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Built Area Change in Rural-Urban Fringe of Semarang

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***Abstract*—Development of urban areas has penetrated the rural urban fringe of Semarang. The growth of new housing in rural urban fringe is inseparable from the increasing number of people accompanied by an increase demand for residential land. The development of residential areas or new housing in rural urban fringe could lead to various impacts on the environment. This study aims to examine changes in land use (built area) in the rural urban fringe of Semarang, namely in Gunungpati District. The methods used was digital image interpretation with multispectral classification method and pattern comparison analysis to get a frame of land use in 2005, 2010 and 2015. Interpretation results were tested for validity through field observation. The results showed that the dominant land use change occurred for settlement. The change from 2005 to 2010 was 122.33 ha. While from 2010 to 2017, there has been an increase in the area of settlements by 297.54 ha. The non-settlement-built area expansion was from 10.65 ha in 2005 to 51.87 ha in 2017. Environmental impacts that occur include the reduction of water absorption area and rising of surface temperatures in the area which may further affect the pattern or lifestyle of the community**

Keywords— built area; environmental impact; rural urban fringe; Semarang; settlement

I. INTRODUCTION

Urban growth and development have penetrated the rural-urban fringe of Semarang. A number of new housings or settlements were started to build in Banyumanik, Gunugpati, Mijen and Pedurungan Districts, which are the border areas of Semarang with the surrounding districts. The growth of new housings or settlements in the rural-urban fringe was inseparable from the increase in the population which is accompanied by an increase in demand for residential land [1]. The increasing number of populations is not only influenced by the factors of birth and death, but also by the movement of people to Semarang with various purposes. The reason for this transfer could be economic or social reasons [2], [3].

The economic reasons that generally affect the population moved to the rural-urban fringe are the increasingly high prices of land or houses in the city center or the area around the city center [4]. Although there was a possibility that new housing on the outskirts of the city is not easily accessible by public transportation [5]. However, the price of cheaper land is a logical reason for people to settle in rural-urban fringe with the consequence of being commuters when their workplace is in the city center [6].

While the social reasons that could affect the population movement to the rural-urban fringe, for example, were the existence of educational places that are indeed in the area. One example is the existence of Universitas Negeri Semarang (UNNES) in the rural-urban fringe of Semarang which then encourages people, especially students, to live around the university. This condition illustrates that the population movement to the rural-urban fringe was based on the need for easy access to certain facilities [7], [8].

The growing development of settlements area in rural-urban fringe areas could cause various impacts to the environment [9]–[12]. One of them is the changes from an opened land (non-built area), such as agricultural land, gardens and moor, to become built area with various functions such as housing, trade and services, public facilities and other social facilities [7]. In addition, there is also a shift in the function of the area to be characterized by urbanity even though the pattern tends to be irregular. In urban studies, the phenomenon of urban development that tends to spread irregularly in the rural-urban fringe is known as urban sprawl.

The phenomenon of the tendency of shifting urban functions to suburban areas is often referred to the perforation process of the city's physical appearance to the outward or rural-urban which called urban sprawl [13]. Sprawl is defined as a form of low-density land occupancy or leapfrog development with unlimited expansions [14], [15]. In other words, significant developmental expansion takes place in the form of residential land and non-residential land in an environment that was not touched before. In fact, this development is characterized by low density, leapfrogging development to other regions (such as agricultural land, or on the border with other regions) and occurring in rural-urban fringe or peri-urban areas. In developing countries, urban sprawl could be divided into two characteristics [16]. First, the broad development in the peri-urban area with the pattern of informal and illegal land use development. Generally, this was worsened by the lack of infrastructure and public service facilities, even minimum or lack of public transportation, and inadequate road access. Secondly, the form of residential land use for middle to high income groups with the high value commercial areas are well connected with public transportation facilities.

This study specifically examines the increase or change of the built areas in the rural urban fringe of Semarang. This happened as a result of a land use change due to the increasing need for building land. It was further revealed that changes in open land become built area could affect the environment in various ways, including the high temperature of land's surface surrounding the built area [9],[17],[20].

