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Agricultural Land Evaluation on Coastal Areas of Kebumen Regency Based on Land Degradation Levels for Biomass Production

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Abstract-The research was aimed at identifying : (1) the type and area of agricultural land in the coastal areas of Kebumen Regency; (2) the degree of land degradation and (3) the status and the causes of land degradation. The research was undertaken using a semi-detail soil survey based on the interpretation of Landsat imagery. Methods of observation and data analysis were undertaken in accordance with the government regulation of the Republic of Indonesia No. 150/ 2000 concerning land degradation control for biomass production and Minister of Environment Regulation No. 7/2006 regarding the measurement procedures for standard criteria of land degradation for biomass production. The results indicated that: (1) existing land uses consisted of irrigated rice field (14,849.7 Ha); rain-fed rice field (2,210.3 Ha); dry land (3,189.2 Ha); garden (844.7 Ha), grasses and shrubs (446.1 Ha); settlement, bodies of water, and beaches (9,819.1 Ha); (2) the severity of land degradation was grouped as follows: very low (10,993.5 Ha); low (20,359.2 Ha); and medium 6.4 Ha; (3) land degradation status of the area was classified as slightly damaged (score < 7) with soil fraction, soil porosity, soil permeability and redox potential values as the main determining parameters of land degradation.

***Keywords*:** coastal, land degradation, biomass

1. Introduction

Soil as a land component is a main natural resource that should be utilized, maintained and improved for sustainability of human and other living creatures. Composed of minerals, organic matter, water and air, soil possesses a very dynamic physical, chemical and biological characteristics (Foth, 1990). Land Degradation refers to changes in soil conditions resulting in loss of its potential production capability. Land degradation can be induced by human activities or natural processes. In developing world, deteriorating land is greatly induced by human activities such as over exploitation and mismanagement of land. Meanwhile, infrastructure development, fast-growing population and urban sprawling have put heavy pressure on land. Other factors like absence of land use policy and ineffective implementation of laws and regulations might also have a great influence on land degradation. Natural events such as floods, salinisation and acidification can also significantly decrease functional capabilities of soil.

Land degradation can be viewed from three aspects i.e. physical, chemical and biological aspects. Physical damage is usually related to soil compaction, water balance and soil erosion. The decreased chemical quality of soil is generally associated with the processes of soil acidification, salinity, alkalinity and toxicity. While biological aspects include decreasing in biodiversity and biomass carbon.

Biomass refers to organic matter generated from the photosynthetic process. Biomass can be in the form of primary products or co-products or residues. Primary

products basically include plant parts such as leaves, stems, seeds, nuts, flowers and bulbs While co-products include plant residues, animal manures and other agricultural waste. Besides being used as primary purposes like for food, fibre, animal feed and building materials, biomass can also be used to produce energy like bio-fuels (Demirbas and Balat, 2006). Land utilisation for economic purposes, especially for biomass production without considering its nature and properties may result in land degradation (Siradz, 2006).

Land can be regarded as degraded if there is a decreased quality in physical, chemical or biological conditions as determined based on standard criteria for soil damage. According to the Government Regulation of the Republic of Indonesia No. 150 (2000) regarding land degradation control for biomass production, there are at least 10 parameters of soil properties to be observed in order to identify the severity of degradation. The parameters include solum thickness, soil surface stoniness, fraction composition, total porosity, soil permeability, soil pH, electrical conductivity, redox potentials, number of soil microorganisms. The observation and determination procedures for the parameters are based on Minister of Environment Regulation No.7 (2006) concerning standard criteria observation procedures for land degradation for biomass production. The determination of the severity of the land degradation can be then used as a guidance for land users and the local government to determine necessary preventative measures and rehabilitation of degraded land.

Regency of Kebumen is situated in the southern part of Central Java Province along the coastline of Indian ocean. Administratively, Kebumen consists of 26 districts with the total area of 128,111.5 hectares. According to the local statistics office, in 2013 the land utilisation in Kebumen can be grouped into two main landuses i.e. rice fields that covers an area of 39,748 hectares (31.04%) and dry land 88,343 hectares (68.96%) which can be further divided into upland agriculture (42,799.5 hectares) and non-agricultural landuse (45,543.5 hectares). According to the development vision 2005 - 2025., the local government of Kebumen is committed to achieving its development goals with the motto "Kebumen Mandiri dan Sejahtera Berbasis Agrobisnis" or "Self sufficient and Prosper Kebumen on the Basis of Agribusiness" (Regional Government Regulation of Kebumen No. 23., 2012). Based on that vision, land degradation data and management play an important role in supporting Kebumen as one of the agriculture centers in the Central Java.

