which then become Jakarta, as the center of economic and business activities beyond its role as the capital of Indonesia. The economic growth of Jakarta accelerates its development, mostly in networks and infrastructures. Better networks have been stimulating better goods exchange and distribution as well as population mobility. The development has offered favorable condition as a living place with high quality of living standard and it can be seen by the increase of total population in Jakarta from year to year as shown on Table 1.

Table 1. Population of Jakarta 1970-2010

Year	Population	Increase Percentage
1971	4,576,009	-
1980	6,480,654	41,62
1990	8,227,746	26,95
2000	8,347,083	1,45
2010	9,607,787	15,10

The population increase encourages Jakarta to become one of the metropolitan cities in the world. Population increase is identified in demographic processes and its dynamics has been strongly influencing urban growth in Jakarta. Urban growth can not be separated from urbanization. Urbanization is a terminology to define population movement, from non-urban area to urban area

including socio-economic and physical feature change in the urban area (Mcgranahan and Satterthwaite, 2014). Urbanization has both positive and negative impacts. The positive impact is the acceleration of economic growth which leads to better prosperity for the people. Otherwise, the reverse impact is threat to urban sustainability since the city is growing physically and consuming land at a rate that exceeds population growth (Belete, 2017).

Massive urbanization in Jakarta has led to increase of land needs for buildings such as settlements, offices, and industries. Uncontrollable urbanization triggers landuse change. Most area in Jakarta has been transformed into settlements. Growing population is in harmony with increased settlements. It means there is rising population density as well as settlements density. Cengkareng is one of Jakarta's district to experience landuse change due to urbanization (Prasasti et al., 2015)

Cengkareng area extends 26.54 km² in the western part of Jakarta. Its area consists of six sub-districts and the location is strategic. Cengkareng has a close proximity to the International Airport of Soekarno-Hatta in Tangerang. Its proximity to the airport reveals high mobility from and to the Jakarta metropolitan area. It is also circled by Jakarta Outer Ring Road Toll (JORR) which connects the entire province and the surrounding region.

The presence of the airport and toll road correlate with positive population mobility. Its presence opens wider accessibility to get in and out of the province. The economic activities are also supported along with its people's mobility. It offers many opportunities for outsider to move

into the region, some of them settle along with locals and the rest becomes commuters. Thus, there is increasing number of inhabitants live in Cengkareng as shown on Figure 1.

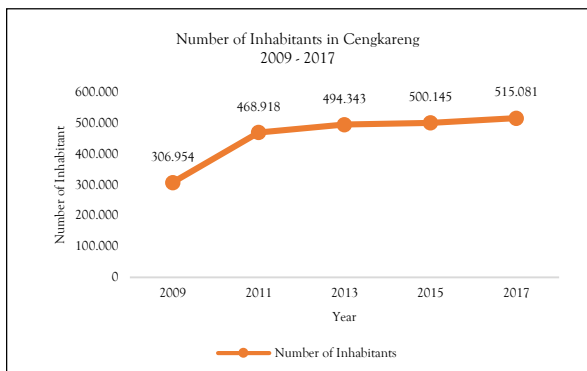


Fig 1. Inhabitants of Cengkareng. To prepare your paper, use directly this template and simply replace this text by your text.

Table 2. Population Growth of Cengkareng 2009-2017

Year	Population	Area (km ²)	Population Growth
2009	306,954		11,565.71
2011	468,918		17,668.35
2013	494,343	26.54	18,626.34
2015	500,145		18,844.95
2017	515,081		19,407.72
Average of population growth			17,222.61

Based on the Figure 1, the population rises from 2008 until 2018. The data indicates that there is population growth and it results to increase in population density. Admittedly, Cengkareng is predicted to have rising

population density and may experience more landuse change. By this means, a study is conducted to assess landuse change in Cengkareng based on population density and settlement pattern.

2. Materials and Methods

The research implements descriptive method in spatial context. This method integrates quantitative and qualitative analysis to describe the object of the study from a certain sample of a population. By this method, the collected data is used to explain the landuse change in the study area using population density variable through quantitative calculation and settlement pattern by qualitative analysis.

2.1 Location

The area studied in this research is Cengkareng district, West Jakarta. The area consists six sub-districts as shown on the Figure 2. Cengkareng district elevation is about 2 meters above mean sea level and this area is passed by three big rivers such as Cisadane River, Pesanggerahan River, and Kali Angke River which have been canalized but ironically the inundation still occurs in both rainy and dry season.

The reason of choosing Cengkareng as study area due to the rapid landuse change stimulated by urban growth. It is supported by the increasing number of population density due to high demand jobs in the industrial sector in Cengkareng. It makes the migrants who have obtained employment tend to settle that cause increase the population density. Population density increased from 11,471 inhabitants/km² in 2011 be 18,769 inhabitants/km² in 2015 that impact to the landuse change of settlement from 1825.84 Ha in 2011 be 2087.61 Ha in 2016 (Putri et al., 2019).

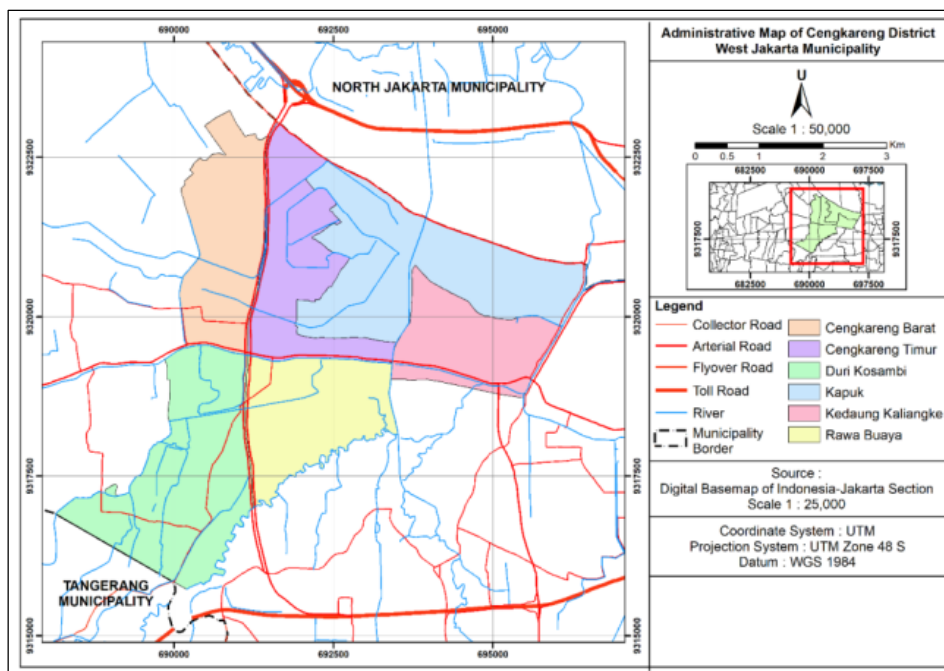


Fig 2. Administrative Map of Cengkareng District, West Jakarta Municipality

2.3 Research Design

The research design is classified into three main steps as shown on Figure 3. The first is determining population density from statistics of population. The second is gaining

the landuse change percentage from statistics of landuse. The third is determining the population pattern by interpreting satellite imagery. Later, the data are analyzed to describe the objective of the study.

