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Analysis of land use and cover changes in Ciliwung and Cisadane Watershed in three decades

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Abstract

The globalization and the developing of technology cause the increasing of human needs, which impacted to land use and cover change (LUCC), particularly in watershed area. Two watersheds have been investigating, namely Ciliwung and Cisadane watershed. The LUCC in those watersheds still continues since the growth of society and economy are increasing. Therefore, it needs a significance breakthrough to analyze the driving factors of LUCC. The aims of this research are 1) to monitor and analyze the LUCC, and 2) to figure out the driving factor of the LUCC. The outputs are LUCC maps, spider web diagram and the driving factor of a change during three period of time, i.e. 1978, 1995 and 2012. The LUCC and its driving factors were analyzed through Landsat satellite image. The results show the LUCC are always changed during those periods. The LUCC in those watershed following several processes and in the end changed into settlements and dry lands, predominantly.

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Keywords: driving factors; geographic information system; landsat image; logistic regression analysis; watershed management.

1. Introduction

The fulfillment of community needs always grow and demanding. Those impacts the excessive nature exploitations. One of those impacts can be found in Ciliwung and Cisadane Watershed. The land use and cover change (LUCC) impacted the remain forest only left 12.0% in Ciliwung and 36.6% in Cisadane Watershed [1]. The excessive change influences the water quality [2], decreasing ecological condition [3,4], giving negative effect to next generation. One of negative effects of LUCC is increasing carbon emissions because reducing area that serves

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as a regional carbon sequestration [5]. Those negative effects can be minimized by a robust watershed management [6] through geographic information system (GIS) technology. This technology gives information about the occurrence of LUCC remotely of the area to be examined.

This research are planning to achieve goals, i.e. 1) classifying the major changes of LUCC and 2) determining the driving factor impacting on LUCC. The classifying are derived from Landsat image of three periods, i.e.1978, 1995 and 2012. The driving factor are calculating statistically using auto logistic regression [7].

2. Methodology

2.1 Location

This research was carried out in Ciliwung and Cisadane Watershed (Fig. 1). The geography, location and boundaries of those watersheds are presented in Table 1. The data acquisition are shown in Table 2.

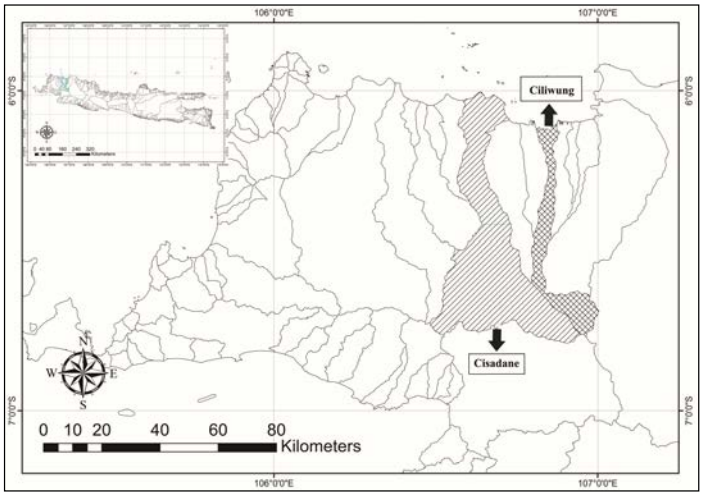

Fig. 1. The Location of Ciliwung and Cisadane Watersheds

Table 1. The general information of Ciliwung and Cisadane Watershed

Name of Watershed	Geography Location	Area (ha)	Administrative Regions
Ciliwung	06° 06’ 00” - 6° 46’ 12” S and 106° 48’ 36” - 107° 00’ 00” E	38,610.25	Bogor District, Bogor City, Depok City, and Jakarta Province
Cisadane	06° 37' 48” – 6° 46' 12” S and 106° 49' 48” – 107° 00' 00” E	151,808.00	Bogor District, Bogor City, Tangerang District, and Tangerang City

Table 2. Landsat data acquisition

Landsat Data	Acquisition Date
LANDSAT1 MSS	July 17th, 1978 Path 131 Row 065
	July 17th, 1978 Path 130 Row 065
LANDSAT5 TM	August 8th, 1995 Path 122 Row 065
	July 25th, 1996 Path 122 Row 065
LANDSAT7 ETM+	May 26th, 2012 Path 122 Row 065

2.2 Research methods

The methods used are:

- Inventory: the compilation of required data for research. The data were obtained by compiling spatial information and field survey check. The spatial information [8] was obtained through landsat imagery for three periods, i.e.1978, 1995 and 2012 which were used to perform the comparison of the LUCC. The field survey check [9] was conducted by taking 15 sampling of each land use/cover classification.
- Analysis: the examining of training area followed by classification of supervised classification, prediction accuracy, detection of change of land use/cover and determination of the driving factor.
- Stepwise regression analysis: the clarifying of correlation of six variables, i.e. rainfall, soil type, slope, population, population density, and the distance to the city centre.

3. Results

3.1 Landuse and cover identification and changes during three times

Based on image classification, all of land use and cover class in Ciliwung and Cisadane Watersheds always changing (Fig. 2). Ciliwung Watershed is dominated by built up area and Cisadane Watershed is dominated by dryland area.