The objectives of the study were to identify: (a) the type and area of agricultural land in the coastal areas of Kebumen Regency; (b) the degree of land degradation and (c) the status and the causes of land degradation

2. Materials and Methods

The study was carried out using a semi-detail soil survey method based on the interpretation of Landsat imagery. Soil samples were determined based on the homogenous land unit (HLU) obtained by overlying a number of maps including geological, topographic, climate, and land use maps. Data observation and analysis were conducted based on Government Regulation of the Republic of Indonesia No. 150 (2000) regarding land degradation control for biomass production and Minister of Environment Regulation No.7 (2006) concerning procedures for standard criteria determination for land degradation for biomass production. The parameters include solum thickness, soil surface stoniness, soil fraction composition, total porosity, soil permeability, soil pH, electrical conductivity, redox potentials, number of soil microorganisms (Food and Agriculture Organization, 2006).

Two methods were employed to determine the severity of land degradation, i.e. Matching Method and Scoring Method.

a. Matching Method

Matching method was conducted by comparing data obtained from the observations of soil damage parameters and standard criteria for soil damage as formulated in the Government Regulation No. 150 (2000). The comparisons were used to classify the severity of the soil damage of each land unit as damaged (D) or not damaged (N).

b. Scoring Method

Scoring method is conducted by assigning values of each parameter with values ranging from 0 to 4 (Table 1.). Relative frequency is a percentage value which is determined based on the comparison of the number of soil samples that are classified as damaged and the total number of soil samples. In this research, the number of soil samples was 15. Hence, the relative frequency of damaged soil was calculated as follows:

$$\text{Relative Frequency} = \frac{\text{Number of soil samples that is classified as damaged}}{15} \times 100\%$$

Table 1. Score for soil damage based on relative frequency

Relative Frequency of Damaged Soils (%)	Score	Soil Damage Status
0-10	0	Not damaged
11-25	1	Slightly damaged
26-50	2	Moderately damaged
51-75	3	Heavily damaged
76-100	4	Extremely damaged

The degree of soil damage was determined based on the score values obtained from each parameter. The number of parameters for soil damage is 10. Therefore, the maximum value for the total parameters is 40. The severity of soil damage is classified into 5 categories (Table 2.)

Table 2. Soil damage status based on the total score of all parameters

No	Soil Damage Status	Total Score of Soil Damage
1	Not Damaged	0
2	Slightly damaged	0-14
3	Moderately damaged	15-24
4	Heavily damaged	25-34
5	Extremely damaged	35-40

Materials and equipments used in the study comprised a set of computer equipped with GIS program and a color printer, landsat 8 imagery, Path.Raw 121/065, Digital RBI map with a scale of 1 : 25,000, a soil map, a regional planning map of Kebumen, a topographic map, a geological map, soil survey kits and equipment, and materials and

equipments for laboratory analysis. Soil analysis was carried out in the soil laboratory of the Faculty of Agriculture, Jenderal Soedirman University, Purwokerto.
The research was conducted from the month of September to December 2014 in the coastal region of Kebumen regency, Central Java which included 6 districts namely Puring, Petanahan, Klirong, Buluspesantren, Ambal and Mirit, respectively.

3. Results and Discussion

The results of digital analysis and interpretations of Landsat 8 satellite imagery indicated that the total area of research location was 31,725 hectares (352500 pixels). This was 366 hectares or 1.17% higher than data obtained from the Statistics Office of Kebumen. The discrepancy might have been attributable to the inaccuracy in the digitizing process especially on the administrative borders. Administratively, the research location comprised the districts of Puring (6,197 ha), Petanahan (4,484 ha), Klirong (4,325 ha), Buluspesantren (4,877 ha), Ambal (6,241 ha), dan Mirit (5,235 ha) (Figure 1).

