SUSTAINABLE MEGACITIES: vulnerability, diversity, and livability

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Foreword

More than half of the world's population now lives in urban areas. Rapid urbanization in Asian developing countries over the past half century has been followed by excessive urban population concentration in very large urban agglomerations, so called as megacities. The UN defined megacity as a metropolitan area urban agglomeration complex with more than 10 million inhabitants. The number of megacities in the world has increased from 10 megacities in 1990 with 153 million of population or 7 percent urban population of the world to become 28 megacities in 2014 with 453 million populations or 12 percent urban population of the world. The United Nations expected that by 2050 about 66 percent of the world's population will live in cities (UN, 2014).

The rapid growth, high population density and high consumption rate of residents in megacities has led to a wide range of local and global socioeconomic and environmental impacts which requires attention from the global community. Therefore, it will significantly affect the future prosperity and sustainability of the world. The Greater Jakarta or Jabodetabek is experiencing continuous growth that seems to be an unstoppable phenomenon and at the same is facing various problems that may not have been experienced by other major cities in the world. The result of many studies showed that the carrying capacity of the environment, especially land and water in Java Island where Jabodetabek lies, is already overshot. However, given the relatively rapid growth of Mega Urban Jakarta, it is possible that Jakarta will grow to be the world's largest megacity.

Amid the global concern on the negative impacts of the continuing megacities' growth on global environment, the Center for Regional System Analysis Planning and Development (CRESTPENT/P4W), Bogor Agricultural University (IPB) has established Jabodetabek Study Forum since 2001. This Study Forum has conducted biennial international seminar on complex mega-urban issues on Asian megacities as well as urbanization and urban-rural linkages in Asian countries. The biennial conference has a tradition of organizing two types of paper presentations, namely scientific papers and community papers. This year's conference will also open a session for local government officials. This proceeding book covers papers from nearly all the presentations delivered during the conference.

We hope that this proceeding book will be able deliver the aims of the conference: to recognize multi-dimentional aspects, perspectives and knowledge on megacities; to communicate and facilitate experiences, policies, and studies related to challenges of continuing development of Jabodetabek and Asian Megacities, as well as solutions to address these challenges; and to bring up common understanding on the development of Jabodetabek and Asian Megacities.

Bogor, April 2015

Organizer

Content

Spatio-Temporal Land Use and Cover Change Analysis in Southern Region of West Java's Watersheds

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ABSTRACT

The regional development in south region of West Java is very slow, unlike in the northern region. There are two watersheds located in southern region, namely Cimandiri and Cibuni watershed which represent the condition in the southern region. Learning from the north region development, Cimandiri and Cibuni watersheds should consider the environment aspect in their land development process which can be achieved by studying the land use and cover spatially and periodically in both watersheds. The purposes of this study are to identify the land use and cover change in both watersheds periodically and to analyze the driving forces. The used methods are supervised classification and Logistic Regression Analysis (LRA). The results is land use map of Cimandiri and Cibuni watershed in 1978, 1995/6, and 2012, with their land use change maps and diagrams. Farm field, forest, and bushes field are dominating in both watersheds. Both watersheds are still undeveloped, since the built up area percentage is less than 5 percent. The driving factors for Cimandiri watershed are precipitation, population density, and distance to the city, and elevation, while those in Cibuni watershed are slope, population density, and elevation.

Keywords: Geography Information System, LANDSAT Image, Land Use and Cover Change, Spatio-Temporal Analysis, Watershed Management

INTRODUCTION

The development of north region West Java around Jakarta Bogor Depok Tangerang and Bekasi (Jabodetabek) is constantly accelerating, contrary the development in south region of West Java is very slow, although there are many potential lands for development [1, 2]. Meanwhile, the development that occurred in the north region has caused many problems toward the ecological condition, and gradually caused disasters for people who live there [3-6]. The ecological degradation and disasters have to be analyzed as the correlation of the watershed land use development and changing [7, 8].

There are two watersheds are located in south region of West Java which are adjacent to each other, namely Cimandiri and Cibuni watersheds that flow from Gede-Pangrango and Salak mountains. Those watersheds are not yet developed, therefore a robust planning and development should be conducted by the local government, by considering to the previous year of developments and analyzing the factors as driving force the development itself. The watershed function as provider of ecosystem services should be managed in order to achieve the low carbon societies (LCS). The LCS is part of a research project published by Britain and Japan in 2006 Kyoto Protocol which considered the land use/cover change (LUCC) activities. In order to get the information about the development changes and its driving factors, a spatial approach is necessary to identify the LUCC in the previous three decades, and to analyze the drive force of the changes.

