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Use of Vegetation Cover for Erosion Control Physical Characteristics of Soil Improvement in Post Coal Mining in South Kalimantan

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Abstract : *The aims of the research is to evaluate the uses of Desmodium adscendens, Pueraria phaseloides, Centrosema pubescens and Calopogonium mucunoides as a potential species for land rehabilitation in post coal mining in South Kalimantan. Result of the study shows that vegetation cover in post coal mining land able to reduce land erosion risk. The experiment shows that soil surface with plant covers contributes significantly in erosion control. The erosion rate average at soil surface without vegetation cover was about 27.22 ton ha^{-1}. It was followed by soil witch Centrosema pubescens cover (2.13 ton ha^{-1}) and Calopogonium mucunoides (0.33 ton ha^{-1}). plot with Pueraria phaseloides (P2) has erosion rate 0.24 ton ha^{-1}. Plot with Desmodium adscendens has erosion rate 13 ton ha^{-1}. In term of erosion controls potential, there are no significant difference between soil with Desmodium adscendens and soil with Centrosema pubescens.*

Keywords : *erosion control, post coal mining management, degraded land, land rehabilitation*

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I. Introduction

Kalimantan Island is home of biodiversity and contributes significantly in global environmental climates. This islands blessed by numerous living creature and diverse indigenous community which are considered as a crucial resources for the future global development. The contribution of tribal community in forest and land management through indigenous knowledge is crucial in term of the sustainability of island's resources [1]. Kalimantan island is also blessing with abundance oils and coal deposit which area become the main energy for global community. Oils and coal is contributes significantly in the national economic [2].

Coal mining in South Kalimantan Province is one of the massif mining activity, in which it is reported numerous problem. Problem raging from social, economical and environmental aspect which are contributes to the local conflict. Environmental degradation is one of the main problems which are widely reported. Mining destroy tropical forest, clearing vegetation and remove fertile top soils. Mining contributes to land pollution, land slide and increase of waste which area dangerous for community. Post coal mining in South Kalimantan requires the restoration of degraded lands. This has required science and knowledge of the ecosystem structure, including land and soils, before restoration implemented. Restoration program requires funding support which are in many cases the amount was limited [3] [4] [5] [6].

There is comprehensive knowledge on the contribution of vegetation in land conservation. Vegetation have been reported becomes potential agent to countermeasure soil erosion. Vegetation contributes significantly to reduce run off and soil erosion, and in many post mining area vegetation has been chosen as a cheap way to improve soil structure. Vegetation also reported able to improve soil characteristic, both in term of chemical and physical aspects. Slope stabilization and erosion control has employed vegetation as a biomechanics techniques, and it is widely reported success in many regions. Ecologically, the use of vegetation to countermeasure soil erosion should be considered the locality of the species. Species should be able to grows easily in natural situation, and provides positive benefits for local environment [7] [8].

There are many research to analyze the effect of vegetation to reduce soil erosion. Scholars point out that the type of species and vegetation composition ultimately contributes to the ability of vegetation to reduce soil erosion and increase soils contrition in post mining area or other degraded lands [9]. There is potentially to explore naturalized flora in South Kalimantan Province as a vegetation component in soil erosion reduction in

post coal mining area. South Kalimantan has numerous potential flora [1] [2] in which may of the has potentiality as a component for land rehabilitation in post coal mining area. The objectives of the study is to evaluate the uses of four species, namely *Desmodium adscendens*, *Pueraria phaseloides*, *Centrosema pubescens* and *Calopogonium mucunoides* as a potential species for land rehabilitation in post coal mining in South Kalimantan.

