

学位論文の要旨 (論文の内容の要旨)
Summary of the Dissertation (Summary of Dissertation Contents)

論 文 題 目
Dissertation title

Assessing Land Use and Land Cover Change toward Sustainability
in Humid Tropical Watersheds, Indonesia

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Land use and land cover (LULC) change is increasingly considered as an important component of sustainability studies particularly in landscape change. It is also a central part of global environmental changes in current strategies for managing natural resources. In Indonesia so far many researches related to analyzing LULC change and its ecological impacts. Due to research priority, there is a present and growing need to assess the sustainability level of watersheds in Indonesia. The originality, as well as the main purpose of this study, is that it is the first attempts in assessing LULC change toward sustainability or degree of watershed sustainability in humid tropical watersheds in Indonesia.

The landscapes focus of this research are the two selected watersheds humid tropical watersheds in Indonesia, which are located in Sumatera island (Batang Merao watershed) and Java island (Cirasea sub-watershed). Batang Merao watershed, a representative of the little known land change in humid tropical region in Indonesia, is one of the key regions of LULC research and plays an important role in maintaining the conservation function of Kerinci Seblat National Parks and socioeconomic function of Jambi Province, Indonesia. Cirasea sub-watershed, a representative of the Indonesian's most densely populated watersheds, was also selected for this research because it is one of the most important sub-watersheds of Citarum watershed, a main water resource in West Java. Cirasea sub-watershed has a prominent role as a conservation area and buffer zone of ecosystem in relation to other regions. Environmental degradations in this landscape can disturb the sustainability of conservation and cultivation functions. In addition, it had undergone substantial land use and land cover change and it was subject to high population pressure.

Chapter 1 primarily presents an overview of dissertation including background of the study, statement of research problem, aim and objectives, the significance of the study, scientific contribution of the study and structure of the dissertation.

Chapter 2 consists of theoretical background and methodological approaches, i.e. theory of LULC, analysis of LULC, theory of watershed and watershed management, theory and application of sustainability and its assessment, general description of watershed management in Indonesia and technical steps of general methodological approaches.

Chapter 3 aims to investigate dynamic patterns and driving forces of LULC, and population pressure from 2006 to 2011. Dynamic patterns have been investigated with GIS and Remote Sensing techniques, driving forces have been analyzed with multiple regressions combining biophysical and socioeconomic variables, whereas population pressure has been quantified with Population Pressure Index (PPI). The results indicated that dynamic of LULC showed an increase in agricultural area (mix plantation and agricultural land), with mainly at the expense of forest and shrub/bush. On the contrary, forest area decreased from 24.20% in 2006 to 18.13% in 2011 respectively. Annual rate of LULC change clearly showed that the dynamics of different LULC classes over the study periods. The socioeconomic driving factors that significantly involved

in the dynamic of LULC change were population growth/pressure, number of farmers, GDRP agriculture, GDRP total, and Human Development Index (HDI). Change in LULC and its dynamics were closely associated with human activities in the region such as the expansion of agricultural area. The results are critically important for sustainable watershed management where agriculture is the major income for most people in and around the watershed.

The first section of chapter 4 aims to determine the relationship between land use land cover (LULC) changes and land degradation using multi temporal Landsat data from 1990, 2000 and 2010. The results showed that during the last two decades, two major changes took place. Forest decreased at rates of 330.85 ha y⁻¹ (period of 1990-2000) and 145.25 ha y⁻¹ (period of 2000-2010); on the other hand, agricultural land, mix plantation, and settlement have shown increments. Concerning land degradation, Batang Merao watershed exhibited potential soil degradation where the mean annual potential land degradation was 128.03 ton ha⁻¹ y⁻¹ in 1990, 144.68 ton ha⁻¹ y⁻¹ in 2000 and 194.14 ton ha⁻¹ y⁻¹ in 2010. This study reveals that there is relationship between LULC change and land degradation that land cover type plays an important role in protecting soil from land degradation in this watershed. In order to prevent the areas from an extremely high level of land degradation, the proper use of land cover and soil conservation program are highly recommended to be widely implemented.

The second section of chapter 4 investigates the relationship between LULC and water quality in the watershed. The water quality parameters were analyzed by using the Water Pollution Index (WPI) and STORage and RETrieval (STORET) methods as the national standard of river water quality in Indonesia. Analysis of variance, correlation analysis, and stepwise multiple regression analysis were used to investigate spatial and temporal variations of LULC, water quality, and the relationship between them. The water quality study revealed that Batang Merao watershed was classified as lightly polluted (86.67%) and moderately polluted (13.33%) meanwhile, the STORET results indicated that about 80% of them were moderately polluted. Statistical analysis showed that there was a relationship between LULC and water quality parameters. As implication that there is a growing need to evaluate the status of water quality in order to anticipate its potential negative impacts of water quality degradation in the watershed.

Chapter 5 examines LULC change, population pressure and priority determination on handling land degradation in West Java, as a comparative study. The results of this study showed that most areas of Cirasea sub-watershed where high soil erosion, population pressure and degraded land areas that were more much higher and complex than the condition in Batang Merao watershed. This case study contributes to the direction of handling land degradation at watershed scale. Because of the high population growth, it should be better to involve people participation in the soil conservation and reforestation program.

Chapter 6 aims to assess the sustainability of Batang Merao Watershed for the period of 2006-2011 using HELP (Hydrology, Environment, Life and Policy) indicators. The results showed, the watershed was at an intermediate level of watershed sustainability (overall WSI score = 0.59) and was still in high pressure due to its pressure parameter, which was higher than both state and the response parameters. This mean that this watershed needs kind of improvement or management to reach the better level of sustainability (>0.59). Therefore, it is urgent to improve the integrated watershed management programs for achieving the sustainability of this watershed.

Finally, Chapter 7 generally discusses the major findings and the implications of the study, recognizes the limitation of the study, suggests direction for future research, and finally gives recommendations.

The main contribution of this study is that it was successful in assessing LULC change and its ecological impacts, and could contribute to land and watershed planning in order to achieve sustainability in humid tropical watersheds in Indonesia. On the conceptual level, the research highlights the dynamic and complex relationship of LULC change at the watershed level. In terms of the methods, this research invite the open room and challenge of bringing together various data sources and methods toward sustainability in humid tropical watersheds. Finally, this research is a kind of pioneer in successfully assessing the sustainability in Batang Merao Watershed. Therefore, in Indonesia perspective, what we have done hopefully will be followed by the policy makers related watershed management.

備考 論文の要旨はA4判用紙を使用し、4,000字以内とする。ただし、英文の場合は1,500語以内とする。

Remark: The summary of the dissertation should be written on A4-size pages and should not exceed 4,000 Japanese characters. When written in English, it should not exceed 1,500 words.