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in The International Seminar on Land Reclamation Technology for Sustainable  
Land Use at The University of Jambi, Indonesia  
on 6<sup>th</sup> - 7<sup>th</sup> November 2014*



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# LAND RECLAMATION THROUGH SOIL AND WATER CONSERVATION METHODS: A Review<sup>1</sup>

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## ABSTRACT

Degradation of land function is increasing as caused of some exploitative human activities, especially mining. Jambi Province is one of region that has high potential in mine material and targeted area for mining exploitation like coal. The coal mining has caused soil function changes, although at post mining have refilled. The functions of soil are including hydrology and fertility functions. This paper discuss about several techniques of soil and water conservation to reclaim ex-coal mined land. Therefore, land ex coal mined in Jambi must be reclaimed in order to reuse for many uses. Organic carbon content is important indicator for soil productivity, because soil organic carbon influences on soil compaction, porosity, and nutrient availability. Based on Law Indonesia No. 37/2014 about soil and water conservation and *World Overview of Conservation Approaches and Technologies* (WOCAT), soil and water conservation methods consist of vegetative, agronomy, structure, and management method. But the effective soil and water conservation methods to increasing and maintenance soil organic carbon are (1) agronomy method and (2) vegetative method. Both of them are easier and cheaper than structure method. The structure method need specific knowledge, complicated, and high cost.

**Key words: land reclamation, ex-mined land, soil carbon organic, agronomy approach, and vegetative approach**

## INTRODUCTION

In Indonesia, the land degradation is accelerated by several land uses without principles of soil and water conservation. Based on data from Forestry Ministry of Indonesia Republic (2014), critical land area in Indonesia on 2011 have been 27.29 million ha and 1.42 million ha is at Jambi Province. The area of critical land at Jambi Province is increasing significantly than the critical land area on 2005. The critical land area at Jambi Province on 2005 was only 0.62 million ha. Based on Indonesia Republic Law No. 37/2014 about soil and water conservation, critical

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<sup>1</sup>Presented at International Seminar “Land Reclamation Technology for Sustainable Land Use”, on 6-7 November 2014, at Jambi University

land is the land that have bad function as production media to grow crop and plant. The critical land have potency arise degraded land.

The land use for mining without land reclamation constitute one of causes of land function degradation. In Indonesia, the more amount of mining license (IUP) with no control to land reclamation post mining, the more area of degraded land. According to data from Directorate General of Mineral and Coal of Energy and Mineral Resources Ministry (2013), amount of the registered mining permit have been 10,809 and consist of 5,502 mining license clear and clean and 5,307 mining license non clear and clean. The Jambi Province constitute one of provinces that have quickly increasing of mining license. Therefore, the area of critical land at Jambi Province is also susceptible increasing, especially when mining without reclamation post mining. Based on data from Statistical Agency of Jambi Province (2014), on 2013, the amount of mining license at Jambi Province is 349, consist of 208 exploration license and 141 exploitation license. The coal mining license constitute the most license mining at Jambi Province.

The degraded land (including ex-coal mining land) must be reclaimed as soon as possible because the increasing of the degraded land area will influence on water availability, food security, health, and increasing of poverty. The rate of land reclamation is not balance with rate of land degradation. The land reclamation need time, resource, and high cost than land degradation. According to data from Forestry Ministry of Indonesia Republic (2014) can be knew that on 2013, government of Indonesia Republic is only able to rehabilitate 664,067 ha of forest and land.

Several result of research showed that land reclamation with several soil and water conservation application. Hermawan (2011) proved that ex-coal mined land is suitable for food crop, after 12 years reclaimed by revegetation (vegetative method of soil and water conservation). Every soil and water conservation methods have advantages and disadvantages. Therefore, selection of soil and water conservation method for land reclamation have to considerate availability resources. This paper discuss about soil and water conservation method application to support reclamation of ex-coal mining land.

## CHARACTERISTICS AND PROBLEM OF EX-COAL MINED LAND

The land degradation is reduce or loss of biological or economic productivity and complexity of rained cropland, irrigated cropland, or range, pasture, forest and woodland resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitat pattern, such as soil erosion caused by wind and/or water; deterioration of the physical, chemical, and biological or economic properties of soil; and long-term loss of natural vegetation (UNCCD, 2012). The other nomenclature called the degraded land as destroyed land. The destroyed land can't be as production media to grow crop and plant (The law of Indonesia Republic No. 37/2014). The land degradation is caused by erosion, salinity, acidification, contamination, forest fire, waterlogging, and mining. The cause of land degradation including natural and human activities factors. The human activities factor constitute accelerated factor for land degradation. The human activities factor can degrade land direct and indirect. The cause direct for land degradation including erosion, land and crop management, deforestation, activity of industry and mining, urbanization, and infrastructure of development, contamination, and degradation of water cycle. Furthermore, the cause indirect for land degradation including population depression, land tenure, poverty, labour availability, input of infrastructure, education, war/conflict, and government/institutional (*World Overview Conservation Approaches and Techniques/WOCAT*, 2010).