II. Methodology

Field experiment was done in post-mining reclamation land in South Kalimantan Province, Indonesia. Geographically, it is located at 02º11'12" S and 115º30'33.3" E with altitude 104 meter asl. (Fig. 1). Experiment was done in disposal land fill area of post mining lands.In order to evaluate the potential of vegetation to reduce soil erosion hazard, an experimental plot was established in disposal land fill area. Plots with 4 x 10 meter were setup at the slope with 35 meter in length and height 12 meter. Experiment design was includes (1) control plot, a plot without legumes plant as land coverage (P0), (2) plot with *Desmodium adscendens* (P1), (3) plot with *Pueraria phaseloides* (P2), (4) plot with *Centrosema pubescens* (P3), and (5) plot with *Calopogonium mucunoides* (P4). *Desmodium adscendens* seedling was prepared from mature fragment herbaceous stem, while *Pueraria phaseloides*, *Centrosema pubescens* and *Calopogonium mucunoides*were grown from seedling at polybag plastics before transferred and planted at plot experiment after six weeks. Each plot was replicated 3 times for soil erosion experiment. Sediment container by 2,5 m x 4 m x 1 m was set up in the bottom of the slopes to analyzed to soil erosions. The effects of vegetation of each plots (Po, P1, P2, P3 and P4) on soil erosion were analyzed descriptively. The observation was done when rains occurs. Water rain will influence soil surface and produce soil sediment which area collected at the container. The collected soil sediment was transferred to laboratory for further analysis.The analysis includes erosion rate, water holding capacity, soil aggregate stability and soil permeability. Data was analyzed using F test and DMRT test (5%).

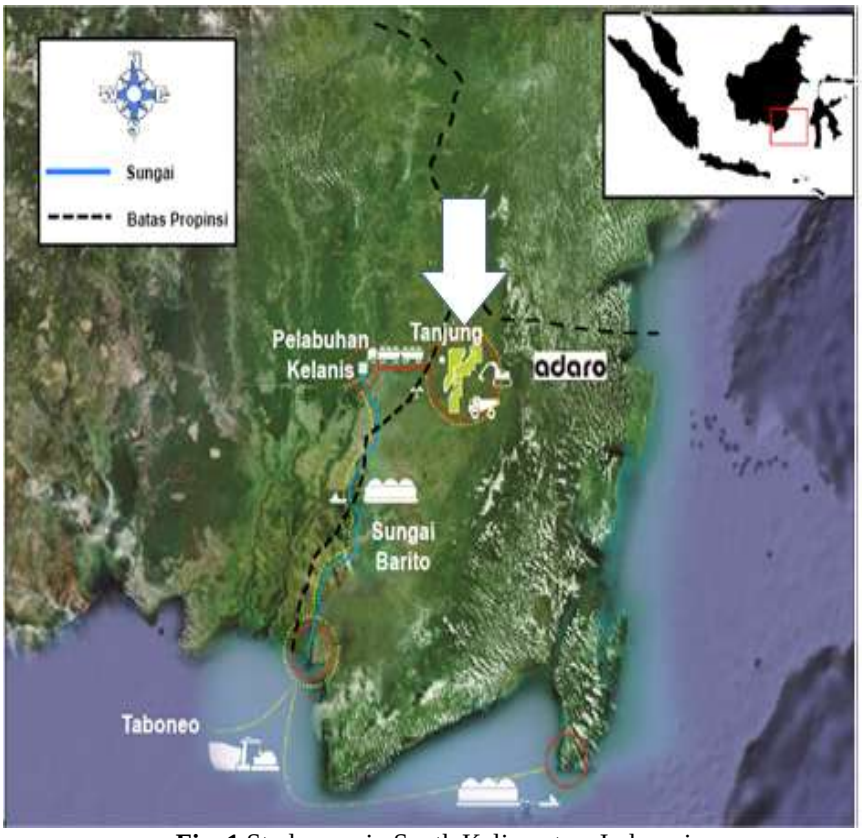

Fig. 1. Study area in South Kalimantan, Indonesia

III. Result And Discussion

Rainfall is important factors in land erosion. Rainfall intensity influence the rate erosion. In the study area, meteorological data shows that low rainfall intensity (<100 mm) occurs in July, September and October. The rainy season recorded long in 2014 and it is contributes significantly in many land erosion incident.