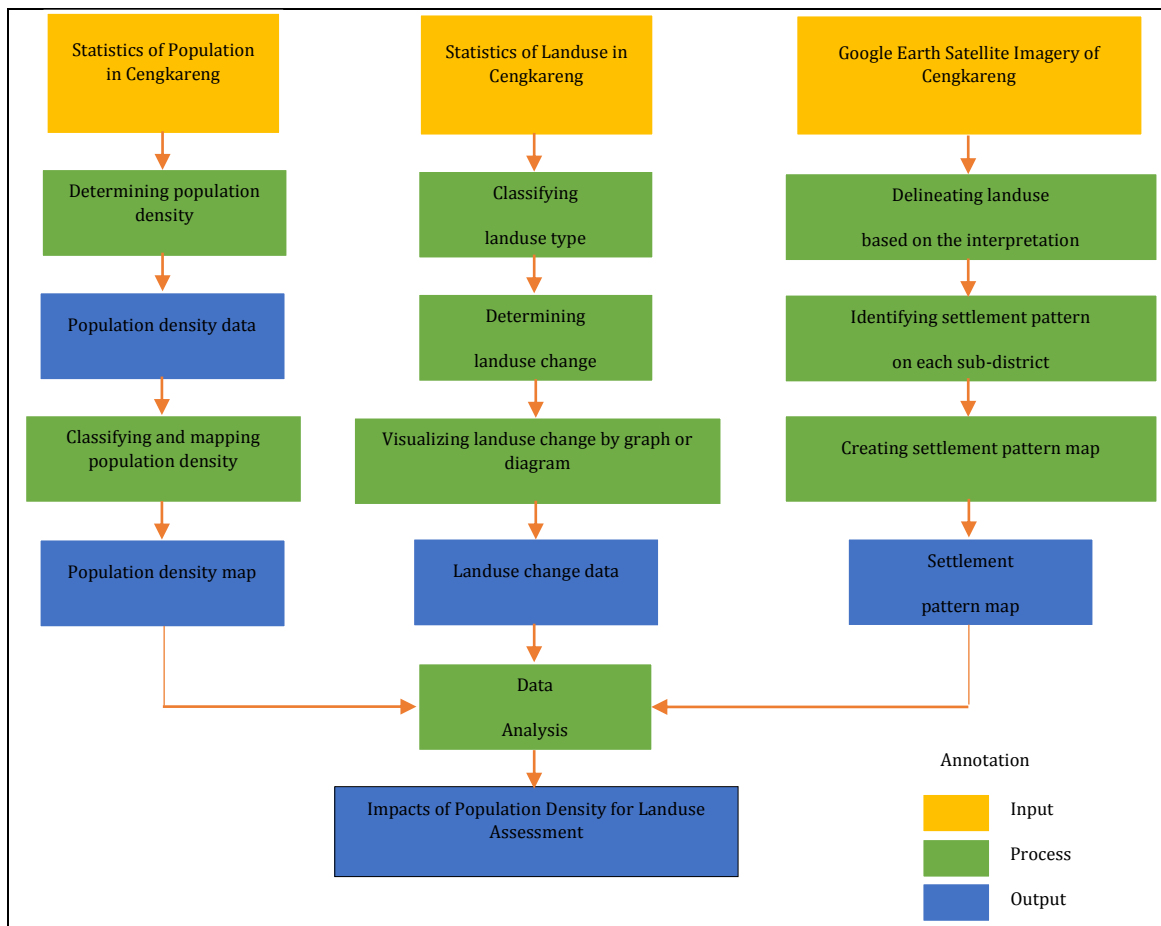


Fig 3. Research Flowchart

2.3.1 Population Density

Population density, refers to the objective of the study, is the arithmetic population density. It is the main parameter for landuse assessment. Arithmetic population density represents the total inhabitants who live in a certain place and time per unit of area. The data needed for population density calculation is total population and area in a certain place and time which were obtained from the data recorded by Indonesia Central Bureau of Statistics. The use of population density data adapts the research of (Li et al., 2015) which studies how population density related to landuse change in the western Jilin province. The arithmetic population density uses the following equation.

$$\text{Population} = \frac{\text{Total inhabitants}}{\text{Total area (agricultural + non - agricultural area)}}$$

The population density of each subdistrict in Cengkareng then classified to categorize the class of the population density and processed by GIS (Geographic Information System) Software to produce population density map.

2.3.2 Landuse Change

Landuse change is the variable impacted by the dynamics of population. Change in population density is analyzed from the landuse proportion from year to year. Landuse proportion data were taken from the statistics of landuse published by the Indonesia Central Bureau of Statistics. Landuse proportion of each subdistrict is visualized through graph for the analysis.

2.3.3 Settlement Pattern

Settlement pattern refers to the way of how house arrange each other which is primarily influenced by the variety of surrounding landscape, consists of physical landscape and cultural landscape. Settlement pattern is relatively dynamic, following any development in urban area. Settlement pattern can be classified into three different categories, forming nucleated pattern, dispersed pattern, and linear pattern. Nucleated settlement formed as a lot of houses agglomerate creating a big clustered and mainly found in lowland area. Dispersed settlement is a typical settlement where houses are spread out in different place, usually found in highland area. Meanwhile, linear settlement is a settlement which develops in line and is adjacent to road, river, or shoreline. The settlement pattern can be investigated from satellite imagery. The satellite imagery using Google Earth as it can depict settlement, including other landuses. The image was through digitation process to produce settlement pattern map.