METHODOLOGY

Location, tools, and materials

This study was located in Cimandiri and Cibuni Watersheds, West Java, Indonesia (Fig. 1). The tools used in this study consist of some hardwares, which are digital camera, GPS and some softwares i.e. geography

system (GIS) and statistical analysis. Materials used are Landsat images (year of 1978, 1995/6, 2012 (Table 1), administrative boundary map, watershed boundary map, precipitation map, digital elevation model (DEM), soil type map, and demography data. This study used remote sensing technology to identify LUCC in Cimandiri and Cibuni watersheds periodically, identify the land use and cover changes, and analyze the change's driving factors, also to make recommendations for both watersheds' management.

Table 1. Landsat Imagery 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

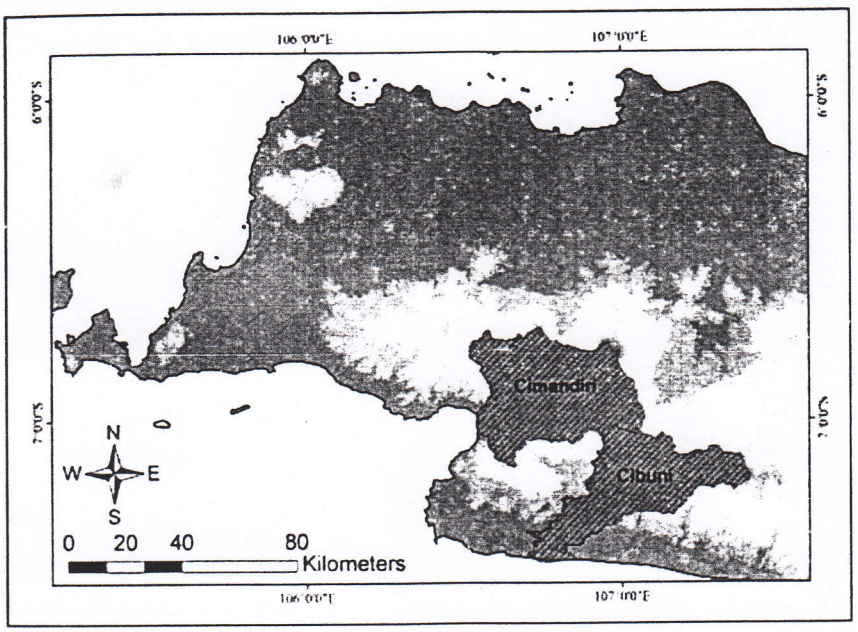

Figure 1. Cimandiri and Cibuni watersheds location

METHODS

The main method used in the study are supervised classification for land use and cover identification, post classification comparison for LUCC identification, and logistic regression analysis (LRA) for driving force analysis. Land use and cover that classified in this study are (1) water bodies, (2) forest, (3) agricultural field, (4) vacant land, (5) built up area, (6) farm field, (7) bushes, and (8) cloud. The factors analyzed in the study by using LRA are (1) soil type, (2) elevation, (3) slope, (4) precipitation, (5) population, (6) population density, (7) distance to main city, and (8) distance to main road.

RESULT AND ANALYSIS

Land use and cover classification

Using LANDSAT images, land use and cover classification maps have been made. The second period, 1995/6, is necessary to be different from the other two periods because the cloud cover both in 1995 and 1996 are too high, therefore it needed to be combined to create a better land use and cover classification map.

Based on Figure 2 and Table 2, on the first period, 1978, both watersheds are dominated by bushes (
green), while on the next period, 1995/6, Cimandiri watershed is dominated by farm field (yellow),
Cibuni watershed is dominated by forest (dark green), finally on the last period, 2012, Ciman
watershed is still dominated by farm field, and Cibuni watershed is dominated by bushes. Ciman
watershed that covers most of Sukabumi District has agricultural economic characteristic, so the fa
field dominates the watershed on the last two periods. On the other side, Cibuni Watershed is the le
developed one, showed by the percentage of built up area is only around 2,550 ha (1.78%). The built u
area development in Cimandiri Watershed focused on Sukabumi City and along the main road th
connect Sukabumi City and the northern region of West Java, especially Bogor City. It may be caused b
some factors that have been hypothesized.