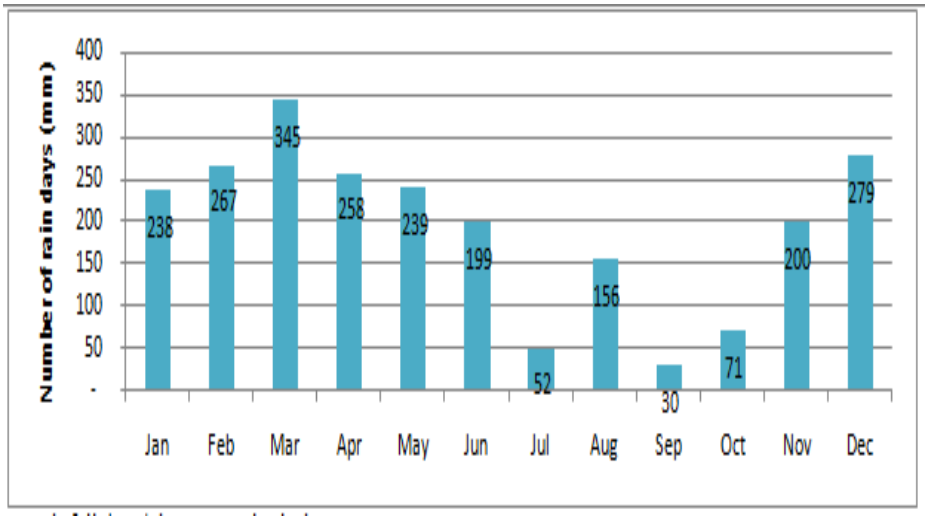

Fig.2. Rainfall (mm) in area study during 2014

The experiment shows that soil surface with plant covers contributes significantly in erosion control. The erosion rate average at P0 was about 27.22 ton ha^{-1}, while in P2 was about 0.24 ton ha^{-1}. The erosion average at P3 was calculated about 2.13 ton ha^{-1} and in P4 was about 0.33 ton ha^{-1}. In P1 (plot with *Desmodium adscendens*), the erosion averages was calculated about 0.13 ton ha^{-1}. The soil erosion in soil surface with *Pueraria phaseoloides* (P3) has highest erosion rate than soil with soil surface with *Desmodium adscendens* (P1), soil surface with *Centrosema pubescens* (P3) and soil surface with *Calopogonium mucunoides* (P4). In term of erosion controls potential, there are no significant difference between soil with *Desmodium adscendens* (P1) and soil with *Centrosema pubescens* (P4), soil surface with *Calopogonium mucunoides* (P4) (Fig.3).

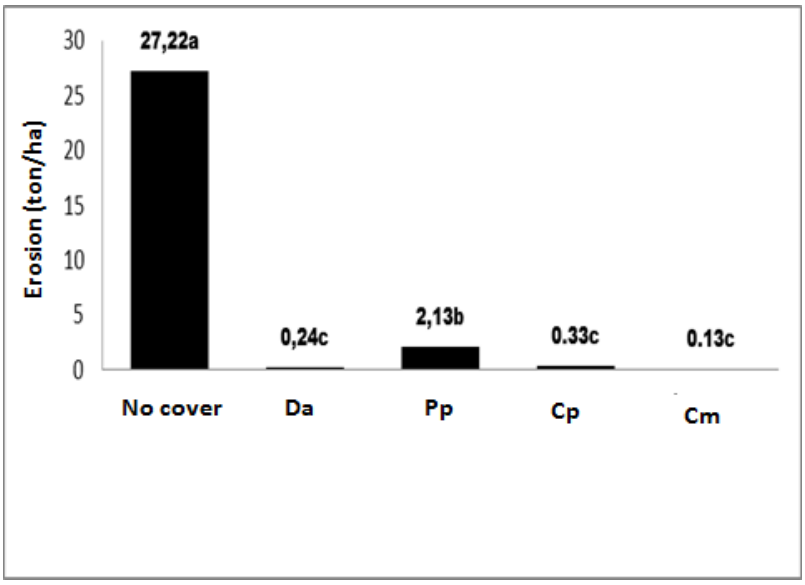

Fig. 3. Plant contribution to minimize potential erosion in post-mining lands (ton/ha). Notes:Da; soil with cover *Desmodium adscendens*, Pp= soil with cover *Pueraria phaseoloides*, Cp= soil with cover *Centrosema pubescens*, and Cm= soil with cover *Calapogonium mucunoides*.