The data resulted in this research are population density, landuse change in proportion, and settlement pattern. Population density and landuse change data are used to identify how far population density influences the configuration of landuse in Cengkareng while settlement pattern data is used to identify the settlement pattern in Cengkareng regarding to the existing landuse proportion. From this analysis, it can be described the population density impacts for landuse assessment in Cengkareng District.

3. Result and Discussion

Population dynamics can indicate urbanization. Mainly, urbanization occurs as a result of urban growth. In developing country like Indonesia, urbanization is a common phenomenon, characterized by high population increase in urban area. Refers to urban growth, impacts of population assessment towards the surrounding environment, is easily identified through its spatial distribution of the population beyond emphasizing the population absolute number. Spatial distribution of population can be described through population density. Thus, population density becomes the most important demographic parameters involved in analyzing the impacts of population towards landuse change.

Population and its surrounding environment are influencing each other. As population changes dynamically, environment would get the impact. Physical parameters such as landuse and landcover is well enough to represent the degree impacts of population dynamics. Moreover, physical parameters are relatively easy to measure rather than socio-cultural parameters (Arifin et al., 2018).

Cengkareng district has the most population among other districts in Jakarta (BPS 2018). With its small area, Cengkareng also gets predicate as a district with high population density in Jakarta. Admittedly, a high total population in Cengkareng is encouraged due to its strategic location which relatively close to the Soekarno-Hatta International Airport. Obviously, the presence of the airport itself stimulates the growth of industrial activities, trade, and business. The growth of Cengkareng can not be separated from the development in the Jakarta metropolitan area.

Jakarta plays role as a big metropolitan area. In general, metropolitan area is divided into CBD (Central Business District) zone and outskirts zone. The CBD is a specialized zone in urban area, plays role as the center of urban population activities in the field of economic, capital, business, and financial (Taubenbock et al., 2013). CBD becomes attractive due to its availability and accessibility to jobs, transportation points, as well as markets. Its role as central location has turned the land becomes expensive and is intensively used. The investment in CBD also contributes in increasing economic benefit following land value. The intensive use in CBD encourage increase in land consuming and transform most of the land into built-up area, like what it looks like in Jakarta recently. It also increases the population density in the center of metropolitan area. As population grows from time to time following metropolitan area development, the CBD becomes unfavorable for the residential area. Hawley theory of human ecology states that metropolitan population growth would have two consequences. First, the population density should decrease rapidly with distance from the CBD. Second, metropolitan population growth would increase population density in CBD since the shortage of available land. In shorts, there will be population deconcentration to the outskirts zone and changing in settlement pattern. This phenomenon can be identified clearly in Jakarta, especially in Cengkareng. Population dynamics have resulted impacts to the landuse change occurred in Cengkareng.

3.1 Population Density Impact on Landuse

3.1.1 Subdistrict of Duri Kosambi

Subdistrict of Duri Kosambi located in the southern part of Cengkareng District, occupies an area of 5.91 km². According to its population density in 2009 to 2017, Duri Kosambi is known to have experienced significant increase of population density for the past few years as shown in Figure 4.

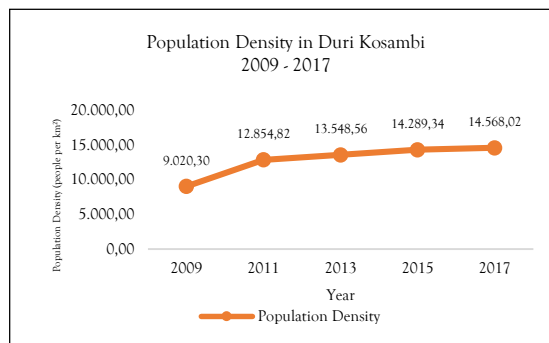


Fig 4. Population Density in Duri Kosambi 2009-2017

Population density grows from 9,020.30 inhabitants/km² in 2009 to 14,568.02 inhabitants/km² in 2017. The highest increased of population density occurred in 2009 to 2011 which is believed to be stimulated by high incoming migration. Yet the population density of Duri Kosambi is relatively low, compared to other subdistricts of Cengkareng.

Table 2 shows landuse of Duri Kosambi. Landuse area can be converted into percentage unit to describe the proportion of the landuse. Based on Figure 5 that shows the landuse proportion of Duri Kosambi, 56 per cent of the area is used for settlement, 21 per cent is allocated for industrial area, 18 per cent for office building, the rest is for open space and other landuses. Landuse proportion may represent the population dynamics as population correlate with land demand. When land demand rises over the population growth, it will give impact to the existing landuse. Landuse may be transformed to another landuse or collide with the existing landuse as what has occurred in Duri Kosambi subdistrict.

Table 3. Landuse of Duri Kosambi.

Type	Area (km ²)
Settlement	3.29
Industri	1.24
Office	1.06
Open Space	0.10
Other	0.22

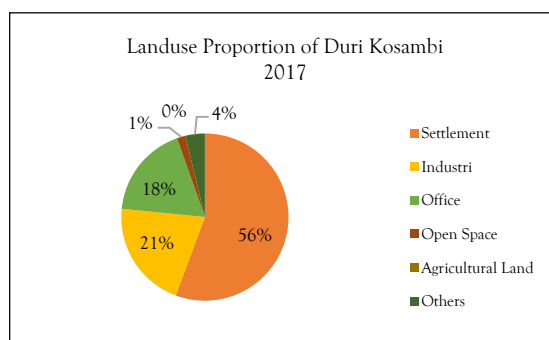


Fig 5. Landuse Proportion of Duri Kosambi 2017

According to BPS (2017), Duri Kosambi has the largest industrial area among other subdistricts in Cengkareng.

Along with increase of births, the presence of industrial area has resulted to increase of productive workers from incoming migration to Jakarta (Putri et al., 2019) and emerged population density in the area. Rising in population density create problems in the landuse. The land needed for residential area is the major problem regarding to population growth. Land consumption for residential area that exceeds the available land has brought impact to decline in open space and it becomes obstacle to improve the environment quality and the sustainability of community in Duri Kosambi. Low-waged workers tend to settle adjacent to industrial area to prevent additional transportation cost. Ironically, most settlement built by these workers is categorized as slum settlement. Slum settlement promotes negative impacts such as pollution and social problems. River pollution is undergoing following the development of slum settlement as the community has been dispose their wastes in unproper way. Less open spaces impact to unavailable temporary disposal site in Duri Kosambi which has led the bad behavior of the community to spread their waste to the river, road, and subsequently hampers flood management and the surrounding community will experience flood more often (Aditianata, 2015).