II. METHODS

The location that became the object of this study was the rural-urban fringe of Semarang, namely in Gunungpati District. It was chosen because there were massive land use changes occurred in Gunungpati District within the last 10 years. The method used was a digital image interpretation with multispectral classification method to get an overview of land use in 2005, 2010 and 2017. The variables studied were land use or land cover (LULC) at the study site in 2005, 2010 and 2017. While the validity or accuracy of the satellite imagery interpretation results was conducted by field observations and comparing the results of interpretation at the sample points with the real conditions. The number of sample locations taken for the validity or accuracy test was 50 points. The validity test result showed in Table 1.

TABLE 1. VALIDITY OR ACCURACY TEST RESULT OF LAND USE INTERPRETATION IN GUNUNGPATI DISTRICT

Image Test / Interpretation	A	B	C	D	E	F	G	Total
A	**12**	**1**						**13**
B	**1**	**9**						**10**
C			**6**				**1**	**7**
D				**2**				**2**
E	**1**				**4**			**5**
F						**5**		**5**
G	**1**						**7**	**8**
Total								**50**

Explanation:

A : Plantation land
B : Agricultural land
C : Settlement (Built Area)
D : Moor
E : Shrub
F : Non-Settlement (Built Area)
G : Water body

The calculation of the accuracy of each land cover class was as follows:

A. Plantation land: $\frac{12}{13}$ x 100 % = 92,30%

B. Agricultural land: $\frac{9}{10}$ x 100% = 90,00%

C. Settlement : $\frac{6}{7}$ x 100% = 85,71%

D. Moor : $\frac{2}{2}$ x 100% = 100%

E. Shrub : $\frac{4}{5}$ x 100% = 80%

F. Non-settlement : $\frac{5}{5}$ x 100% = 100%

G. Water body : $\frac{7}{8}$ x 100% = 87,50%

Overall accuracy : $\frac{45}{50}$ x 100% = 90%

Based on validity or accuracy calculation result of the land cover that has been conducted in Gunungpati District in 2017, the accuracy of the land cover interpretation results was 90%. Referring to McCoy's opinion that the results of a minimum permissible interpretation accuracy are above 85%, so the interpretation of the land cover that has been done has met the minimum percentage of the level of accuracy, so that the maps prepared could be used for the next analysis [21]. The results of interpretation are mostly caused by the similarity of spectral reflection (spectral values) of several objects, which makes it a little difficult for visual interpretation that has been done, such as spectral reflection values of agricultural land with plantations, shrubs with moor and settlement buildings with non-settlements buildings.

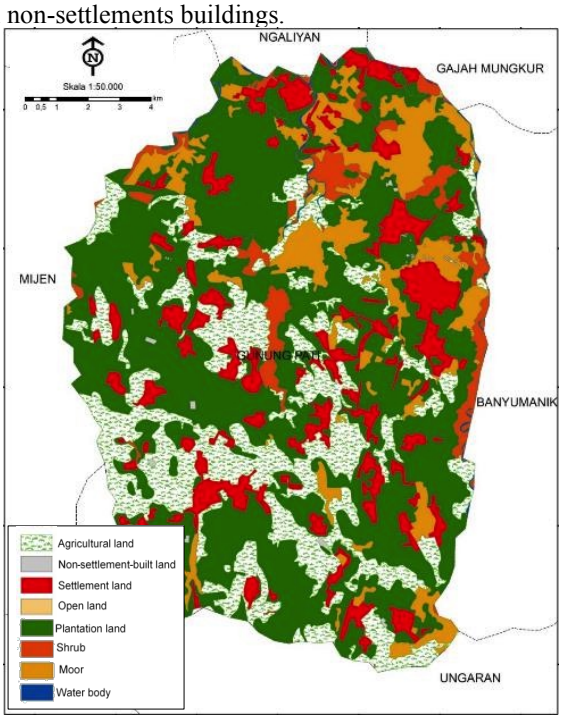

Figure 1. Land Use Map of Gunungpati District in 2005 (Source: Digital Globe Image, 2005)

III. RESULTS AND DISCUSSION

Land use change in Gunungpati District could be observed through satellite image processing. Figure 4 showed an overview of land use changes in Gunungpati District from 2005, 2010 and 2017. The details of land use change in Gunungpati District are presented in Figures 1, 2 and 3.

