The dynamic of built land development in the Cikapundung riverside area, Bandung City, Indonesia

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Abstract. The development of built land from year to year is very significant and one of the massive land use choice is along the riverside of Cikapundung, Bandung City, Indonesia. There are 3 areas traversed by the Cikapundung River: Coblong Subdistrict, Bandung Wetan Subdistrict and Bandung Kidul Subdistrict. The research data was obtained by conducting a ground check point (GCP), using the geographic information system (GIS) analysis method, satellite image interpretation by overlaying the map of the spatial plan of 2011–2031 Bandung City, and multiple linear regression. The results of this study indicate that the growth of built land is increasing every year with a sprawl index value of 2.2, meaning that the growth of built land is higher than population growth. The suitability between the growth of built land and the Spatial Planning of 2011–2031 in an inconsistent proportion of land area was 10.08% for Coblong, 17.32% for Bandung Wetan and 15.14% for Bandung Kidul. The most influential factor on the growth of built land is the increase in population each year.

Key Words: built land, land use, population, spatial plan.

Introduction. One of objectives of the Sustainable Development Goals (SDGs) program is to locate cities in sustainable development cores amid fast urbanization areas. McGee (1995) postulated that in 2020 would be more than 56% residents in urban areas in Southeast Asia (ASEAN). According to the World Bank, Indonesia would have more than 60% of residents who would live in urban areas (World Bank 2014). Hidajat et al (2013) stated that activities of urban function increase might negatively affect the environment. If this phenomenon cannot be anticipated by avoiding low price housing to low income residents, it will affect irregular settlement clusters (Ooi & Phua 2007).

Ineffective and inefficient land use might lead urban residents to live in landed houses, although urban land price is high. Thus, urban development grows horizontally (urban sprawl) (Sabaruddin 2016). According to Doxiadis (1968), settlements are dwelling areas for human beings. Settlement has bigger scope of meaning than housing. Recently, the settlement area on Cikapundung riverside has been unplanned in spatial use, with high population density, illegal status, low quality of infrastructure, and ecological function decrease (Rusdiyanto et al 2019), which might decrease the settlement area sustainability.

The phenomenon of urbanization in Bandung City, Indonesia, has resulted in a significant increase in population. The population of Bandung City based on population

statistics in 2018 recorded 2503708 people and in 2019 there were 2507888 people (Statistics of Bandung Municipality 2020). The population increase has an impact on the need for settlement land, so that it increases the area of built land.

In accordance with the direction of the Bandung City Spatial Plan of 2011-2031, the area of Bandung City is divided into 3 regional groups: the restricted development area (the northern part of Bandung City), the under development control area (the western part of Bandung City) and the development-driven area (the eastern and southern part of Bandung City) (Bandung City Urban Law Number 18 from 2011). In the last few decade, Coblong subdistrict, Bandung Wetan subdistrict and Bandung Kidul subdistrict, located on the Cikapundung riverside, have seen a significant increase in built land. These 3 regions represent 3 regional groups each under the 2011-2031 Bandung City Spatial Plan.

Based on this, it is relevant to study and analyze the dynamics of built land development in the 3 subdistricts. The objectives of this research are to analyze changes in land use and trends in built land growth, to analyze the consistence of built land under the Bandung City Spatial Plan of 2011-2031 and to analyze the factors that affect the dynamics of growth in built land. The results of this study could be further input for the management of settlement areas on the riverside of Cikapundung, Bandung City.

Material and Method. In general, the research was conducted in the administrative areas of Coblong, Bandung Wetan and Bandung Kidul subdistricts, West Java Province, Indonesia. This location was chosen to analyze the dynamics of built land development in settlement areas on the riverside of Cikapundung, Bandung City. The study was carried out during 9 months, from March to December 2019. The location of the study is presented in Figure 1.

Figure 1. The research location.

The data used is secondary data. Secondary data in the form of digital maps are land cover maps of 1999, 2007, 2013, 2018, obtained from the interpretation of LandSat TM Path/Row

122/065 and Bandung City Spatial Plan of 2011-2031 (Bandung City Regulation Number 18 of 2011). Other secondary data is in the form of population data and socio-economic-education facilities of the study area.

The increase in the area of built land in Bandung City, especially for settlement, resulted in increased space for activities. The sprawl index is an indicator of the amount of land taken by urban activities, in this case residential areas, which can show the rate of change in the rate of suburbanization and the size of the pressure of regional development (Staley 1999).

The calculation of the value of the sprawl index in the study area is done by comparing the percentage of population growth with the growth of the suburbanization rate. In this case, the growth of residential areas was considered during the period of 2013-2018. The sprawl index formula used is the following:

Sprawl Index=% of residential area growth/% of population growth

Data analyses. Before multiple regression analysis is performed, the data test is performed. Test data used is the normality test. The normally distributed profit data is considered to represent the population. The basis for making normality test decisions is: data are normally distributed, if the value of significance is higher than 0.05; the data are not normally distributed, if the value of significance is less than 0.05.