3.1.2 Subdistrict of Rawa Buaya

Rawa Buaya Subdistrict has an area 4.07 km² and its area is adjacent to Kali Angke River. This subdistrict for the recent years has experienced population growth identified from its population density as shown on the Figure 6. Based on Figure 6, Rawa Buaya is known to have highly increased population density in 2009 to 2011, which interspersed with some fluctuation from 2011 to 2017. Population density have increased from 7,460.80 inhabitants/km² in 2009 to 16,562.05 inhabitants/km² in 2011 while the fluctuations occurred in 2011 to 2017 with a range of change about 300 to 500 inhabitants/km². In 2017, the population density reached 17,383.14 inhabitants/km².

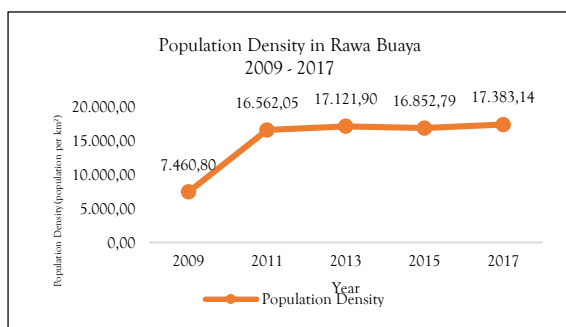


Fig 6. Population Density in Rawa Buaya 2009-2017

Table 3. Landuse of Rawa Buaya.

Type	Area (km ²)
Settlement	2.48
Industri	0.60
Office	0.92
Open Space	0.02
Other	0.05

The increasing population density in Rawa Buaya has influenced the land arrangement. The landuse type in Rawa Buaya shown on Table 3 which represents the landuse in unit of are. the data is also processed into unit of percentage to know the proportion of the landuse as shown on Figure 7. In general, landuse in Rawa Buaya is

dominated by settlement which occupies roughly two-third of the area, 15 per cent is covered by industrial area covering, office building uses 23 per cent of the area, and less than 3 per cent is used for open space the other landuses. Apparently, landuse of Rawa Buaya does not change significantly from 2009 to 2017. In the past few years, the population density did not change significantly too which indicates slower development of settlement in this area probably because of less available land for housing.

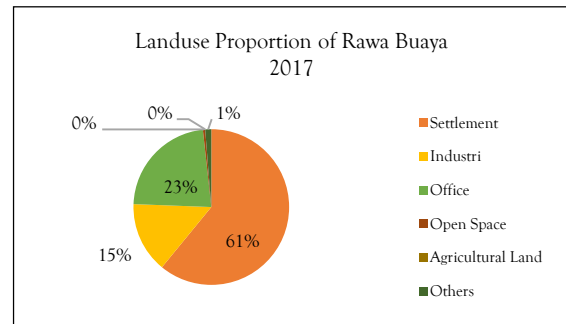


Fig 7. Landuse Proportion of Rawa Buaya 2017

Lack of available land for settlement has encouraged most of the low-waged workers from incoming migration to develop irregular settlement. Eventually, the irregular settlement transforms into slum settlement. Most of the settlement is adjacent to industrial area and on the riverbank, especially in the Kali Angke River. The mushrooming of slum settlement in the Kali Angke riverbank comes as a consequence of the local government's failure to provide decent housing for low-waged immigrants in the area of Rawa Buaya (Asvada, 2013).

The slum settlement is directly influencing the physical process of the river. The community in slum area disposes their waste to the river. The wastes worsen the water quality and the discharge of the river. Later, it can cause more destructive flood and inundate the surrounding community. Moreover, the existing slum area has been being obstacle for the local government in river normalization. It has shown that there is still conflict between the landuse for protection function and utilization function. The decreasing open spaces may occur due to the development of slum settlements. It can also be obstacle for the flood management. Besides, open spaces can be designed and developed for artificial water retarding zone that may help to reduce the inundation.

3.1.3 Subdistrict of Kedaung Kaliangke

Kedaung Kaliangke subdistrict location is between two notoriously big river canals named Kali Kapuk and Kali Angke and has area of 2.81 km², makes it as the smallest subdistrict by area in Cengkareng districts. Population dynamics which is represented by change in population density, has been influencing the landuse arrangement in this subdistrict. The population density in Kedaung Kaliangke has increased for the past few years as displayed on the Figure 8. In 2009, the population density is on 9,531.19 inhabitants/km² and dramatically change into 13,168.30 inhabitants/km² in 2017. The increase of population density is inseparable from regional economic development which constantly attracts new immigrants who seek for better livelihood. But in fact, the population density results some problems towards landuse arrangement.

Table 4 describe the existing landuse in Kedaung Kaliangke. As shown on the table, it can be extracted the area of each landuse which can be derived into percentage unit as shown on figure 9. In 2017, the landuse in this subdistrict is dominated by three type of landuse. The first is settlement which approximately cover 64 per cent of the area, followed by office which occupies 21 per cent of the land, and industrial area for roughly 15 per cent. The open space is less than 1 per cent, which is quiet nonproportional compared to other subdistricts. From the landuse proportion, it can be described the landuse development in Kedaung Kaliangke.

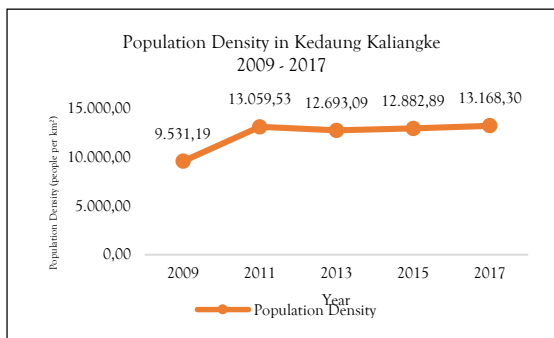


Fig 8. Population Density in Kedaung Kaliangke 2009-2017

Table 4. Landuse of Kedaung Kaliangke.