Plant in plots P1 and plot P4 has similar potential ability to control erosion ranging from 0.13 ton ha^{-1} to 0.33 ton ha^{-1}, better that soil surface with plant cover in plot P2 and P3. Roots system of plant has ability to control soil erosion. Research report by Balai Penelitian Tanah Bogor (2010) [10], shows that *Calopogonium mucunoides* able to use as pioneer plant species in rehabilitation program ofland which are degraded by erosion process. As a cover plant, *C. mucunoides* (Fabaceae) native to tropical America, but recently this species widely spread in many tropical regions, including in Indonesia. This species able to 40-60 cm; but in some case the species able to grows up to several meters. The soils fertility seems influence the grows of the species in tropical

regions. In sandy soils, *Calopogonium mucunoides* can produce animal feeds about 25-30 t/ha/year. In natural condition, plant able to grows rapidly. This plant adapted to hot and wet environment, and therefore suitable as pioneer plant species in land rehabilitation program in degraded land. A lot of number of roots contribute significantly to hold soils particle and therefore contributes significantly in land stability. The roots also contributes in soil organic matter, and therefore this species good for soil improvement program [10]. *Calopogonium mucunoides* provides important benefits not only for soil risk reduction, but this palnt also provides benefit for nitrogen fixation, in which it is important for soil fertility [11].

According to FAO (2012) plant cover has ability in tolerate soils with low fertility, and therefore it is important in rehabilitation programs as pioneer species [12]. Post coal mining land often has minimum organic matter and has low soil fertility. The introduction of legumes plant is important initial steps because legumes plant able to absorb nitrogen from the atmosphere, in which nitrogen is essential nutrient for plant. Legumes is important plant in agricultural technology, especially in term of nitrogen fertility enhancement and soil condition improvement in many countries [13]. The uses of legumes plant as land cover in initial stages of lands rehabilitation provides many advantages, ranging from decreasing erosion threats, and increasing organic matter and increasing land fertility. According to Scholar point out that organic matter in soil able to increase land aggregates stability and increase the infiltration and percolation ability of lands [14]. Soil type in study area is disposal lands, or technically in mining it is called over burden soil. This lands was used to cover post mining lands.

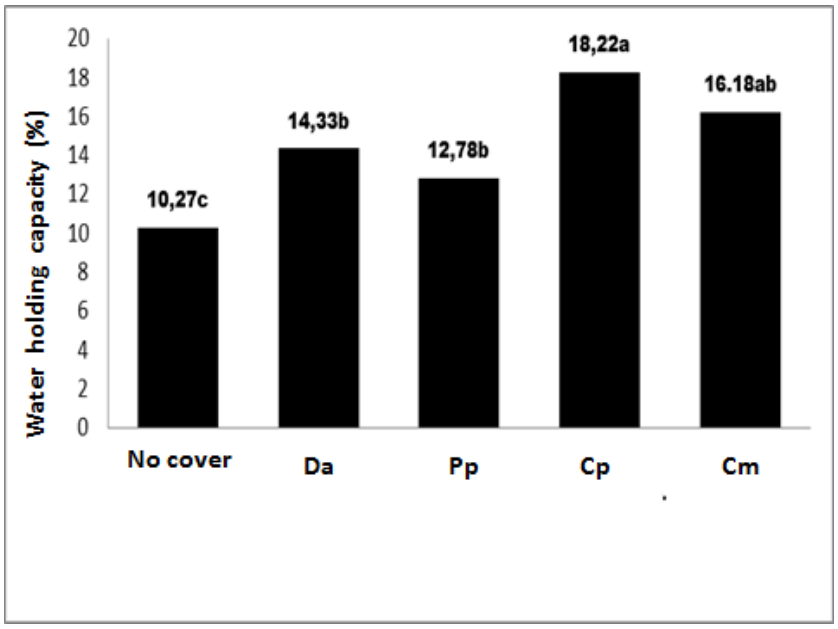

Fig 4. Ability of vegetation in increasing the water holding capacity in post mining land in study area. Notes: Da; soil with cover *Desmodium adscendens,* Pp= soil with cove *Pueraria phaseoloides,* Cp= soil with cover *Centrosema pubescens,* and Cm= soil with cover *Calapogonium mucunoides*. *Similar alphabetic symbols shows now significant different in DMRT test 5%