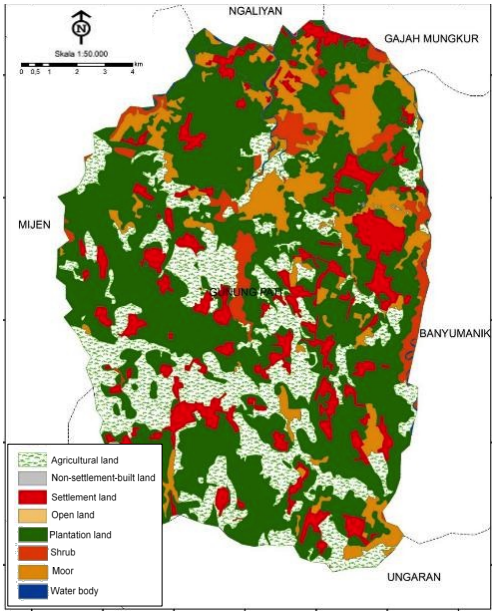

Figure 2. Land Use Map of Gunungpati District in 2010 (Source: Digital Globe Image, 2010)

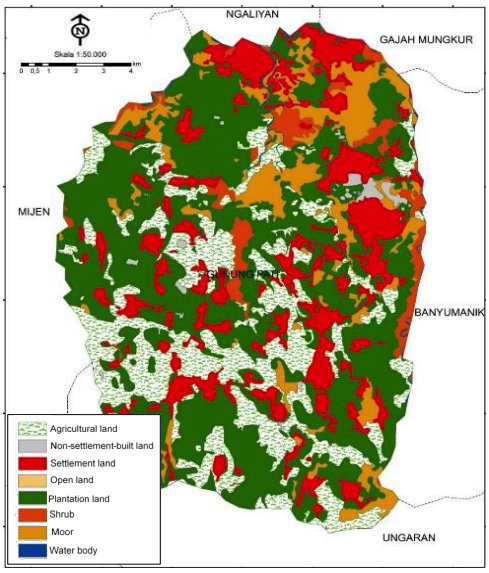

Figure 3. Land Use Map of Gunungpati District in 2017 (Source: Digital Globe Image, 2017)

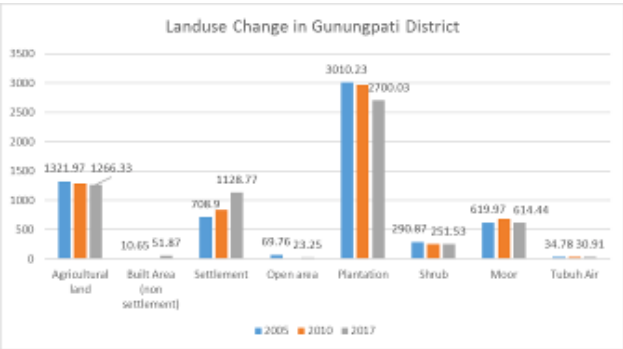

Figure 4. Diagram of Land Use Change in Gunungpati District (Source: Researcher Analysis, 2017)

Based on the calculation of land use changes in Gunungpati District, it was known that there were two (2) built area units (settlement and non-settlement area) in Gunungpati District which have increased. The dominant change was for settlement area. The changes from 2005 to 2010 were 122.33 ha of the new settlement area. Similarly, in the period 2010- 2017, there has been an increase in settlement area of 297.54 ha. While, the expansion of non-settlement area was from 10.65 ha in 2005 to 51.87 ha in 2017.

The changes of built area in Gunungpati District followed by a decrease in the area of five (5) non-built area/open land units, including agricultural land, open land, plantations, shrubs and moor. The most extensive decline in non-built area occurred in plantation land use, which was 47.51 ha in the 2005-2010 and 262.69 ha in the 2010-2017 period. This means that the plantation area of 310.2 ha has largely turned into built area or another land use. The next decrease in size of a non-built area which is big enough was agricultural land, which was from 1,321.97 ha in 2005 to 1,266.33 ha in 2017, or there has been a decrease in area of 55.64 ha. Basically, these non-built area/open lands are water catchment land, so one of the environmental impacts that occurred in relation to the increase of built area was the decreasing ability of land in Gunungpati District to accommodate and to absorb water.

