The characteristic of urban sprawl in Bekasi City, Indonesia

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Abstract. This study aims to identify areas and sprawl characteristics in Bekasi City. The City of Bekasi is a Jakarta’s buffer zone that experiences urban sprawl phenomena. The symptoms of urban sprawl in Bekasi City lead to the conversion process and resulted the densification of settlements in sub-urban areas. To control the land use caused by sprawl phenomena, it is necessary to identify the area and sprawl characteristics. This study used two approaches 1) to measure the urban sprawl index, 2) to analyze the sprawl’s characteristics in each village were identified as sprawl. The urban sprawl index is determined by the difference between the household ratio and built-up area ratio. Furthermore, the analysis of sprawl’s characteristic is using spatial analysis method. The variables in analyzing sprawl characteristics consists population density and building density. The results of this study indicate that 1) 29 village or 51.79% village in Bekasi City identified as sprawl, and 2) From 29 villages, 10 villages indicate as low population density, and 9 villages indicate as low building densities.

1. Introduction
The urban sprawl phenomenon occurs in all the metropolitan cities around the world [1]. This phenomenon also occurs in Jabodetabek area. Generally, the phenomenon of urban sprawl in Jabodetabek area is caused by the economic activities of DKI Jakarta. The urban sprawl phenomenon can be seen by the uncontrolled development of residential areas in sub-urban areas. Bekasi City is one of Jakarta’s buffer zone. This situation has caused Bekasi City to receive various activities, both the economic activities and residential developments. Every year, the additional area of built-up areas in Bekasi City is an averages 9.03% or 234.64 Ha, with the largest expansion occurring in residential areas of 125.67 Ha [2].

In the early days of its development, Bekasi City grew unplanned and its population spread in a sprawl pattern [3]. Urban sprawl symptoms in Bekasi City resulted in the process of conversion of an agricultural land conversion into non-agricultural land that causes settlement densification (compaction) in suburban areas [4]. To manage the uncontrolled land use, it is necessary to first identify the characteristics of the areas that experience sprawl. Based on this, this study aims to analyze the characteristics of sprawl in areas were identified as sprawl in Bekasi City.

Urban sprawl as a phenomenon began to develop in the second half of the 20th century, along with the rapid increase in population. The rapid increase in population led to the city development pattern towards the sub urban areas and finally conversing agricultural and forest lands. Urban sprawl phenomenon occurs in various forms that are closely related to geographical, economic and institutional contexts [5].
Urban sprawl can be defined in many different ways. The European Environment Agency describes urban sprawl as a low density physical expansion from large urban areas to the surrounding agricultural areas [5]. In addition, Bruegmann defines urban sprawl as an unplanned, dispersed, low-density urban development, affected by numbers of suburban cars, without land use planning [5]. Other experts argue that urban sprawl is an uncontrolled and unplanned city growth [6].

Most researchers argue that the main causes of sprawl are urban population growth, government policies, highway system development, widespread use of cars, economic prosperity, and the democratization of society [7]. In addition, Siedentop cites that the demand for urban land and urban planning are the two main causes of sprawl. Other researchers, namely Gordon and Richardson argue that natural economic factor is the cause sprawl [7].

On several cities in India, a number of studies have found that rapid urbanization and migration are the most significant causes of urban sprawl [7]. Other researchers stated that underdevelopment and lack of employment opportunities in rural areas and small towns are the biggest causes of migration to urban areas which cause urban sprawl in the Gautama Buddha Nagar district of India [8]. Other important causes of migration to the district are the availability of employment or income opportunities, proximity to Delhi, and a relatively lower rental values in the region [8]. Apart from the above, basically urban sprawl occurs due to a rapid increase in population, both natural growth and migration. The driving factor for the urbanization is the hope for a better future [9]. On the other hand, the existence of a lower rent, easy access to urban areas, attracts these migrants to occupy these areas randomly. Apart from the above, measuring urban sprawl is the right way to develop policies [10]. Sprawl needs to be surveyed and recognized to improve the quality of policy development.

2. Research methodology
This study utilizes two approaches, (1) calculating the sprawl index to identify the sprawl region, and (2) analyzing the characteristics of the sprawl in the areas identified as sprawl. The analysis unit is limited on village level. Sprawl index calculation is done by the difference between the household’s ratio and built-up ratio [11]. If the difference between the household’s ratio and built-up ratio shows a value of < 0, then the area is identified as "Sprawl" [11]. On the other hand, if the difference between the household’s ratio and built-up ratio shows a value of > 0, then the area is identified as "Compact" [11].