Type	Area (km ²)
Settlement	2.48
Industri	0.60
Office	0.92
Open Space	0.02
Other	0.05

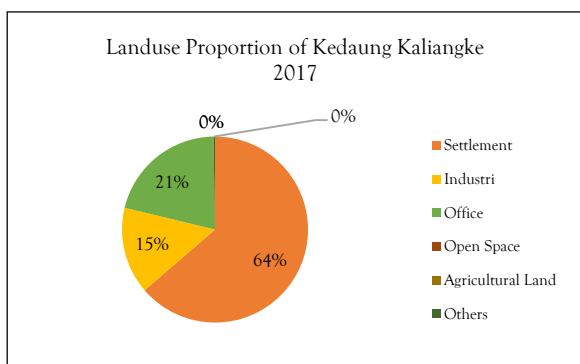


Fig 9. Landuse Proportion of Kedaung Kaliangke 2017

Population growth has shaped the development of landuse in Kedaung Kaliangke in the same pattern like the other subdistricts. The landuse is dominantly covered by settlement, office, and industrial area which depicts the relationship between population growth and land resources. Settlement covers the most area as a result of the population increase encouraged by increasing birth and incoming migration. Increase in incoming migration to the area has been caused by attraction of industry development which absorbs many workers. The presence of well-developed industries is due to the strategic location, close to international airport and the CBD of Jakarta. By this means, population increase has been creating high demand on land need while Jakarta's available space for settlement is declining. Instantly, there is some irregular settlement settled close to industrial sector or riverbank and develops to slum settlement. This

slum community discharges their wastes directly to the river and disrupt the natural processes in the river. Moreover, they contribute to the increase of pollution which eventually reduce the water quality. The presence of slum settlement also creates another problem for the local government policy in flood management since the settlement disrupts the flood fringe of the river.

3.1.4 Subdistrict of Kapuk

Kapuk subdistrict area is the second biggest in Cengkareng. Its area extends about 5.63 km² and is directly adjacent to Penjarangan district of North Jakarta municipality. Kapuk subdistrict known as the most densely populated subdistrict in Cengkareng (Saraswati 2000). Recently, statistics shows the same condition as shown on Figure 10. Based on Figure 13, it can be identified that there is increase in population density from 2009 to 2017. In 2009, the population density is 16,367.92 inhabitants/km² and reaches 27,369.55 inhabitants/km² in 2017. Population density in Kapuk is the greatest compared to other subdistricts in Cengkareng. The population density increases dramatically which indicated high population growth. The increasing population in Kapuk can be analyzed from the population dynamics and has brought impacts to the surrounding environment.

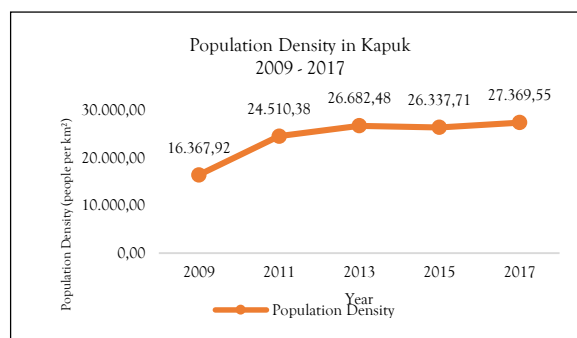


Fig 10. Population Density in Kapuk 2009-2017

Increasing population in Kapuk is influenced by the development of its area as a strategic industrial center in the western Jakarta. The presence of many factories near the airport has resulted in increasing demand of job. Wider job opportunities attract many newcomers from the surrounding city or nearby province to leave their hometown and come to this area, work, and settle their house. Mostly, the newcomers settle and build their house near the industry locations. As a consequence, there is rising in population as well as population density. Population growth in Kapuk has contributed to increase in land need for housing, public facility, and infrastructures hence subsequently results in landuse change.

Table 5 shows landuse of Kapuk subdistrict. Landuse area can be derived into percentage unit to describe the proportion of the landuse (Figure 11). In 2017, the landuse is more dominated by settlement roughly 72 per cent of its area, industrial sector about 13 per cent, and office for 14 per cent. The landuse with small proportion are open space, agricultural land, and other landuse which only reach 1 per cent. Mainly, the domination of settlement is caused by the development of industry. Since the location is strategic, high capitals were invested here and the industrial sector has been well-developed. Ironically, most of the settlement is located in slum area

and forms slum settlements, turning Kapuk subdistrict as the subdistrict in Cengkareng with high presence of slum-categorized settlements (Fitria et al., 2014). The development of settlement in Kapuk has been disturbing the available land for conservation function. As stated in the Local Government Regulation Number 1 Year 2014, Kapuk subdistrict area is one of subdistricts designed for the development of flood management infrastructure such as polders and canals. The function can not run well while the slum settlements and industries create pollution as well as reduces the environment quality. Moreover, little open spaces in Kapuk subdistrict, especially green open spaces, can not support the environmental sustainability since it does not meet the minimum area.

Table 5. Landuse of Kapuk.

Type	Area (km ²)
Settlement	4.06
Industri	0.72
Office	0.78
Open Space	0.02
Other	0.05

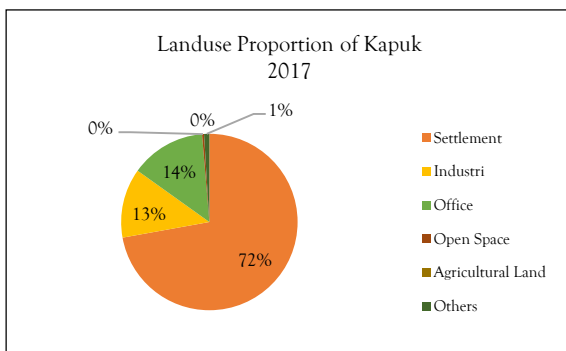


Fig 11. Landuse Proportion of Kapuk 2017

3.1.5 Subdistrict of Cengkareng Timur

Geographically, Cengkareng Timur subdistrict is adjacent to the Jakarta Outer Ring Road Toll (JORR) in the west and its area extends approximately 4.52 km². Cengkareng Timur also has experience population growth like other subdistricts in Cengkareng. It is in Figure 12 that shows rising in population density of Cengkareng Timur from 2009 until 2017. Cengkareng Timur is the third most densely populated subdistricts in Cengkareng after Kapuk and Cengkareng Barat. In 2009, the population density is 11,793.36 inhabitants/km² and continuously increase until reaching 20,064.89 inhabitants/km² in 2017.