The normality test analysis of residual land data developed, population, education facilities, social facilities and economic facilities was conducted using the Kolmogorov-Smirnov test method.

Multiple regression analysis was performed on 5 variables consisting of developed land as a dependent variable and 4 other variables as independent variables: population, education facilities, social facilities, and economic facilities. Input data for multiple regression analysis was from the last 5 years (2013-2018).

In order to avoid doubts in accepting the results of the analysis, a multi-collinearity test was conducted. Multi-collinearity test is used to determine the presence/absence of deviations. The classic assumption of multi-collinearity is the linear relationship between independent variables in the regression model. The prerequisite that must be fulfilled in the regression model is the absence of multi-collinearity. In this study, a multi-collinearity test was conducted by looking at the tolerance value in the regression model. According to Hair et al (2014), in general, multi-collinearity occurs if the tolerance value is smaller than 0.1 or the Variance Inflation Factor (VIF) value is greater than 10. Thus, the variable presents multi-collinearity problems with other independent variables.

The stepwise method is a method to obtain the best model of regression analysis. The stepwise method is conducted by entering the predictor in stages based on the highest correlation coefficient.

To analyze the interrelated variables, statistical regression techniques were used. Multiple linear regression is a regression model with one dependent variable and more than one independent variables (Uyanik & Guler 2013). The goal of the multiple regression method is to use estimator variables to predict the destination variables. The equation produced in this study can be explained as follows:

$Y=A_0+A_1X1A_2X2+A_3X_3+A_4X_4$

Where: Y - the dependent variable, percentage of built land (2013-2018); Y≤subdistrict area; A_0 - constant; A_{1-4} - regression coefficient; X - independent variable, consisting of: X_1 -the number of population (2013-2018, in people); X_2 - the number of educational facilities (2013-2018, in units); X_3 - the number of social facilities (2013-2018, in units); X_4 - the number of economic facilities (2013-2018, in units).

A simultaneous test (F test) and partial test (t test) were carried out on the multiple regression model. Simultaneous tests were carried out to find out the independent variables

together with the dependent variables, and partial tests were carried out to test the regression coefficients individually. The variables used in the multiple regression analysis are: the percentage of land use in residential areas from 1999 to 2018 as the dependent variable; the number of residents, the number of social facilities (hospitals, clinics and worship facilities), the number of economic facilities (industry, markets, malls and hotels) and the number of educational facilities (elementary, junior high school, senior high school and university), all as independent variables.

Results and Discussion

The changes in land use and trends in built land growth. The dynamics of the growth of built land in the study were recognized by the configuration of developed built land based on observations in 1999, 2007, 2013, and 2018. The dynamics of the growth of developed built land and the percentage of land use in the study area during the period of 1999-2018 (Table 1).

Table 1

Percentage of land use in the study area from 1999 to 2018

Year	*Land use (%)*				
	City forest	*Garden*	*Rice fields*	*Shrubs*	*Built land*
1999	2.77	5.44	14.54	25.59	51.66
2007	2.49	8.08	12.69	4.96	71.77
2013	2.03	4.67	10.61	9.04	73.64
2018	1.69	2.99	8.02	2.38	84.92

Based on Table 1, in 1999, the area of built land was the largest, with 51.66% of the total area. The built land dominates most of the Coblong subdistrict, Bandung Wetan and Bandung Kidul subdistricts. The land use with the smallest percentage of area is the forest area, which is 2.77%. In 2018, there was a very significant change in the study area, the built land increasing with 33.26% from 1999, so that it became 84.92% of the total area. On the other hand, city forest decreased with 1.08%, and became 1.69% of the total area, gardens decreased with 2.45% and became 2.99%, rice fields also decreased with 6.52% and became 8.02%, and shrubs decreased with 23.21% and became 2.38% of the total area, as presented from Figures 2 to 5, respectively.

By observing the changes in built land from 1999 to 2018, it could be said that the most common conversion of land use from non-built land to built land was shrub land. Changes in land use occurred continuously from 1999 to 2018. In the period of 2007-2013, the built land merged together and formed the growth of the newly built land spreading irregularly. This occurred in Coblong, Bandung Wetan and Bandung Kidul subdistricts around the Cikapundung riverside.

This built land change increases continuously since it is triggered by rapid development and high population density. Thus, it increases the number of large and medium scale housing by non-integrated private developers (Hara 2010; Munawir et al 2019). The intervention into built land on agricultural land (non-settlement area) is very rapid. One of the triggers is the low price of land. In addition, the rapid development of trade, service and industrial activities requires more land due to changes and diversification of urban activities of people who live and come to the study area. This happens in the case of speculative transformation of agricultural land before it becomes built land.