This large change in a non-built area into a built-up land in Gunungpati District was inseparable from the spatial planning policy in Semarang that directs the development in Gunungpati District which is an area with the main function as an education area. Therefore, the existence of UNNES as one of the higher education magnets in Central Java has encouraged the arrival of residents from outside the area (students) who directly need or increase the demand for residential land. Except, Gunungpati District is one alternative choice of settlement locations in rural-urban fringe of Semarang. Beside the land price was still relatively cheaper compared to the urban center area of Semarang, it adds to the stability of the community to choose settlement locations in Gunungpati District. Although in the future, land price increases in this district could be expected to be difficult to control due to the relatively fast growth of the region.

In addition, the development of sub-center service in Gunungpati District which includes three (3) villages, namely Plalangan, Cepoko and Nongkosawit, has encouraged the construction of trade facilities and services, educational facilities, health facilities, religious facilities and other public service facilities. This is because the development of settlement was also increased rapidly along with the development of public service infrastructure and facilities in Gunungpati District.

Other environmental impacts that occur due to changes in an open land to build lands are the increase in surface temperature in the Gunungpati District area, especially in the built land cover, both settlements and non-settlements. As shown in Figure 5, the area in Gunungpati District which is marked in red has a higher surface air temperature compared to other regions around it. Some subdistricts whose land use is a settlement includes the areas of Sukorejo, Sadeng, Sekaran, Patemon,

Pakintelan, Nongkosawit, and Sumurejo. In addition, a number of residential areas are also spread in other regions.

The quite prominent non-settlement-built land is found in the Sekaran Subdistrict, which has UNNES Campus in it. The high surface temperature in the region (marked in red) indicates the high increase in the built land area or the conversion of land from open land to build land. Specifically, on the campus of UNNES, there is indeed the development of new buildings as an effort to improve services to students and other campus academic communities.

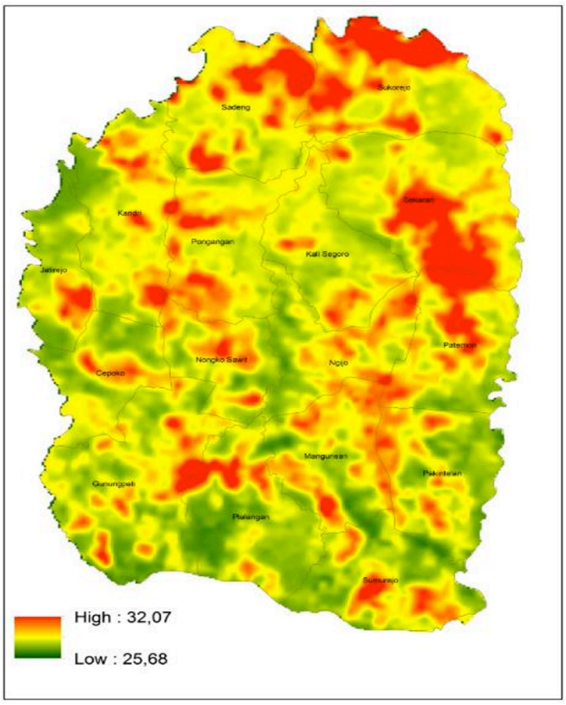

Figure 5. Map of Surface Temperature Condition Distribution in Gunungpati Subdistrict
(Source: researcher analysis, 2017)

IV. CONCLUSION

Land use changes occurred at the research location. The built land use for settlements and non-settlement-built lands occurs quite large. The development of residential areas in Gunungpati District increased from 708.90 ha in 2005 to 1,128.77 ha in 2017. There were additional new residential areas covering 419.87 ha. While the change in changes in the area of the non-residential built land is from 10.65 ha in 2005 to 51.87 ha in 2017. The increase in the built-up land area for the residential areas and non-residential areas was followed by a decrease in the area of non-built land use (water catchment land), including agricultural lands, open lands, plantations, fields and shrubs. This also caused an environmental impact such as the surface temperature around the built area tends to be higher than the surrounding areas which were opened.

The development of the rural-urban fringe of Semarang (namely in Gunungpati District) was inseparable from the spatial planning policy that has been regulated in the law. Whereas in every part of the region, there are sub-centers of services that could encourage the development of public service facilities, including trade facilities and services, educational facilities, health facilities, religious facilities and another public service facility.

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