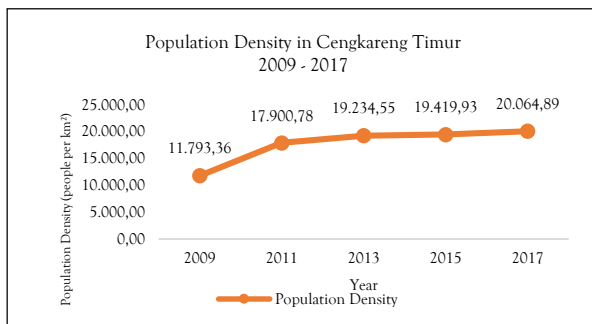


Fig 12. Population Density in Cengkareng Timur 2009-2017

Population density increase in Cengkareng Timur is more influenced by the incoming mobility to the area. Incoming mobility is encouraged as the presence of well-connected accessibility and road infrastructure. Mostly, the newcomers come to look for job and expect for better prosperity. Cengkareng Timur is neighboring with Kapuk and Duri Kosambi subdistrict which have the most industrial units among other subdistricts in Cengkareng. It makes Cengkareng Timur so strategic for residential area. Thus, there is increasing population density as the settlement develops.

High demand of land for residential area has brought to high pressure towards existing landuse (Table 6). Landuse proportion of Cengkareng Timur has represented the landuse pressure as shown on Figure 13. In 2017, Cengkareng Timur's land use is used for residential area roughly 78 per cent, followed by industrial area with proportion as much as 11 per cent and office for about 6 per cent. Small proportion is used for open spaces, agricultural land, and other landuses with only 5 per cent of total area. The current development of settlement occurs in different type of housing. First type is slum settlements which represents housing community with low quality of cleanliness, health, and sanitation as well as the environment.

Table 6. Landuse of Cengkareng Timur.

Type	Area (km ²)
Settlement	3.55
Industri	0.49
Office	0.27
Open Space	0.17
Other	0.03

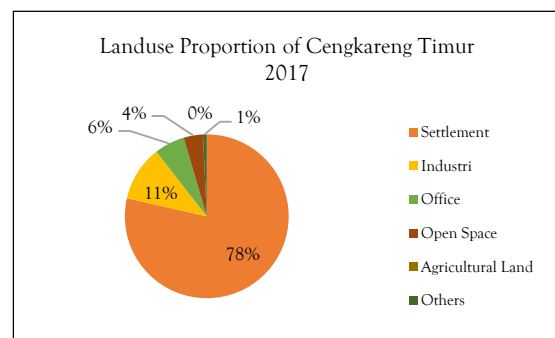


Fig 13. Landuse Proportion of Cengkareng Timur 2017

It is resulted as not all workers can afford for better housing hence they create slum settlements which is mainly adjacent to industrial area or riverside. Second type is the development of real estate, apartment, and such kind which is less-dominated by low-waged workers but high-class businessman. The last type is typical low-cost rent housing, commonly named as Rusunawa (Rumah Susun Sederhana Sewa) and owned-simple flat housing or also known as Rusunami (Rumah Susun Sederhana Milik). The second and third type housing is literally vertical housing which aims to accommodate more inhabitants and potentially increase population density. Moreover, the development of Rusunawa and Rusunami can help to prevent any illegal land expansion for settlement by slum community and reduce any conflict with other landuses. The land consumption for housing is believed to have reduced the green open spaces in Cengkareng Timur. Cengkareng Timur should have minimum open spaces 1.56 km² but in fact the existing

open spaces is only 0.8 km²(Susilawati et al., 2018). Declined open spaces worsen flood management and hamper flood problem solving that occurred in Cengkareng Timur. Nevertheless, the existing open spaces is relatively wider compared to most of subdistricts.

3.1.6 Subdistrict of Cengkareng Barat

Cengkareng Barat, which has area about 3.61 km², is located closer to the Soekarno-Hatta International Airport and potentially encouraging population growth. The population density of Cengkareng Barat subdistrict shows the same trend like the other subdistricts in Cengkareng as shown on Figure 14. In 2009, the population density of Cengkareng Barat is at 13,620.73 inhabitants/km² and increases significantly for upcoming years. In 2017, the population density becomes 20,685.54 inhabitants/km² and makes Cengkareng Barat as the second most densely-populated subdistrict in Cengkareng.

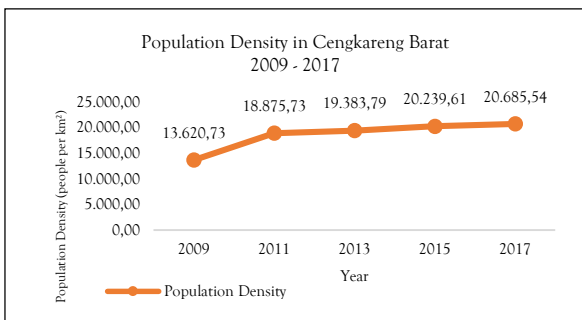


Fig 14. Population Density in Cengkareng Barat 2009-2017

The population density rises following economic development and have contributed in attracting many outsiders to come to the area. These outsiders create community and mostly decide to dwell in the area. Obviously, it stimulates population density growth which is in harmony with increase in land need for housing, commercial building, and industrial area.

The landuse type in Cengkareng Barat shown on Table 7 which represents the landuse in unit of area. Landuse area can be transformed into percentage unit to describe the proportion of the landuse. The existing landuse of Cengkareng Barat can be viewed on Figure 15. In 2017, the land is most occupied by residential area as much as 81 per cent of its area. The presence of numerous housing unit can be found in this subdistrict. Smaller area and more population than Cengkareng Timur, Cengkareng Barat is depicted as a densely-populated subdistrict in Cengkareng.

The more inhabitants in the area is dominated by newcomers who come from outside of Jakarta. The more population in Cengkareng Barat has created landuse pressure also and caused any land conversion into settlements. It has depicted that the landuse arrangement in Cengkareng, especially Cengkareng Barat is relatively bad. Furthermore, the incoming migrants may potentially develop slum settlements which can reduce environmental quality, even worsen. The another landuse which is dominant in this area is office, about 11 per cent of Cengkareng Barat area. The industrial area in this subdistrict is lesser than the office. It indicates and builds understanding that Cengkareng Barat is specialized for residential zone rather than industrial zone. The open space proportion in the area is extremely small compared to Duri Kosambi and Cengkareng Timur subdistrict. The

minimum open space may result problem in local climate, air circulation, and flood management as this area is designed for reduction of inundation.

Table 7. Landuse of Cengkareng Barat.