Fig. 4 shows that planting vegetation in experimental plot able to increase significantly the water holding capacity of soil compared to the land without vegetation (control). Soil with cover *Centrosema pubescens* shows highest contribution to increase water holding capacity, following by soil with covering *Calapogonium mucunoides*, *Desmodiuma dscendens,* and *Pueraria phaseoloides*. Plot experiment P1 shows significant different with plot P0 and P3, but there are no significant difference with P2 and P4. Water holding capacity in plot P1 better than P2. The ability of *Desmodium adscendens* in increasing water holding capacity in post mining soil related to the ability of the species population to covers reclamation lands. In the field, it is observed that the population of *Desmodium adscendens* reach to ±20 cm, with clumped roots. The length of roots was about 10-15 cm. This situation lead impact of rainfall to soil surfaces reduced systematically and cause water flow goes slowly in soil surface. According to Masnang (2011) water capacity to hold water was different, depend on the land structure, soil texture, and organic content in soil [14]. Soil with good texture and rich organic matter abke to hold water compare to soil with poor organic matter.Soil with rich oraic matter often has four time capacity to hold water than soil without organic matter or clay [14].*Desmodium adscendens*

(Fabaceae) native to Africa, Asia tropic, Northern and Southern America is a tropical herbs which area recently grows in many tropical regions.

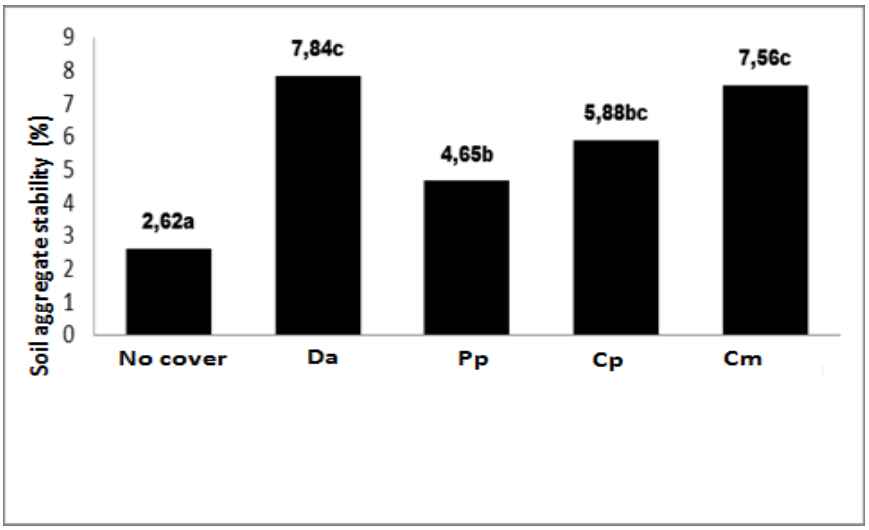

Fig 5.The ability of *Desmodium adscendens*in increaseing soil agregate stability in post coal mining lands. Notes: Da; soil with cover *Desmodium adscendens,* Pp= soil with cover *Pueraria phaseoloides,* Cp= soil with cover *Centrosema pubescens,* and Cm= soil with cover *Calapogonium mucunoides*. *Similar alphabetic symbols shows now significant different in DMRT test 5%.

Compared tothe soil without vegetation cover, plant cover contributes significantly in the increase of soil aggregate stability (Fig. 5). Soil with cover *Desmodium adscendens* contributes higest soil aggregates stability, following by soil with *Calapogonium mucunoides*, *Centrosema pubescens* and *Pueraria phaseoloides* covers. The lowest soil aggregation stability found in soil without vegetation covers. This data indicates that vegetation contributes in soil aggregate stability. Soil aggregate stability in P1 significantly different with P0 and P2, but there are no significant different with plot P3 and P4. The ability of *Desmodium adscendens* in increasing soil aggregate stability in post coal mining better than plot P3 and P4. This aggregate stability has correlation with the content of organic matter [15].