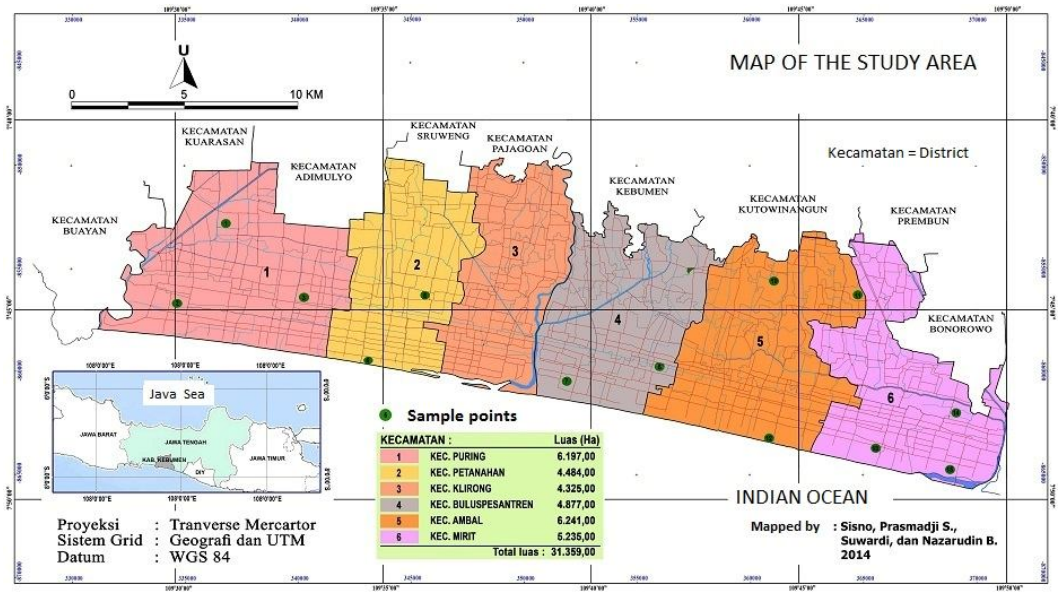

Figure 1. Map of study area.

The results of interpretation and classification of land use based on the Landsat imagery of 8 RGB 543 with the supervised classification technique showed that the land use of the research location could be divided into 7 main landuses including settlements, beaches and body of water (9,819.1 Ha or 31.31%); Irrigated rice fields (14,849.7 Ha or 47.35%); Rain-fed rice fields (2,210.3 Ha or 7.05%); grasses (433.4 Ha or 1.38%); dry land agriculture (3,189.2 Ha or 10.17%); garden (844.7 Ha or 2.69%); and shrubs (13 Ha or 0.04%).

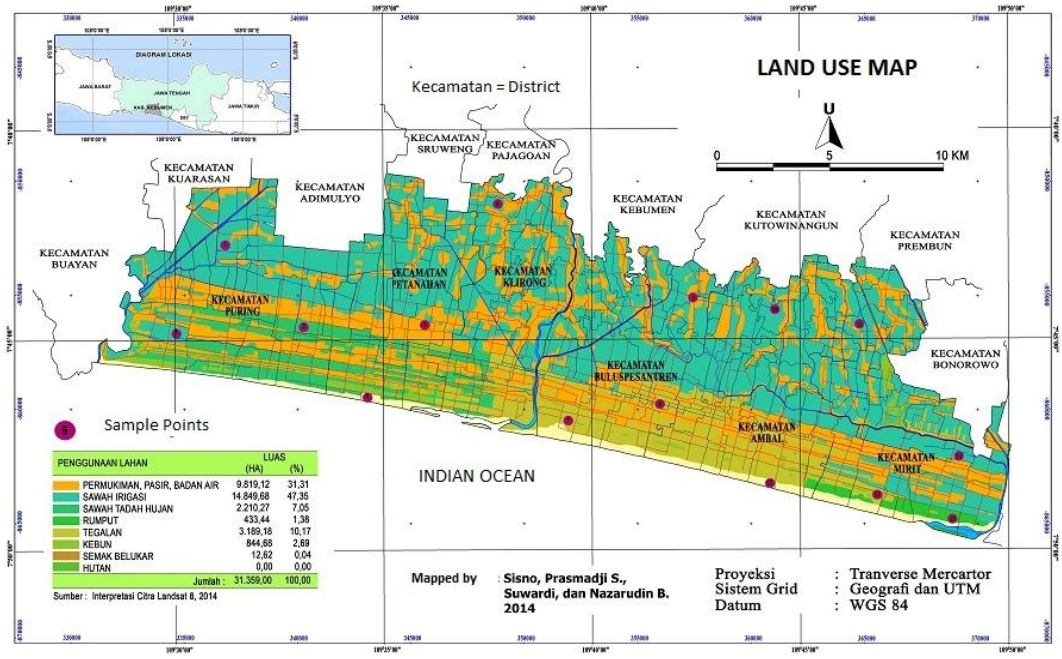

Figure 2. Landuse map of the study area.