Type	Area (km ²)
Settlement	2.91
Industri	0.09
Office	0.40
Open Space	0.04
Other	0.17

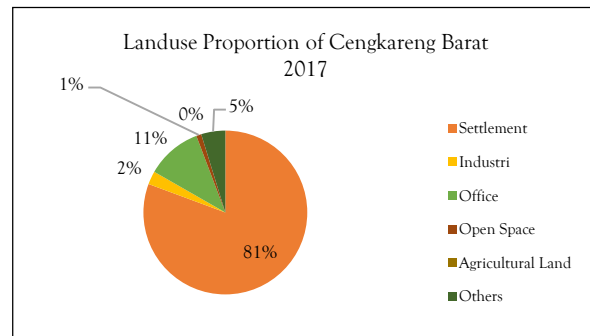


Fig 15. Landuse Proportion of Cengkareng Barat 2017

3.2 General Analysis

Population density in Cengkareng District is high-categorized in the West Jakarta Municipality, even in Jakarta Province. Increase population density has been occurring for several years as a result of urban development. It is believed that population density increase is the main factor that drives any land use change in Cengkareng. Land use in Cengkareng District develops dynamically year by year and it indicates any land use change. Most land use change occurs on settlement, office building, open space, and other land uses. Figure 16 shows trend of land use change by proportion in Cengkareng District from 2008 to 2014. Residential area seems to have increased significantly from 64.72 per cent in 2009 into 68.60 per cent in 2014. Increase in residential area land use is followed by decline in other landuses from 5.01 per cent in 2008 into 1.96 per cent in 2014. Both office and open space has also decline with proportion less than 0.5 per cent.

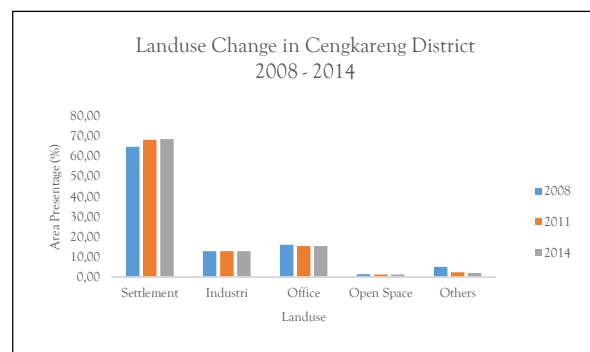


Fig 16. Landuse Change in Cengkareng District 2008-2014

Increasing landuse proportion for residential area in the past few years is encouraged by highly increasing land demand following increase of incoming migrants in Cengkareng District. Rapid incoming migration has been caused by increase of worker demand since the growth of industrial area is significant. Industrial area has occupied about 12.82 per cent of Cengkareng area. Land demand for residential area has resulted in changing other

landuses such as agricultural land open space which would be converted into horizontal or vertical housing.

Growth of settlement or residential area has been stimulating the mushrooming of city village in urban area, which is unintendedly developed, creating city village community (Darmawan, 2018). Open space which is supposed to be utilized as place for the interaction and socialization of urban community has been an important need regarding to increase of population density. However, limited available space as well as increasing demand for housing has sacrificed most of open space and agricultural area to be developed as residential area. Moreover, increasing population density means more population exist and may extract groundwater excessively, accelerating land subsidence due to decline in groundwater table. Worse land subsidence has put Cengkareng to experience serious flood, coastal flood, or inundation, severe damage for buildings and infrastructures, seawater intrusion, and destructing of local aquifers. The land subsidence evidence can be found in Cengkareng in form of subsidence bowl with subsidence rate up to 260 mm/year (Ng et al., 2012). Another problem resulted from population density

increase is the development of slum settlement that disrupts the flood management conducted by the local government.

Population density in Cengkareng can be categorized statistically into three class which compares population density of a certain subdistrict among others, as shown on Figure 17. Subdistrict of Duri Kosambi, Rawa Buaya, and Kedaung Kaliangke are categorized as low densely-populated subdistrict with population density less than 17,902.05 inhabitants/km². Subdistrict of Cengkareng Barat and Cengkareng Timur have moderate population density between 17,902.05 and 22,636.80 inhabitants/km². Meanwhile, Kapuk subdistrict has the highest population density, more than 22,636.80 inhabitants/km². But, another classification of population density done by the Census of India has classified population density into five categories. Based on Census of India (2011) compiled in (Kuchay, Nissar A; Bhat, Sultan; Shafi, 2016), population density which exceed 10,000 inhabitants/km² is categorized high. It means, according to the general classification, population density in Cengkareng is high.

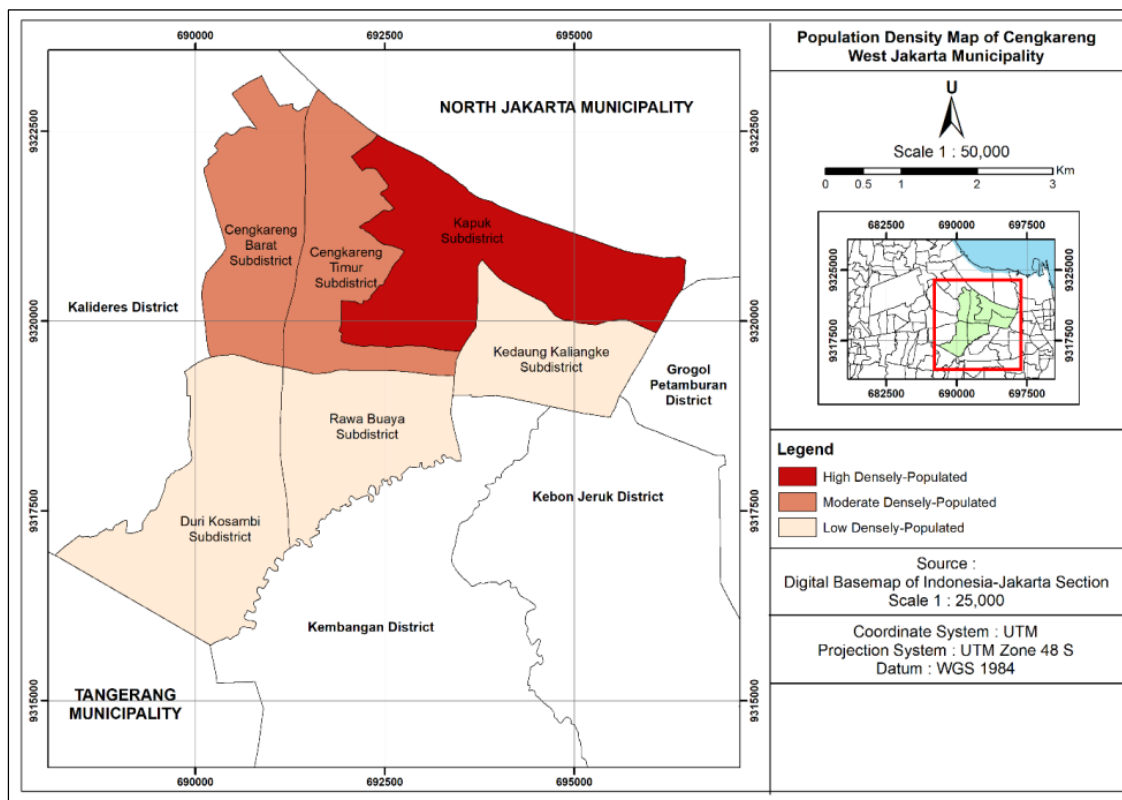


Fig 17. Population Density Map of Cengkareng District, West Jakarta Municipality 2017