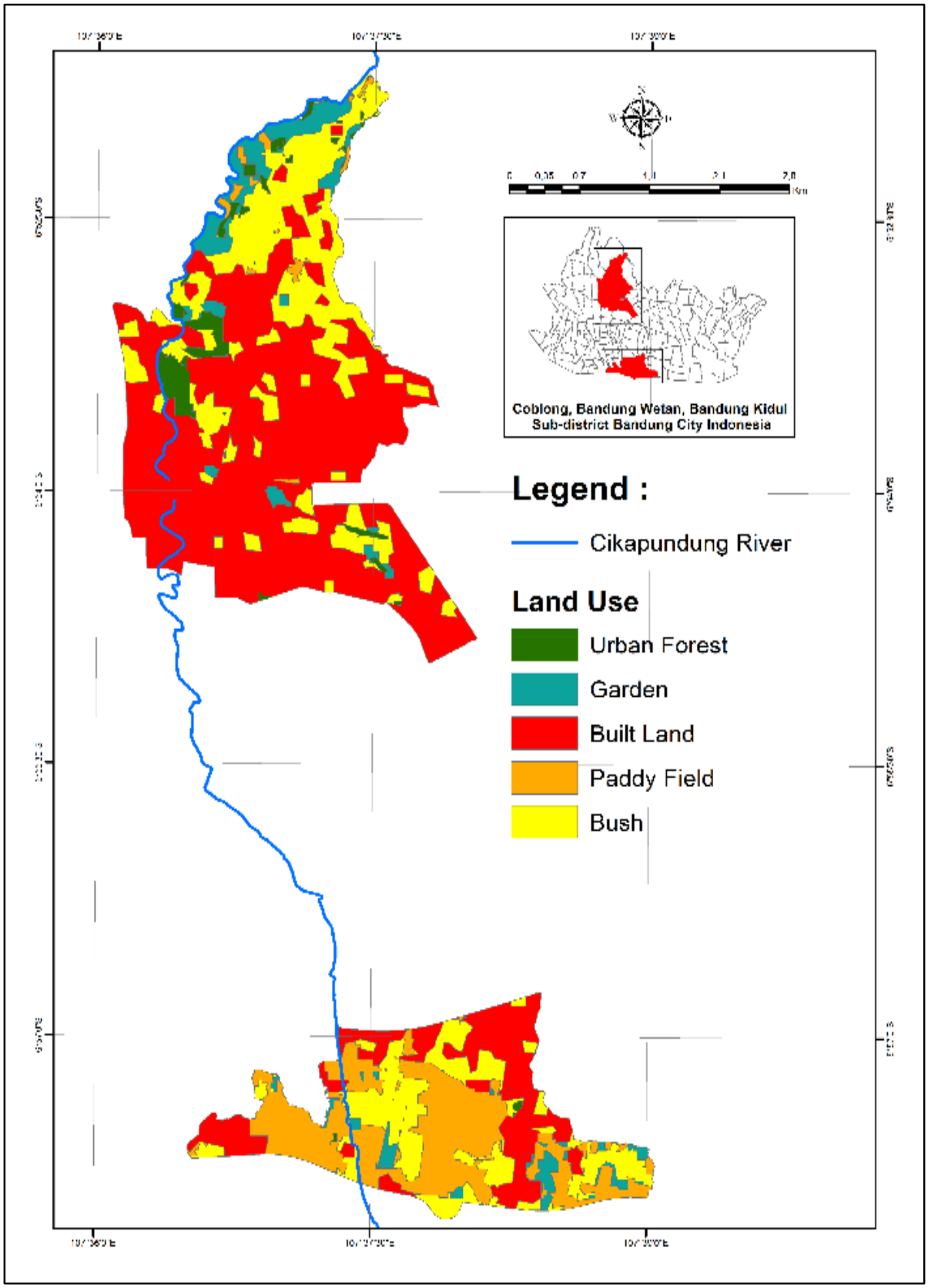

Figure 2. Land use map of 1999.