Based on the superimpose analysis of a number of maps and the scoring method, the the land degradation of the research area could be group into three different severity levels of degradation: (1) not damaged with a total score of 80-155 covering an area of 10,993.5 hectares or 35.06%; (2) slightly damaged with a total score of 156-230 covering an area of 20,359.2 hectares atau 64.92%; dan (3) moderately damaged with a total score of 231-305 covering an area of 6.4 hectares or 0.02% (Figure 3).

The results of the research also showed that in some locations, soil property parameters were beyond the threshold values of the quality standard as determined in the Government Regulation No. 150/2000, for example soil fraction composition (Districts of Puring, Buluspesantren and Mirit), bulk density (districts of Petanahan and Bulupesantren), total porosity (Districts of Puring, Klirong, Buluspesantren, Ambal dan Mirit); soil permeabillity (districts of Puring, Buluspesantren, Ambal dan Mirit) and redox potentials (districts of Puring dan Ambal). (Table 3 and 4).

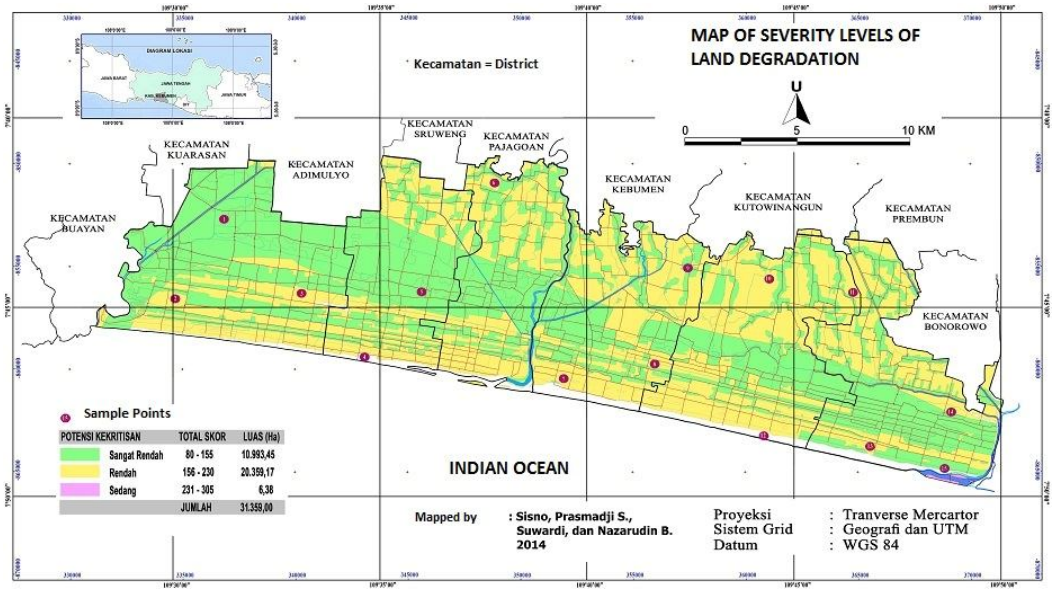

Figure 3. Map of severity levels of land degradation in the study area

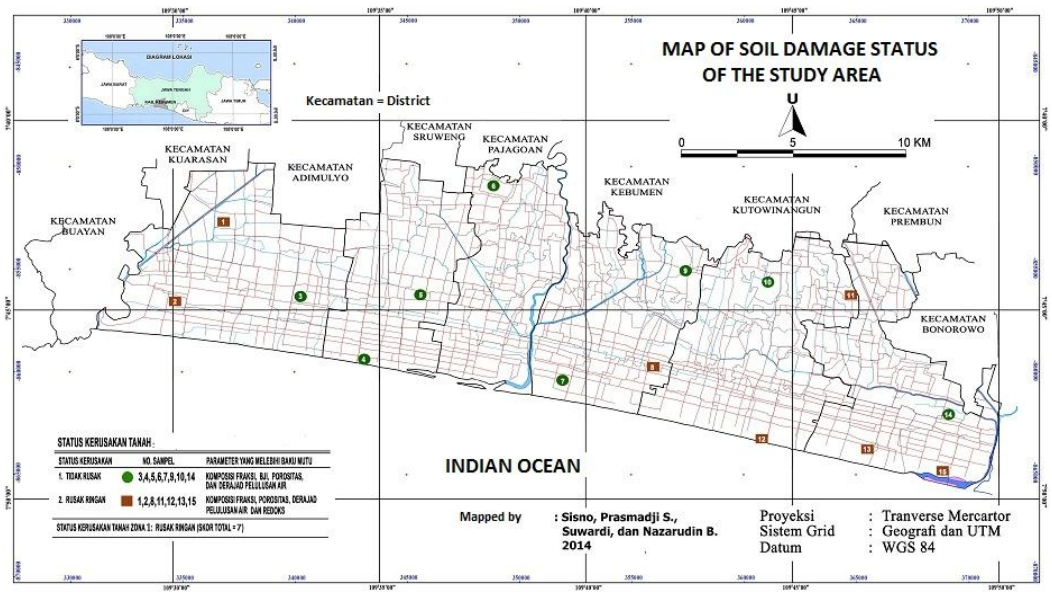

Figure 4. Soil damage status map in the study area

Table 3. Results of the parameter observations in the study area

Sample	Solum tanah (cm)	Stoni-ness (%)	Fraction composition (%)		Bulk density (g/cm3)	Porosity (%)	Permeability (cm/jam)	Soil pH	DHL	Redox	Number of microbes (cfu/g)
			% Koloid	% Sand					(mS/cm)	(mV)	
1	**> 80**	**0**	29.37	2.89	**1.38**	**29.26**	**0.98**	**7.48**	**0.150**	**155**	**$7.8x\ 10^{7}$**
2	**> 80**	**0**	**10.79**	**83.27**	**1.27**	**29.94**	**0.68**	**5.82**	**0.020**	**201**	**$3.3x10^{7}$**
3	**> 80**	**0**	**6.71**	**88.25**	**1.20**	**55.04**	**0.77**	**5.38**	**0.040**	**230**	**$2.4x10^{8}$**
4	**> 80**	**0**	24.95	37.72	**1.40**	**43.98**	**0.86**	**5.40**	**0.040**	**240**	**$2.28x10^{7}$**