In this study, the analysis of sprawl characteristics uses 2 sprawl characteristic variables. These variable are population density, and building density. The two variables are classified into 3 ranges of low, medium, and high. The classification is done by range method.

\[ \text{Class range} = \frac{(\text{Highest Value} - \text{Lowest Value})}{3} \]  \hspace{1cm} (1)

Furthermore, the analysis of the characteristics of the sprawl is done by overlaying the urban sprawl area with population and building density. The data utilized in this research is as Table 1.

| Variables       | Indicators         | Type of Data |
|-----------------|--------------------|--------------|
| Sprawl Index    | Household Ratio    | Secondary    |
| Population Density | Total Population | Secondary    |
| Building Density | Building Unit      | Secondary    |
|                 | Built-up Areas     | Secondary    |

| Table 1. Data requirements. |
3. Results and discussion

3.1. Sprawl area identification

The identification of sprawl areas in Bekasi City is conducted by utilizing the household ratio formula, reduced by the built-up ratio. Based on the results, it was identified that out of 56 villages in Bekasi City, 29 villages or 51.79% of them identified as sprawl, 3 villages identified as normal, and 24 villages were identified as compact. Henceforth, the 29 villages identified as sprawl will be the focus of this research for further analysis. According to Bhatta, this approach is highly useful for conducting sprawl analysis between cities or between zones in a built area, but it still unable to show the absolute of sprawl size [11].

Villages identified as sprawl in Bekasi City include Jatikarya, Jatirangga, Jatiraden in Jatisampurna Subdistrict. Jatiluhur, Jatisih and Jatimekar sub-districts in Jatiasih District; Jatimurni and Jatimelati Sub-Districts in Pondok Melati District; Jatiwaringin, Jatibening, and Jaticempaka villages in Pondok Gede District. Other kelurahan include Bintarajaya, Bintara, and Jakasampurna Kelurahan in the District of West Bekasi; Medan Satria Village in Medansatria District; Harapan Jaya Village, Kaliabang Tengah, and Marga Mulya in North Bekasi District; Pekayon Jaya and Marga Jaya sub-districts in South Bekasi District; Margahayu Village, Bekasi Jaya, Duren Jaya and Aren Jaya in East Bekasi District. Meanwhile, the rest are Bojong Rawalumbu Village in Rawalumbu District; Pedurenan Village, and Cimuning in Mustika Jaya District; Cikiwul and Bantargebang sub-districts in Bantargebang District. The location of villages identified as sprawl can be seen on Figure 1.

3.2. Sprawl characteristics

3.2.1. Population density. The calculation of population density is conducted by dividing the total population and built-up area. Population density is one of several approaches to assess sprawl characteristics in each village. The lower the value of population density in an area identified as sprawl, indicates that the higher the value of sprawl of this area.

The results of population density show that the highest population density is located in Kaliabang Tengah Village in North Bekasi District with a density level of 363,421 People/Ha, while the lowest population density is located in Jatirangga Village in Jatisampurna District with a density level of 61,021 People/Ha. Based on the two population density values, the following population density classification is obtained: low population density with a range of classes of 61,021-161,821; moderate population density with class range of 161,821-262,621, and high population density with class range of 262,621-363,421.

Based on the overlays results between sprawl areas and population density, 10 villages are identified as sprawl with low population density, 13 villages are identified as sprawl with moderate population density, and 6 villages are identified as sprawl with high population density. Villages identified as low density sprawl include Jatikarya, Jatirangga, Jatiluhur, Jatisih, Jatimekar, Jatimurni, Jatimelati, Medan Satria, Cikiwul, and Bantargebang. Villages identified as sprawl with moderate population density include Jatiraden, Jatiwaringin, Jatibening, Jaticempaka, Jakasampurna, Marga Mulya, Pekayon Jaya, Margajaya, Margahayu, Bekasi Jaya, Duren Jaya, Bojong Rawalumbu, and Padurenan villages. Meanwhile, villages identified as sprawl with high population density include Kelurahan Bintarajaya, Bintara, Harapan Jaya, Kaliabang Tengah, Aren Jaya, and Cimuning. Location of villages identified as sprawl based on population density characteristics can be seen on Figure 2.