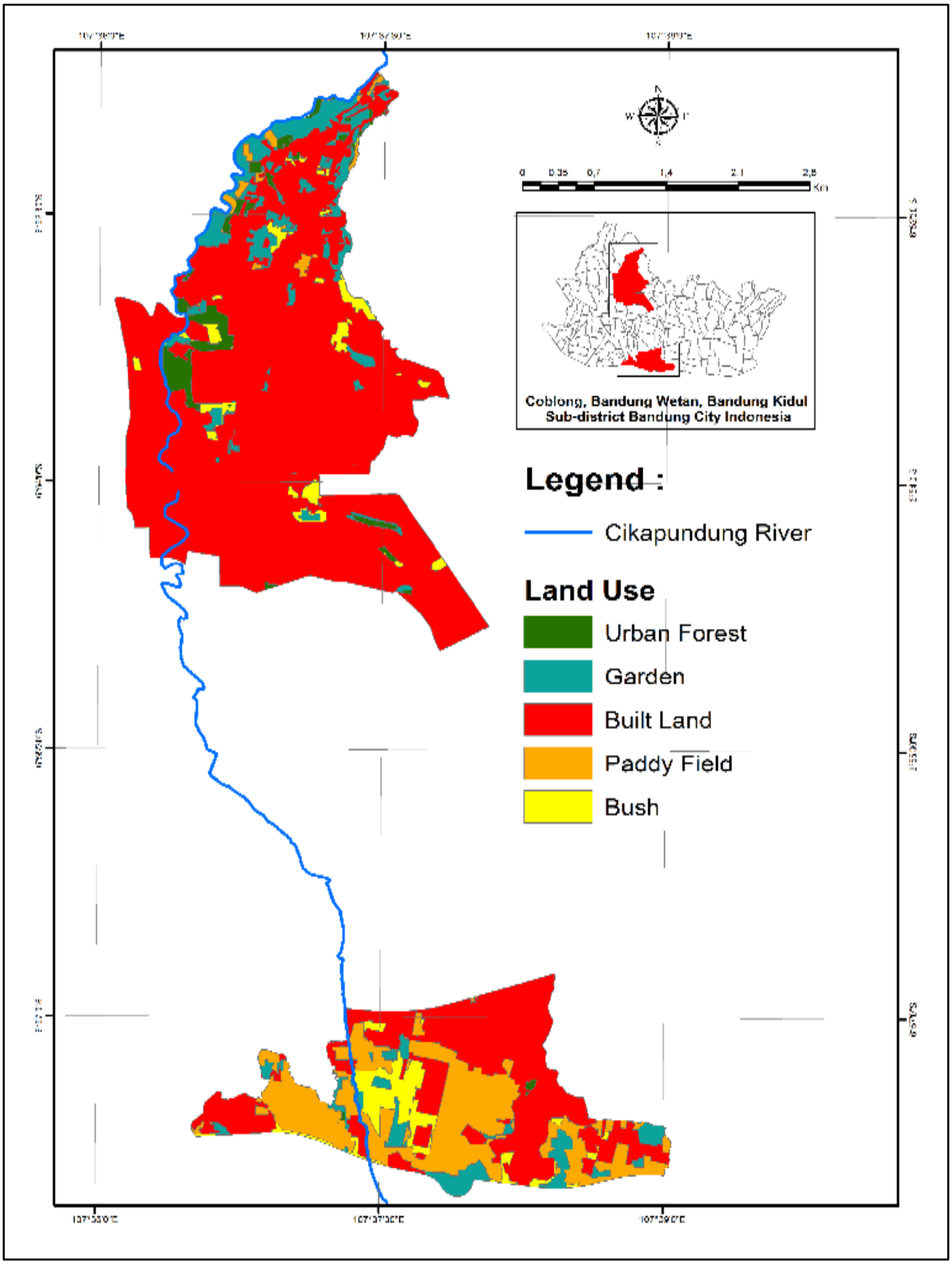

Figure 3. Land use map of 2007.