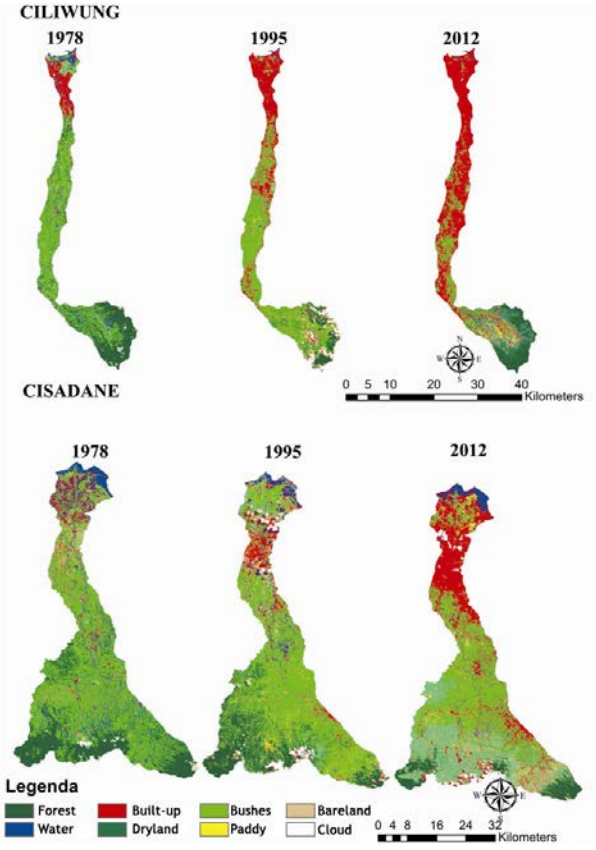

Fig. 2. The LUCC of Cimandiri and Cibuni Watersheds during three periods

3.2 Driving factor

The results of LUCC that occurred during three periods are correlated with six variables. The equation of linear regression using the stepwise regression through logistic regression analyses (LRA) method (Table 3). Our finding shows five variables are impacted the LUCC of Ciliwung watershed, while there are three variables that effect of the LUCC in Cisadane Watershed (Table 4). It means the variables of population density, the distance to city centre and precipitation should be considered in government development programs in order to detain the LUCC acceleration. In addition, those programs should figure out that the LUCC is the result of the complex interactions between behavioural and structural factors (drivers) associated with the demand, technological capacity, social relations and the nature of the environment in question [10]. On the other hand, this research results in compliance that climate-driven land-cover modifications interact with land-use changes [11].

Table 3. The result of LRA method for the correlation of the LUCC

Name of Watershed	Period	Equation
Ciliwung	1978-1995	$Y = 0.100 + 0.156\ X_1 - 0.11\ X_2 - 0.001\ X_3 - 0.010\ X_5 + 0.670\ X_6$
	1995-2012	$Y = 75.190 + 1.410\ X_1 - 0.630\ X_2 - 0.070\ X_3 - 0.700\ X_5 + 12.540\ X_6$
Cisadane	1978-1995	$Y = 166.950 + 12.840\ X_1 - 7.300\ X_5 - 614\ X_6$
	1995-2012	$Y = 268 + 2.130\ X_1 - 6.720\ X_5 - 1332\ X_6$

Table 4. The LUCC driving factors of Ciliwung and Cisadane Watershed

Name of Watershed	Rainfall (X_1)	Soil type (X_2)	Slope (X_3)	Population (X_4)	Population density (X_5)	The distance to the city centre (X_6)
Ciliwung	(+)	(-)	(-)	no	(-)	(+)
Cisadane	(+)	no	no	no	(-)	(-)

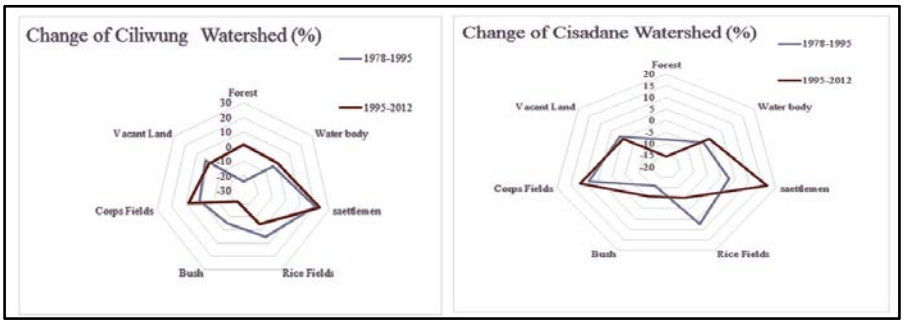

Fig. 3. The LUCC Spider web diagram of Ciliwung and Cisadane Watershed

4. Conclusion

Based on the results of the land use/cover classification in 1978, the largest is bushes, while water bodies continued to decline from 1995 to 2012. The LUCC of 1978 to 1995 noted that the changing is 64,83% while not changing is 35,17%. In addition, the LUCC that occurred in 1995 to 2012 is 56,04%, while not changing is 43.96%. The method of LRA by using stepwise regression produces five variables that influence the LUCC. Five variables impacted to the LUCC of Ciliwung i.e. precipitation, soil type, slope, population density, and distance of the city centre, while three variables that affect the Cisadane watershed are precipitation, population density, and the distance to the city centre.

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