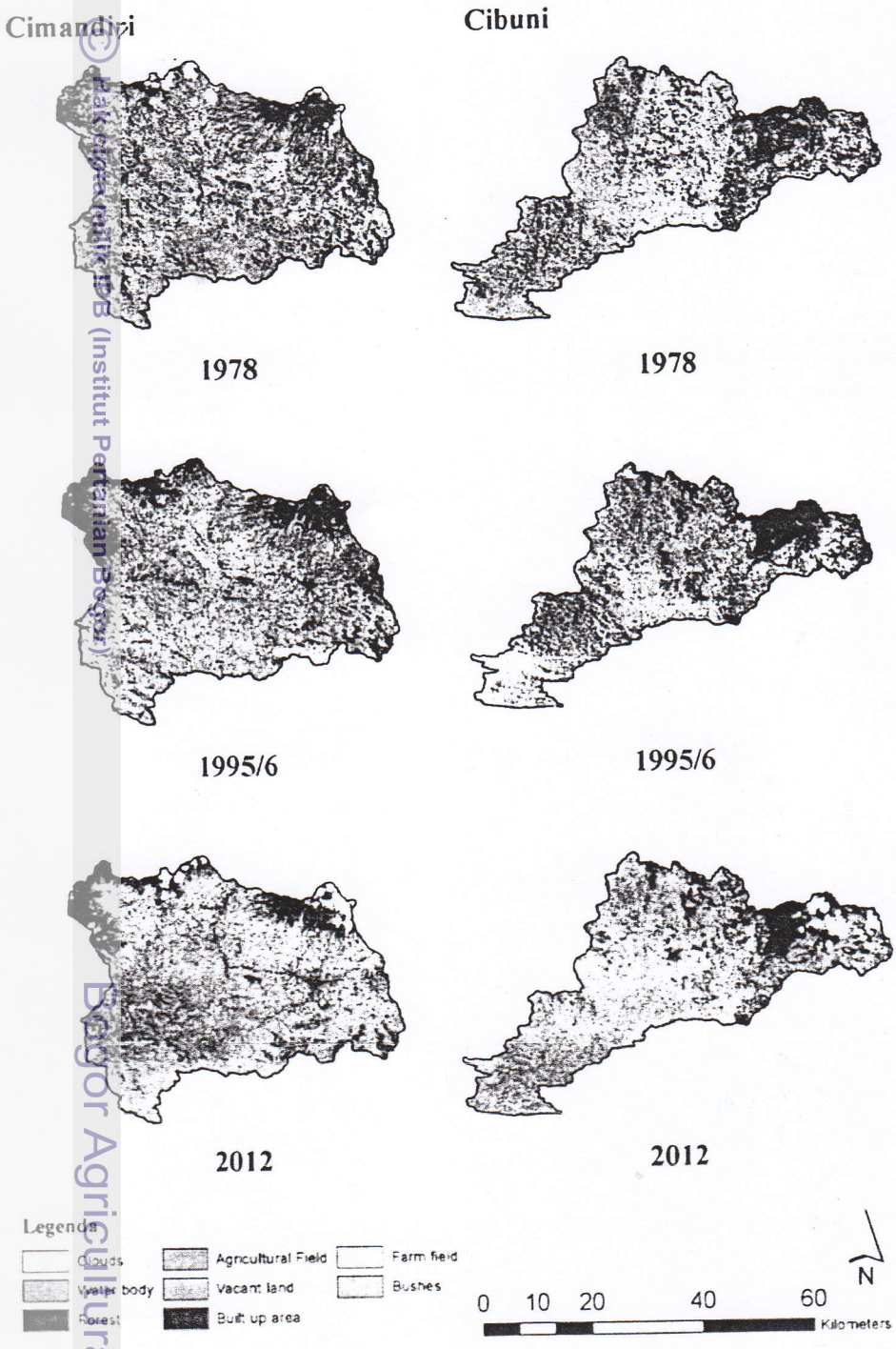

Figure 2. Land use and cover classification for Cimandiri and Cibuni Watersheds

Land use and cover area in Cimandiri and Cibuni watersheds

Land Use Classification	Cimandiri Watershed (ha)			Cibuni Watershed (ha)		
	1978	1995/6	2012	1978	1995/6	2012
Cloud	3,127.32	6,707.70	4,093.56	1,135.44	1,419.39	4,014.81
Water bodies	1,586.52	1,439.91	674.19	1,067.04	790.65	583.20
Forest	40,755.96	47,446.47	39,576.51	35,085.24	46,358.73	35,650.53
Agricultural field	33,144.12	14,152.23	14,164.83	12,208.68	15,735.51	10,986.03
Bare land	1,605.24	809.19	10,845.63	1,080.00	235.35	5,581.44
Built up area	2,973.60	7,321.86	11,659.95	831.24	1,214.10	2,550.96