Activity of coal mining constitute one of activities that have potency to arise land degradation. The coal mining (with open pit method) result big pit as cause dredging top soil and it is saved at the other place. Therefore, Zulkarnain (2014) proved that the coal mining cause land degradation because happened soil properties changes. Physically, the change of landscape and erosion cause arising parent material of soil to surface. The parent material layer have low productivity because soil structure is degraded and high compaction of soil. Therefore soil have degradation hydrology (including low water holding capacity, infiltration capacity, and percolation) and bad soil aeration. Chemically, soil have low pH (high acidity), arising salt with high sulphate and toxic to crop. Chen *et al.* (2009) showed that the new ex-mined land have more amount of sand fraction than before, low cation

exchange capacity, low organic carbon, low nutrients, and high ferroxide. Herdina *et al.* (2012) showed that ex-coal mining land at Ombilin have high acidity (moderate acid, pH 6.5), very low organic carbon (0.73%), and moderate Phosphorus-available (20.77).

The abandoned ex-coal mining also resulted excessive acid and in turn flow to lake, stream, and river. Megharaj *et al.* (2013) proved that chromate constitute one of heavy metals that can arising to surface on ex-coal mining land and in hexavalent form it can soluble in water easily, toxic, and carcinogenic. Therefore it is very hazard for environment. Based on result of research can knew that coal mining cause soil productivity reduction and heavy metal contamination. The condition of ex-coal mining land showed problems to reuse it especially for agriculture land. The type of vegetation that grow at ex-coal mining land is very limited. In addition, acid mine drainage also have negative effect on surface water and ground water quality. According to Saviour (2013), the mining at Indian region have caused colour of river water become to brownish and reddish orange, low pH (between 2-3), high electrical conductivity, high concentration of ions of sulphate and iron and toxic heavy metals, low dissolved oxygen (DO) and high BOD. This is also problem to reuse ex-coal mining land for the other uses type.

#### **LAND RECLAMATION – SOIL AND WATER CONSERVATION**

The reclamation is a process recondition of disturbed land to more productive for several uses (Glossary of Reclamation and Remediation Term, 2002). The land reclamation is an activity in mining stage to manage, recover, and improve environment quality and ecosystem that can use according to its capacity (Rule of Energy and Mineral Resources Minister of Indonesia Republic No. 7/2014). The core of land reclamation is recovery soil function according to its capacity and use, but should not back to the first condition. The land reclamation constitute part of soil and water conservation because according to Arsyad (2010), soil and water conservation is all of effort to protection, recovery, improvement, and maintenance of soil function on land according to its capacity and use to support sustainable development and life with mechanic/physic, vegetative, and chemical method.

According to the law of Indonesia Republic No. 37/2014, soil and water conservation including recovery of soil function on land and is conducted based on watershed, ecosystem, and land unit by vegetative, agronomic, structure, management, and the other method that suitable to science development. This method is adopted from development by world overview conservation approaches and technologies (WOCAT). The vegetative method is a soil and water conservation with planting especially with trees. The agronomic method is a method that have objective to improve or increase soil productivity, as manage cropping system, conservation tillage application, fertilization, and mulching. The structure method is a soil and water conservation method with land use change or management. The successful of land reclamation depend on problem of ex-mining land, objectives of reclamation, method, commitment of practitioner, and controlling.

#### **SOIL AND WATER CONSERVATION METHODS FOR EX-COAL MINED LAND RECLAMATION**

The reclamation of ex-coal mining land can conducted with several soil and water conservation method application. The productivity problem on ex-coal mining land can handle by soil organic carbon improvement. The soil organic carbon constitute representation of soil organic matter that have role to improve soil physical, chemical, and biological properties. Research about soil organic carbon improvement have done by reseachers, including several type of ameliorant application as organic fertilizer and green manure.

Several method of soil and water conservation have been used for reclamation of ex-coal mining land. But, the most method for reclamation of ex-coal mining land are revegetation and bioremediation. Both of them constitute soil and water conservation method namely vegetative and agronomic method. The research improved that revegetation on ex-coal mining land after 5, 8, and 12 years can improve physical and chemical properties of soil and suitable for food crop (Hermawan 2011; Zulkarnain, 2014). But according to Sheoran et al. (2010), revegetation on ex-coal mining land could also improve biological condition of soil. Ulfa et al. (2011) showed that after reclamation, ex-coal mining land have Arbuscular Mychorriza Fungi (AMF) as well. Species of Arbuscular Mychorriza

Fungi on ex-coal mining land depend on reclamation age and dominant plant that grow on ex-coal mining land. Not only Arbuscular Mychorriza Fungi can be found on ex-coal mining land, but also can be isolated soil microbial.

Soil microbial can help better revegetation process because capacity of soil microbial can reduce heavy metals to unavailable form (Widyati, 2008; Herdina *et al.*, 2013). Bacterial of Sulphate reduction was effective for bioremediation process on ex-coal mining land in 20 days incubation as well. The activities of bacterial of sulphate reduction can reduce sulphate concentration on ex-coal mining land with rate efficiency 89.76% and increase soil pH from 4.15 to 6.66.

## CONCLUSION

The land reclamation constitute part of soil and water conservation. Furthermore the reclamation of ex-coal mining land can conducted by various soil and water conservation method. But, the most method and the most effective method are vegetative and agronomic method, because easier and cheaper than structure method. The most vegetative and agronomic method for reclamation of ex-coal mining land are revegetation and bioremediation.

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