5	**> 80**	**6**	21.14	29.03	**1.35**	**37.79**	**6.61**	**5.95**	**0.042**	**246**	**$5.20x10^{9}$**
6	**> 80**	**0**	22.55	16.55	**1.39**	**27.80**	**1.00**	**6.46**	**0.030**	**219**	**$6.62x10^{8}$**
7	**>80**	**0**	**7.47**	**86.24**	**1.12**	**54.77**	**0.75**	**4.93**	**0.078**	**298**	**$3.26x10^{7}$**
8	**68**	**6**	**7.14**	69.73	**1.41**	**25.69**	**7.13**	**5.99**	**0.037**	**249**	**$3.82x10^{7}$**
9	**62**	**13**	**12.46**	46.17	**1.35**	**31.72**	**0.59**	**6.00**	**0.040**	**212**	**$6.08x10^{7}$**
10	**78**	**0**	35.06	16.6	**1.18**	**46.62**	**0.67**	**6.33**	**0.032**	**221**	**$5.80x10^{9}$**
11	**60**	**0**	50.33	5.35	**1.34**	**29.61**	**1.31**	**6.84**	**0.058**	**192**	**$9.60x10^{8}$**
12	**65**	**12**	31.16	24.31	**1.37**	**24.20**	**0.20**	**5.35**	**0.039**	**216**	**$5.70x10^{7}$**
13	**68**	**6**	18.07	52.52	**1.26**	**28.69**	**0.57**	**5.31**	**0.040**	**237**	**$5.76x10^{9}$**
14	**64**	**0**	18.14	46.80	**1.29**	**26.45**	**0.96**	**6.07**	**0.041**	**229**	**$3.58x10^{7}$**
15	**>80**	**0**	**7.14**	**86.19**	**1.34**	**45.52**	**0.54**	**5.27**	**0.042**	**254**	**$2.58x10^{7}$**

Source: Results of field observations and laboratory analysis.

4. Conclusions

The results indicated that: (1) existing land uses consisted of irrigated rice field (14,849.7 Ha); rain-fed rice field (2,210.3 Ha); dry land (3,189.2 Ha); garden (844.7 Ha), grasses and shrubs (446.1 Ha); settlement, bodies of water, and beaches (9,819.1 Ha); (2) the severity of land degradation was grouped as follows: very low (10,993.5 H); low (20,359.2 Ha); and medium 6.4 Ha; (3) land degradation status of the area was classified as slightly damaged (score < 7) with fraction compositions, soil porosity, soil permeability and soil redox values as the main determining parameters of the land degradation.

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