Farm field	24,234.48	55,120.86	59,302.62	24,194.16	39,826.08	41,237.01
Bushes	76,350.24	50,103.54	43,155.90	68,497.92	35,190.09	43,094.79

Land use and cover changes identification

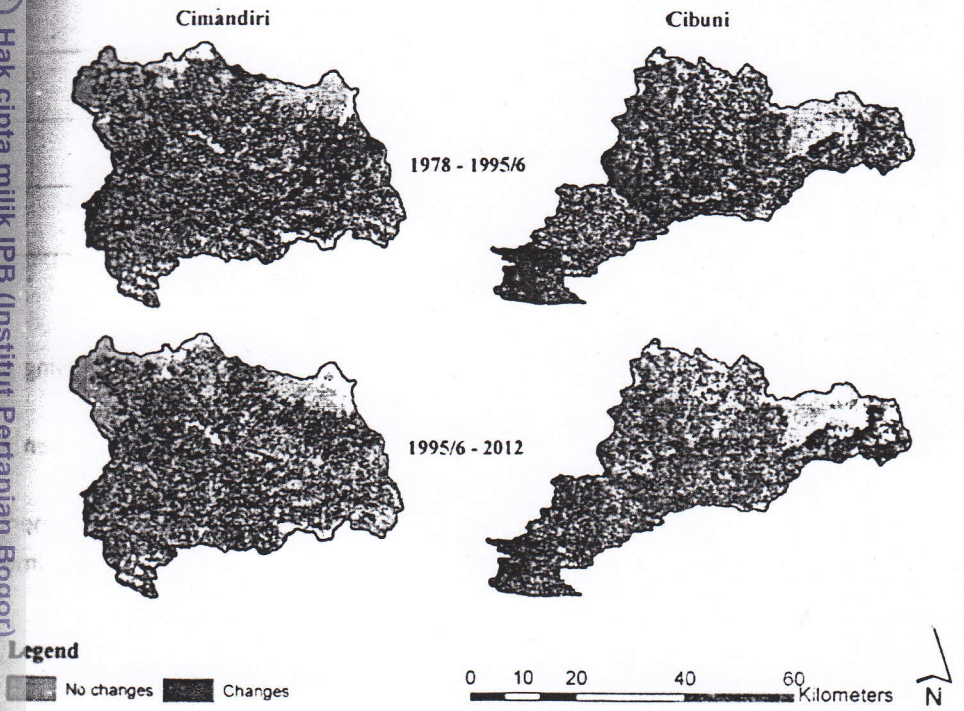

Figure 3. Land use and cover change for Cimandiri and Cibuni Watersheds

use and cover changes happened in most area of both watersheds (Figure 3). The percentage of land use change (Table 3) in Cimandiri watershed in 1978 to 1995/6 is 59.85 percent and 55.00 percent in 1995/6 to 2012, while in Cibuni watershed is 63.07 percent in 1978 to 1995/6 and 61.96 percent in 1995/6 to 2012. Based on this result, it can be stated that LUCC in both watersheds are significantly changing in three previous decades.