Burgeoning population density has resulted not only in increase of land demand for settlement, but also shaped the pattern of urban settlement as displayed in Figure 18. Settlement area in Cengkareng has nucleated pattern. It is due to its flat topography and availability of resources such as water, proximity to industrial area for job, and accessible road network. Dense population has been influencing the settlement configuration or pattern. The more nucleated pattern, means the more compact settlement, which consists of both horizontal and vertical housing hence results in

higher population density (Table 8). In addition, nucleated pattern of settlement in Cengkareng also consists of irregular settlement. The irregular shape settlement is found mainly in flat ground area due to difference between man-maderoad system and the nature lines, such as river lines (Beny O.Y. and Khalimah, 2016). Irregular settlement, along with nucleated settlement, would take greater land area rather than other landuses hence this settlement pattern may accelerate declining open space or agricultural land.

Table 9. Measurement of velocity in every stations.

Subdistrict	Population Density (inhabitants per km ²)	Settlement Pattern
Duri Kosambi	14,568.02	Nucleated
Rawa Buaya	17,383.14	Nucleated
Kedaung Kaliangke	13,168.30	Nucleated
Kapuk	27,369.55	Nucleated
Cengkareng Timur	20,064.89	Nucleated
Cengkareng Barat	20,685.54	Nucleated

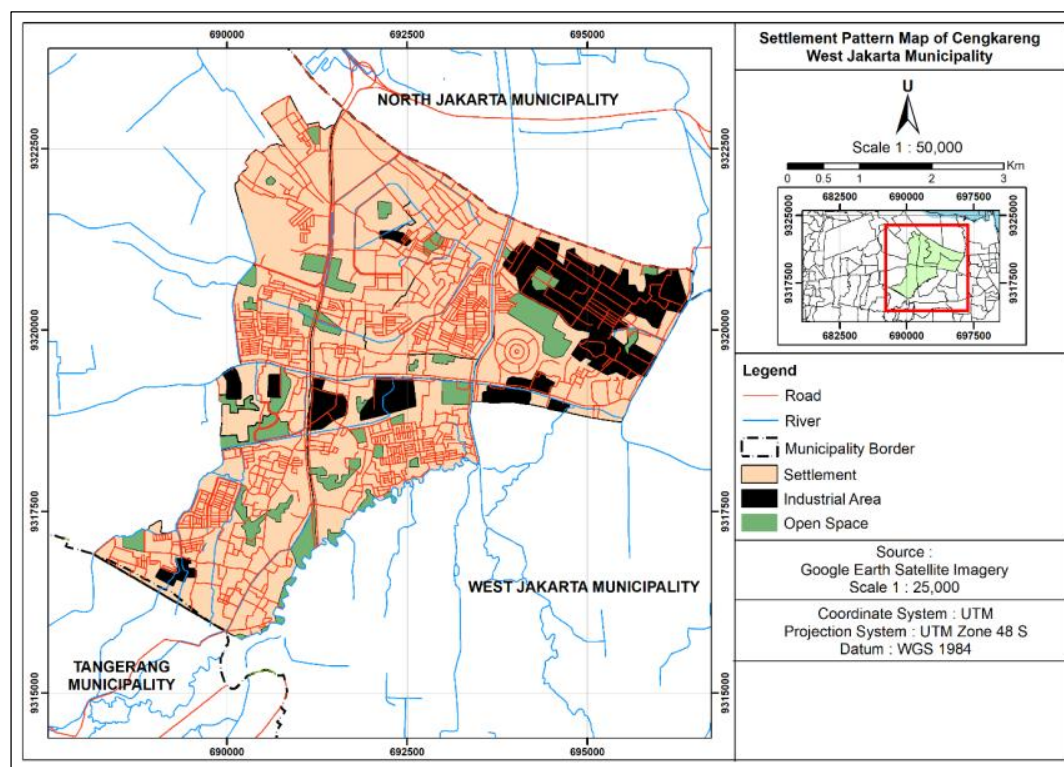


Fig 18. Settlement Pattern Map of Cengkareng District, West Jakarta Municipality

4. Conclusion

Cengkareng District experiences progressive development from year to year. Based on the data recorded by the Indonesia Central Bureau of Statistics, it can be identified significant population growth from 2009 to 2017 which results in increase of population density in every subdistrict. The population density increased drastically in year 2009 until 2011 and significantly in 2011 to 2017. Increasing population density occurs with the same trend in Duri Kosambi, Rawa Buaya, Kedaung Kaliangke, Kapuk, Cengkareng Timur, and Cengkareng Barat as a consequence of increasing births and incoming migration in Cengkareng District.

Dynamics of population density has shaped the landuse arrangement in Cengkareng. Landuse change occurs in most land utilization type such as settlement, office building, open space, and other landuses. Settlement dominates the landuse in all subdistrict with proportion more than 50 percent, followed by industrial area, and office building. The development of industrial area indicates high workers demand and stimulates development of irregular settlement nearby or adjacent to river such as the settlement in Kali Angke riverbank. It causes the mushrooming of slum community in the riverbank and disturbs the sustainability of the river. It becomes serious

problem since its land has low topography and is passed by many big rivers.

In short, regarding the population and landuse trend, the assessment of landuse shows that Cengkareng District is best suited for settlement area thus the government can focus the development of the district for settlement area. Some subdistricts such as Duri Kosambi, Rawa Buaya, Kedaung Kaliangke, and Kapuk are dominated by industrial area and offices land utilization type. Thus, the government consider those subdistricts for economic and business area.

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