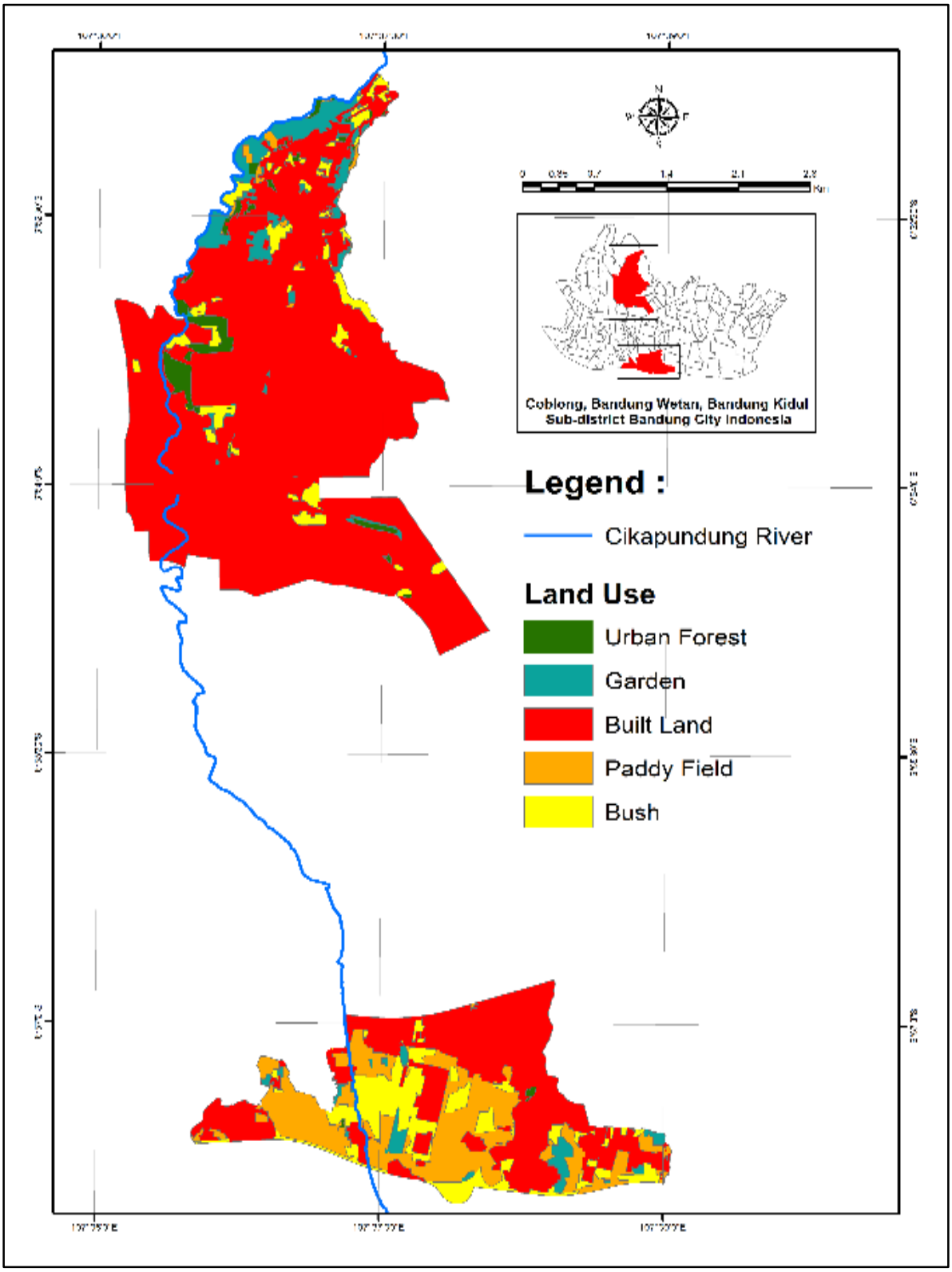

Figure 4. Land use map of 2013.