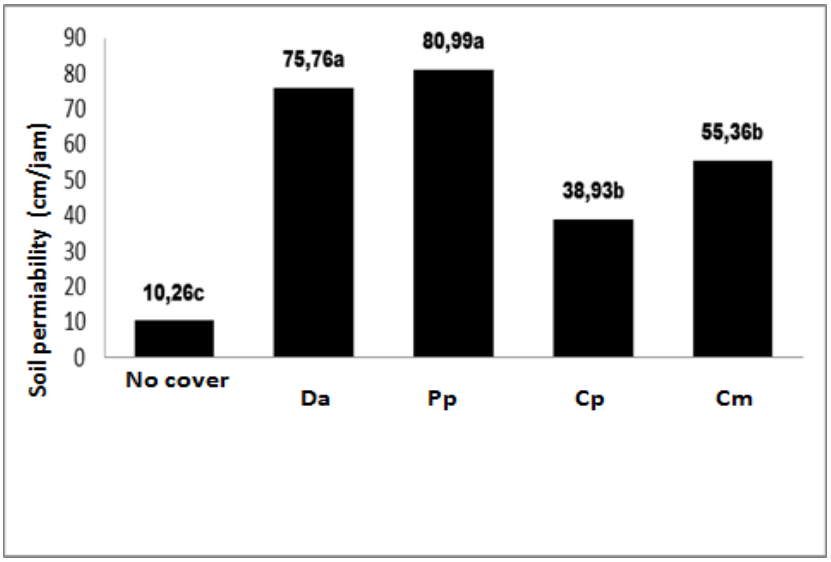

Fig. 6. Ability of *Desmodium adscendens* in increasing soil permiability in post coal mining. Notes:Da; soil with cover *Desmodium adscendens,* Pp= soil with cove *Pueraria phaseoloides,* Cp= soil with cover *Centrosema pubescens,* and Cm= soil with cover *Calapogonium mucunoides*. *Similar alphabetic symbols shows now significant different in DMRT test 5%

Fig. 6 shows that treatment of the land cover significantly increase soil permeability. Soil with cover *Pueraria phaseoloides*hashighestpermeability, following by soil with coverage *Desmodium adscendens, Calapogonium mucunoides* and *Centrosema pubescens*. In plot P1 shows significant differenet with plots P0, P3

and P4, but there are no significant different with P2. The ability of *Desmodium adscendens* as a vegetation land cover not significnatly different with *Puerariap haseoloides* in increasing soil permeability. *Puerariap haseoloides* (Fabaceae) is one of the tropical forage with deep-rooted charateristics that are potential for soil erosion control. This species native to China and south East Asia, including Indonesia, and therefore ecologically has been adapted with local climates in South Kalimantan. This species also well adapted to numerous soil types and no significant pest and diseases was reported; represent the potentiality of the species as a vegetation component in land rehabilitation programs in degraded lands [16].

Vegetation roots can increase soil physical properties and strengthening soil infiltration. The roots system is also able to reduce surface runoff, in which it is important to minimize erosion risk. Therefore, the uses of *Centrosema pubescens*, *Calapogonium mucunoides*, *Desmodium adscendens*, and *Pueraria phaseoloides* can be introduces as vegetation cover in post mining lands. It has been well investigated for many plant species that the usage of plants have strong influence on lands stabilization [17] [18]. This research provides similar result with other research, and confirm that vegetation is crucial in soil erosion control.

IV. Conclusion

Plot covered by vegetation shows ability to reduce soil erosion in post coal mining area.Soil with cover Centrosema pubescens shows higest contribution to increase water holding capacity, following by soil with covering Calapogonium mucunoides, Desmodium adscendens, and Pueraria phaseoloides.Soil with cover Desmodium adscendens contributes higest soil aggregates stability, following by soil with Calapogonium mucunoides, Centrosema pubescens and Pueraria phaseoloides covers. Soil with cover Pueraria phaseoloides has highest permeability, following by soil with coverage Desmodium adscendens, Calapogonium mucunoides and Centrosema pubescens.

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