Table 3. The diagram of LUCC changing from 1978, 1996 and 2012

Period	LUCC Changing	Cimandiri		Cibuni	
		Area (ha)	Percentage (%)	Area (ha)	Percentage (%)
1978-1995/6	Unchanged	69,749.64	40.15	50.556,15	36.93
	Changed	103,975.83	59.85	86.342,31	63.07
	Total	**173,725.47**	**100.00**	136.898,46	**100.00**
1995/6-2012	Unchanged	77,800.05	45.00	51.783,84	38.04
	Changed	95,077.26	55.00	84.341,70	61.96
	Total	**172,877.31**	100.00	136.125,54	**100.00**

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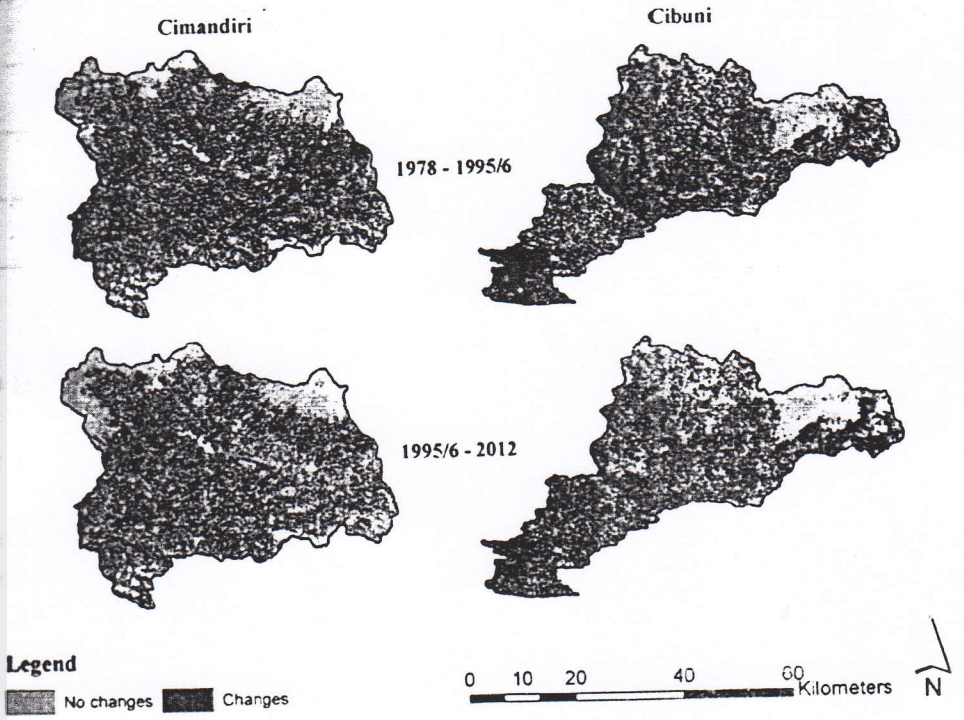

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	Total	172,877.31	100.00	136.125,54	100.00

Driving Force

Based on LRA results, there are five driving forces influenced the LUCC in Cimandiri Watershed i.e. elevation, precipitation, population density, population, and distance to main city, while there are three driving forces in Cibuni watershed i.e. elevation, slope, and population density (Table 4). The positive notation means that the higher the variable obtained, the more LUCC happens, while the negative notation means the less the variable obtained, the more LCC happens.

Table 4. LUCC Driving Forces in Cimandiri and Cibuni Watersheds

		Soil Type (X_1)	Elevation (X_2)	Slope (X_3)	Precipitation (X_4)	Population (X_5)	Population Density (X_6)	Distance to Main City (X_7)	Distance to Main Road (X_8)
Cimandiri	1978 – 1995/6		-		-		+	+	
	1995/6 – 2012		-						
Cibuni	1978 – 1995/6		-	-					
	1995/6 – 2012		-				+		

Recommendations

Following the driving factor results, there are three recommendations purposed for slowing down the LUCC in Cimandiri and Cibuni Watershed as well as environmental management:

1. Conserving forest in low land area and strengthening regulations for green open spaces in watershed,
2. Increasing agricultural infrastructure supported with counseling program to local farmers, and
3. Controlling urbanization by conducting migration to un-dense area and at the same time planning for vertical building application to anticipate the growing of built up area horizontally.

CONCLUSION

Based on the research, it can be concluded that there are three land use and cover classes that dominates Cimandiri and Cibuni Watersheds. They are farm field, forest, and bushes. The LUCC are significantly changing from 1978 to 1995/6 and from 1995/6 to 2012, which is more than 50 percent of LUCC area. There are five LUCC driving forces in Cimandiri Watersheds, while there are 3 LUCC driving forces in Cibuni Watersheds. The recommendations for these conditions have been discussed.

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