DEVELOPMENT OF GEODATABASE AND ITS SPATIAL ASSESSMENT FOR RECLAMATION PROGRESS MONITORING IN INDONESIAN OPEN PIT COAL MINE

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Considering the importance of reclamation in mining activities, many regulations related to reclamation have been issued by the Indonesian Government. The regulations include the Law of the Republic of Indonesia, the Government Regulation, the Minister of Forestry Regulation, the Minister of Energy and Mineral Resources Regulation, and others. Mining companies have to comply with all applicable regulations which mainly obligate mining companies to restore the disturbed land to its initial condition as much as possible. Mining companies also have to submit the progress report of reclamation to several government authorities refer to each applicable regulation. As each government authority and regulation has a different requirement, mining companies should provide the complete database and information to accommodate these requirements.

From the above background, this dissertation proposed a new assessment method to solve the problems in the current reclamation area in Indonesian open pit coal mines. The proposed method is the spatial assessment method. This spatial assessment method combines a direct field investigation and analyses of secondary data, spatial data, and raster data using a geographic information system (GIS). This spatial assessment was chosen and proposed due to its advantages, such as that the geographic location of the data in the field can be identified. The results enable integration with satellite image data and other spatial data. The results are integrated with attribute data that contains important information about the object. The output of this spatial assessment can be visualized by using a map, table, and chart. QuickBird satellite imaging was applied to this study to obtain up-to-date information and to minimize field work activities in large reclamation areas. QuickBird satellite imaging is suitable for this study because it has a high spatial resolution (0.6-2.4 m), complete multispectral bands (panchromatic, red, green, blue and near infra-red), a short revisit time or a temporal resolution (1-3.5 days). In order to achieve the subject of this study, the dissertation discussion is carried out in seven chapters as follows:

Chapter 1 introduces the background of this study, problems related to this research topic and previous research related to the assessment of the reclamation area using remote sensing technique and geographic information system. The objective of this study is described in this chapter.

Chapter 2 describes the description of this study area in the S1 area of KPC coal mine, Indonesia, including its location, topography, climate, soil, geology, and hydrology.

Chapter 3 discusses the methods and the instruments used to assess the site preparation stage of reclamation in Indonesian open pit coal mines. This study focuses on the assessment's parameters that influence the reclamation progress and determine the success of reclamation. This study demonstrates the utilization of QuickBird satellite imaging and GIS to obtain the boundary of the reclamation area and the land cover map. The 3D analysis tool, ArcGIS 9.3, is utilized to generate the slope and elevation maps. Meanwhile, a field investigation was also conducted to obtain several data that are difficult to be obtained from secondary data. In the field investigation, a soil sampling and analysis were conducted to verify the result of satellite image interpretation and to evaluate its soil carrying capacity for plant growth. The topography conditions of this study area had already been reshaped according to the company's specifications for the rehabilitation area. From the results of spatial assessment, their slope angles are classified in the ranges of 0–3%, 3-8%, 8-15%, and 15-30%; their lengths ranged from 50–200 m; their elevations ranged from 50-110 m above sea level. These results show that the topography of this study area is proper for reclamation and their slopes are stable. Moreover, 3D analysis can be adopted to analyze the topographic condition of the reclamation area. From these results, it can be said that this spatial analysis method can substitute the field survey for measurement of the slope condition and elevation.

Chapter 4 describes the methods and instruments used to evaluate the soil erosion control stage of reclamation in Indonesian open pit coal mines. In this study, the soil erodibility and soil erosion rate is evaluated by using soil erodibility equation and the universal soil loss equation (USLE). Originally, the USLE was developed in the U.S. to estimate soil erosion rate for agriculture area and it is the first time to apply the USLE to the reclamation area in open pit coal mines, especially in tropic regions in Indonesia. This equation is used to predict the vulnerability of the reclamation area against soil erosion. From the results of this analysis, it was found that the soil erodibility of this study area ranges from 0.313-0.498 and its erosion rate mostly ranges from 0-10 tons/ha/year. The high soil erodibility value and soil erosion rate indicate the susceptibility to soil erosion. However, it was also found from the field investigation that several soil conservation structures established by the mining company can prevent and/or minimize the soil erosion. Moreover, the

cover crop was applied to all reclamation areas to stabilize the soil's surface against soil erosion. From these results, it can be said that the USLE method is reliable to evaluate soil erosion in large reclamation areas and to provide the spatial distribution of the soil erosion rate in all reclamation areas. Moreover, the effect of the soil erosion control measures conducted by the mining company can also be evaluated by a field investigation.

Chapter 5 describes the methods and instruments used to assess the revegetation stage of reclamation in Indonesian open pit coal mines. In this study, the evaluation of actual vegetation conditions in the field is focused on. The assessment parameters include the planting area, plant health, composition of plant species, and normalized difference vegetation index (NDVI). QuickBird satellite imaging was used for NDVI analysis to obtain the distribution of vegetation density. A field investigation was performed to observe the actual condition of vegetation and verify the results of NDVI analysis. From the results of the proposed assessment method, the characteristics of the revegetation stage in this study area can be represented as follows: a high percentage of local species (mostly >60%), a high percentage of healthy plants (mostly >90%), and a wide variation of vegetation densities (mostly in the range of 0.25-0.50, 0.50-0.75, and 0.75-1.00). Moreover, the result of overlay analysis between vegetation densities and planting year maps shows that the older the planting area is, the higher the positive NDVI values are. Therefore, it can be said that NDVI analysis using QuickBird satellite imaging can be adopted to evaluate the revegetation progress of reclamation areas in Indonesian open pit coal mines. Also, the result of NDVI analysis and the actual condition of vegetation can be verified by a field investigation.

Chapter 6 introduces the geodatabase to manage spatial data, attribute data, and raster data obtained from the assessment of reclamation stages discussed in Chapter 3 to Chapter 5. This system has been developed in ArcCatalog ArcGIS 9.3 software integrated with ArcToolbox and ArcMap. This integration adds the capability to perform various spatial and raster data analyses to this geodatabase besides the storing and displaying of data. This geodatabase can be applied to several spatial analyses to support an analysis of the reclamation progress. The spatial analyses include the land capability analysis, land suitability analysis, spatial linkage analysis, and spatial-raster data analysis. The developed geodatabase can provide the required data by the government in the form of a number that is stored as attribute data. It also provides the graphic data, geographic location, and spatial distribution of the data. Therefore, this geodatabase may give a great help to Indonesian mining companies not only for success of the reclamation process and but also for providing data and/or assessment results required by government authorities. The data accumulated by this geodatabase will greatly help to develop the reclamation guideline for Indonesian open pit coal mines.

Chapter 7 concludes the research findings and the results of this study.