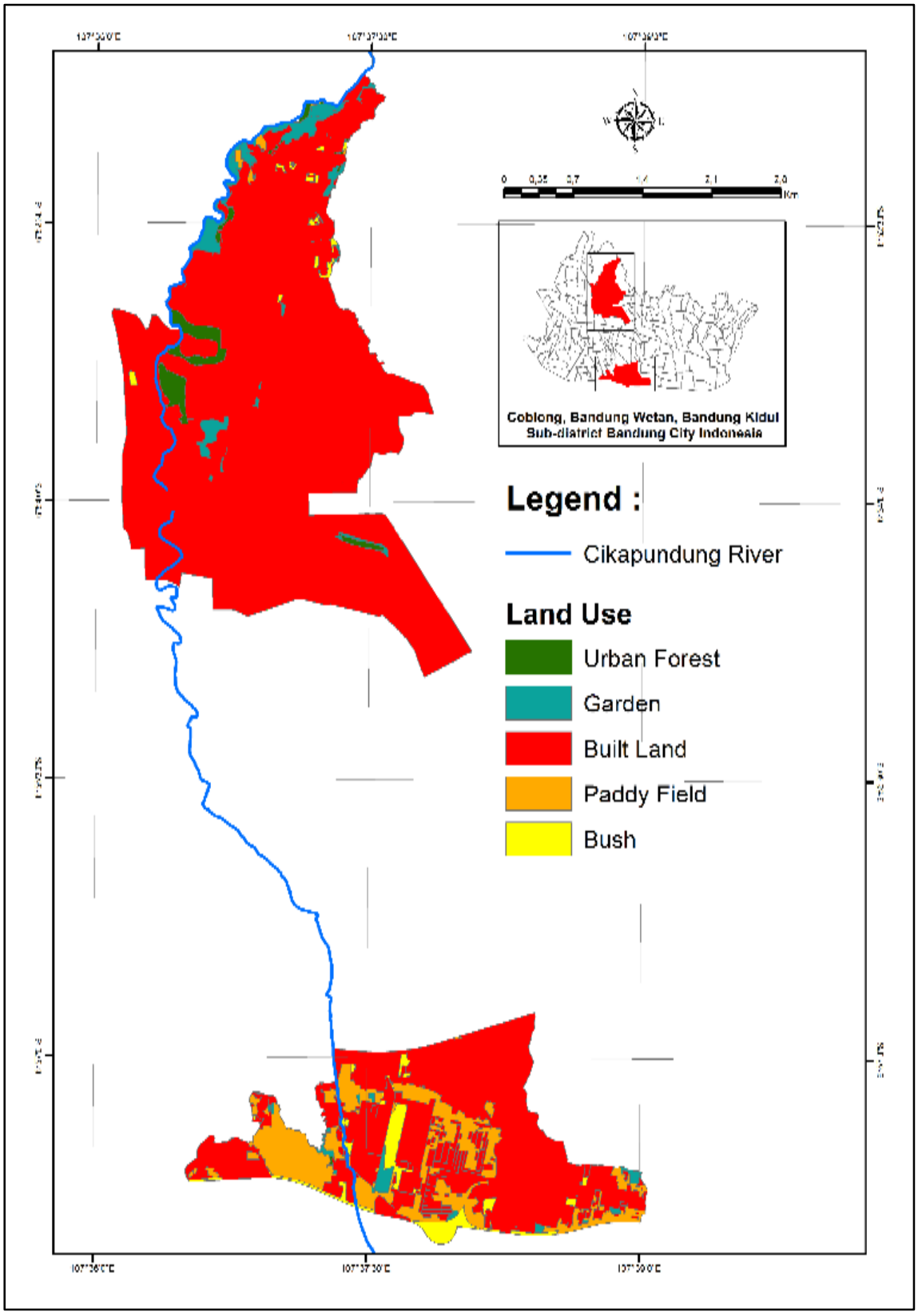

Figure 5. Land use map of 2018.

The observation period of the research area in 2013-2018 was mixed and dominated by conditions and activities characterized by urban traits, such as high-density housing, land use for trade, services and industrial activities. The development is increasing because access to the core city is relatively good and due to the existence or development of regional infrastructure, such as the arterial road network and toll roads. This process develops without recognizing administrative boundaries, affecting environmental sustainability, especially on the edge of the Cikapundung River.

Sprawl index analysis results in the study area had values ranging from 1.8 to 2.6, with an average of 2.2, indicating that the rate of growth of built land (such as housing, shops and hotels) is faster than the rate of population growth. For more details, the value of the sprawl index is presented in Table 2.

Table 2

Sprawl index

No	*Subdistrict*	*Sprawl index*
1	Coblong	1.8
2	Bandung Wetan	2.6
3	Bandung Kidul	2.1

Sprawl index analysis results (Table 2) had values ranging from 0.8 to 1.6, showing that the rate of growth of developed land (such as housing, shops and hotels) is faster than the rate of population growth. Hidajat et al (2013) explain that the sprawl index is the amount of land area used by urban growth activities, in this case the developed land, which can indicate the speed of change in the rate of population density and the size of the pressure of an urban area development. This shows that the growth of constructed land cover is dominant compared to population growth, meaning that the research area in the years 1999-2018 has land development that exceeds the population development. The growth of the developed land encroached on the green lands with the rapid development of new housing on a large scale, and was followed by an increase in population activity due to changes and diversification of population activities such as trade, facilities, utilities and industrial development, which increased the area of developed land.

Consistency of built land and spatial planning. Conformity analysis between land use conditions of residential areas and Spatial Plan directives is carried out through an overlay process between Spatial Plan directives from each administrative region in the study area with the condition of land cover in 2010. The 2011-2031 Bandung City Spatial Plan is used for choosing locations consisting of Coblong, Bandung Wetan and Bandung Kidul subdistricts (Figure 6).

Based on the stages of this analysis, 4 regional categories were obtained consisting of:

1. The built land area in 2018 appropriate to the direction of the 2011-2031 Bandung City Spatial Plan;
2. The unbuilt land area in 2018 appropriate to direction of the 2011-2031 Bandung City Spatial Plan;
3. The built land area in 2018 not appropriate to direction of the 2011-2031 Bandung City Spatial Plan;
4. The unbuilt land area in 2018 not appropriate to direction of the 2011-2031 Bandung City Spatial Plan.

Each of these area categories has a certain proportion of area, as presented in Figure 6.