3.2.2. Building density. The calculation of building density is conducted by dividing the number of building units and built-up area. Building density is also one of numerous approaches to assess the characteristics of sprawl in each village. The lower the value of the building density in the area identified as sprawl, indicates that the higher the sprawl value in the area. The results of the calculation of the building density shows that the highest building density is located in Duren Jaya Village in East Bekasi District with a building density level of 15,784 Units/Ha, while the lowest building density is located in
Cikiwul Village in Bantargebang District with a density level of 4,650 Units / Ha. Based on the two building density values, the following building density classification is obtained: low building density with a class range of 4,650-8,361 units / Ha; medium building density with class range of 8,361-12,072, and high population density with class range of 12,072-15,784.

Based on the overlays results between sprawl areas and building densities, 9 villages were identified as sprawl with low building density, 15 villages were identified as sprawl with medium building densities, and 5 villages were identified as sprawl with high building densities. Villages identified as sprawl with low building density include Jatikarya, Jatirangga, Jatimurni, Jatimelati, Pekayon Jaya, Padurenan, Bojong Rawalumbu, Cikiwul, and Bantargebang. Villages identified as sprawl with medium building density include Jatiraden, Jatiluhur, Jatiasih, Jatimekar, Jatiwaringin, Jatibeneng, Medan Satria, Marga Mulya, Margahayu, Bekasi Jaya, Aren Jaya, Bintarjaya, Jakasampurna, Cimuning, and Margajaya. Meanwhile, villages identified as sprawl with high building densities include Kelurahan Kaliabang Tengah, Harapan Jaya, Duren Jaya, Jaticempaka, and Bintara. Location of villages identified as sprawl based on the characteristics of building density can be seen on Figure 2.

Figure 1 show that most of the areas affected by sprawl in Bekasi City are located near freeways. Several freeway entrances/exits connect areas, located remotely from the city. Highway construction has facilitated the movement of people from a longer distance to the city, so that it will accelerate the development of residential areas connected to the highway. This phenomenon is in line with a theory which states that one of the causes of sprawl phenomenon is the growth of the highway system [7].

In urban development, the growth of the road network will produce a double effect. On one hand, a good transportation network is a must to support a city's economic growth. However, on the other hand, the development of transportation, especially tolls and highways can cause urban sprawl. This research provides empirical evidence that the growth of the transportation network tends to influence the occurrence of urban sprawl in Bekasi City. The phenomenon of urban sprawl in Bekasi City tends to have similarities with urban sprawl phenomenon America. In America, massive highway construction causes urban sprawl, because these roads connect areas located remotely from cities [7]. Development of urban sprawl in Bekasi City also tends to have similarities with the general pattern of urban sprawl in other developing countries [7]. Urban sprawl along the highway is known as the "ribbon sprawl" [7].
Population density serves as an important indicator for sprawl measurement [13]. Ewing indicates that sprawl might be able to occur when the rate of land conversion to non-agriculture or non-natural land utilization exceeds the rate of population growth [13]. In other words, urban sprawl can be considered related to low development density, and related to low population density.

As pictured in Figure 2, urban sprawl characteristics based on population density in Bekasi City show that sprawl characteristics of low and moderate population density are located close to the road network, while sprawl characteristics of high population density levels are located on the border areas of DKI Jakarta and Bekasi District. This indicates that areas located close to the road network have higher sprawl values compared to sprawl that are located in the bordering areas.
From the overlays results between sprawl areas and building densities in Bekasi City, it appears that the sprawl characteristics of high building density levels are located close to the road network and urban areas (Figure 3). This phenomenon is interesting, the sprawl characteristics based on the level of building density are overlayed with the sprawl characteristics based on the level of population density, it indicates that the growth of buildings along the highway is higher than the population growth. The results of this study tend to be parallel with Ewing's statement that sprawl can be occurs when the rate of conversion of land to non-agriculture utilization exceeds the rate of population growth.

4. Conclusion
Based on the results of the study, 51.07% of villages in Bekasi City were identified as sprawl. Sprawl with low and moderate population densities characteristics are generally located along the road network, similarly as sprawl with high density building characteristics. The growth of the transportation network tends to affect the occurrence of urban sprawl in Bekasi City. In addition, urban sprawl in Bekasi City is also indicated to be resulted from the rate of conversion of land to non-agriculture utilization beyond the population growth rate.

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