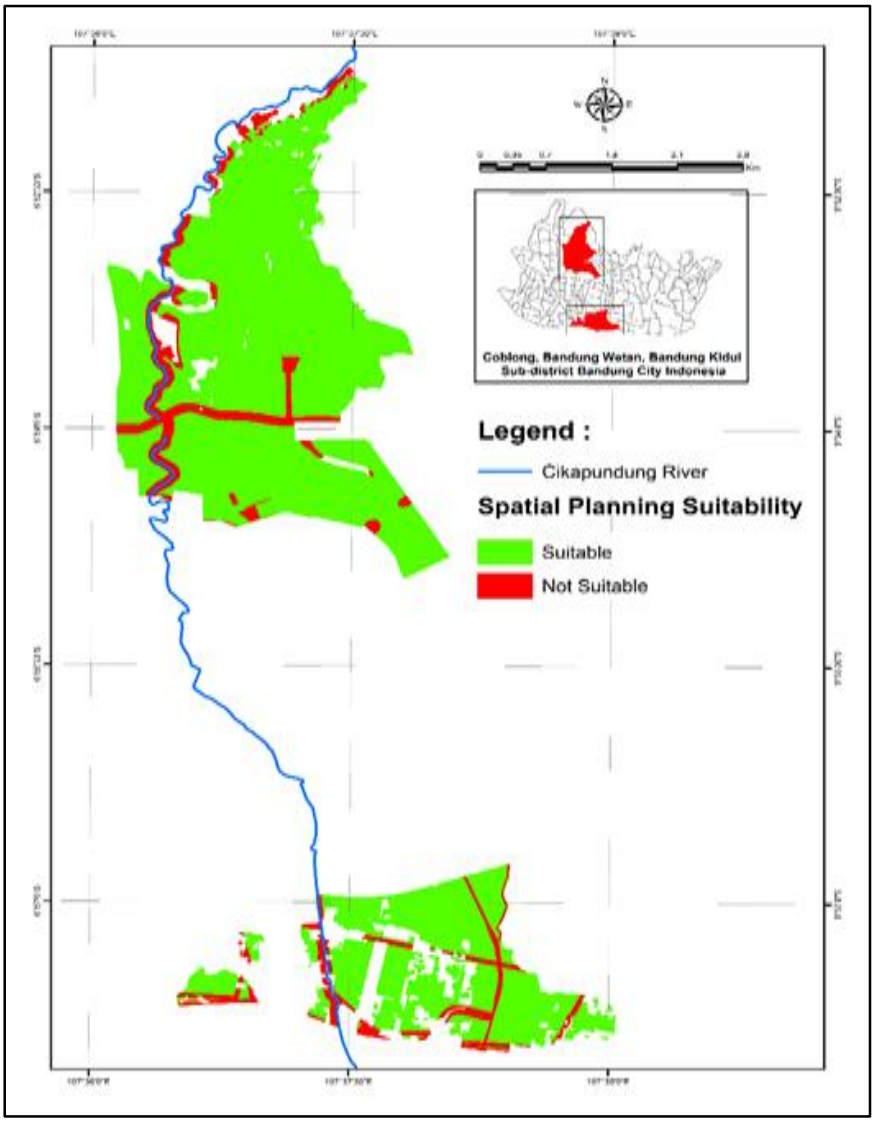

Figure 6. Land use map of results of integration of 2018 with Bandung City Spatial Plan.

The result of built land compatibility with the 2011-2031 Bandung City Spatial Plan showed that the percentage of built land is not compatible with the 2011-2031 Bandung City Spatial Plan in Bandung Wetan and Coblong subdistrict, with only 17.32% and 10.08%, respectively. Most of those built lands were located in Cikapungdung riverside. It was caused due to low land price and access ease to the urban area.

The percentage of unbuilt land (it is categorized as built land according to 2011-2031 Bandung City Spatial Plan) located in Bandung Kidul subdistrict was 15.14%. This land is a potential area to be developed as a settlement area. Regions classified in 3 and 4 categories are areas consistent with 2011-2031 Bandung City Spatial Plan. The irregular development of settlements is a weakness of the rules, controls and regulations issued by the government.

Factors that affect growth of built land. Based on the results of the normality test with the Kolmogorov-Smirnov Test, the average value of a symp.sig is above 0.9, which means the value is greater than 0.05. Thus, it can be concluded that the data is normally distributed.

The total population variable affects the addition of built land. Another variable affecting built land is the addition of available facilities, particularly economic facilities. The increase in

facilities affects built land growth, hastening it. This is consistent with the statements of Chapin & Kaiser (1979) and Arifin et al (1998), who shows that with a higher system of land development (the level of urbanization), in this case residential area, the structure and function of the area/city will be more complex. The reason is the increasingly diverse activities of the local population. Thus, the factors that influence the highest land changes will change the structure of urban land use.

The analysis result was a correlation coefficient (R) of 0.997 or close to 1, showing the strong relationship between the variables developed in the model. The coefficient of determination (R2) is 0.994 or 99.4%, which shows the high variation of data in the developed regression model. This is in line with the results of the data test, where the data shows a normal distribution.

According to the analysis of variance (ANOVA), it can be concluded that land use change (Lhn_Tbgun) is influenced by population, educational facilities, social facilities and economic facilities ($p<0.05$).

The results of the multi-collinearity test analysis showing the total population and social facilities variables had a tolerance collinearity statistics value of more than 0.1 and a variance inflation factor (VIF) value of less than 10. VIF is the multi-collinearity test tolerance value in the regression model. It can be assumed that there is no problem in the multi-collinearity between those variables, while there is problem in multi-collinearity between educational facilities and economic facilities variables (VIF value is higher than 10 and the tolerance value is less than 0.1). One of the requirements in the multiple regression analysis, in addition to the normally distributed data, is not to show symptoms of multi-collinearity. Multi-collinearity is the absence of a linear relationship between independent variables. If there is a linear relationship between independent variables, the model is affected by multi-collinearity problems. If there is a relationship between independent variables, then the variable is not orthogonal. The orthogonal variable is the independent variable whose interindependent correlation value is zero.

Thus, it can be concluded that there are 2 independent variables: total population and social facilities, which influence the dependent variable (built land). Data on educational facilities and economic facilities are not included in the analysis of the relationship of land cover dynamics, so that the resulting model is not affected by multi-collinearity problems.

Following are the results of the bivariate correlation analysis of the parameters of built land (Built_Land), population (Pop_Tot), economic facilities (Econ_Fac) and social facilities (Fas_Sosial). The results show that the population density has the highest correlation, approaching 1 (0.959) with the growth of built land (settlements). The population variable is regressed with the built land to obtain the significance value (Table 3).

Table 3

Bivariate correlation analysis

Variable		*Built_Land*	*Pop_Total*	*Econ_Fac*
Built_ Land	Pearson Correlation	1	0.959(**)	0.894(**)
	Sig. (1-tailed)		0.000	0.003
	N	7	7	7
Pop_Total	Pearson Correlation	0.959(**)	1	0.821(*)
	Sig. (1-tailed)	0.000		0.012
	N	7	7	7
Econ_Fac	Pearson Correlation	0.894(**)	0.821(*)	1
	Sig. (1-tailed)	0.003	0.012	
	N	7	7	7

Note: ** - correlation is significant at 0.01 (1-tailed); * - correlation is significant at 0.05 (1-tailed). Built_Land - built land area; Pop_Total - total population; Econ_Fac - economic facilities.

The results of regression analysis between variable Y (built land) with variable X1 (population) show a tcount of 7.533, where the value is greater than the value of the table (n-1) at a 5%

confidence level, 2.571. Tcount is higher than t table with a sig value of 0.01<0.05. Thus, it can be concluded that H0 is rejected and H1 is accepted, which means the population (X1) significantly influences the built land (Y), which further means that the variable X1 (population) is significantly included into the model. Next, the variable X3 (social facilities) is included into the model after the variable X1 (population) (Table 4).

Table 4

Partial analysis (t-test) of X1 variables on Y

Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*
		B	*Standard error*	*Beta*		
1	(Constant)	-1514.344	366.177		-4.136	0.009
	Population density	0.012	0.002	0.959	7.533	0.001

The results of the regression analysis between variable Y (built land) with variable X3 (social facilities) obtained a tcount of 1.753, where the value is smaller than the value of the table (n-2) at a 5% confidence level, 2.571. The value is higher than the one in the ttable with a value of sig. of 0.154>0.05 (Table 5). Thus, it can be concluded that H0 is accepted and H1 is rejected, which means that social facilities (X3) have no significant effect on built land (Y), meaning that variable X3 is not significantly entered into the model.

Table 5

Analysis of variables (t-test) X1 and X3 against Y

Number	*Model*	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*
		B	*Standard error*	*Beta*		
1	(Constant)	-1569.318	309.441		-5.071	0.007
	Total population	0.009	0.002	0.689	3.676	0.021
	Social facilities	1.278	0.729	0.329	1.753	0.154

The results of the partial analysis showed that the independent variable (X), which affected the dependent variable (Y), consisting of variables X1 (population) and X3 (social facilities) had no effect on the dependent variable (Y). Based on the results of the t-test (partial), the best regression equation is obtained to determine the relationship between the built land (Y) with the independent variables that influence: Y=-1569.318+0.009 X1, where Y is built land, X1 is the population, and Y is less than or equal to the subdistrict area.

Conclusions. The growth of built land is increasing yearly and the sprawl index value of 2.2 means that the growth of built land is more dominant compared to population growth. The suitability between the built land growth and the existing Spatial Plan direction resulted in an inconsistent proportion of land area (17.32%) for Bandung Wetan subdistrict, Bandung Kidul subdistrict (15.14%), and Coblong subdistrict (10.08%). The results of the dynamic analysis in built land changes in Bandung City Cikapundung riverside are expected to be considered by the government in applying standard rules for developing and structuring the Cikapundung riverside settlement area properly. Based on the analysis results, the percentage of built land increase in the study area yearly is not only influenced by population increase, but also by the number of facilities that support the population in their activities.

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