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SAINS TANAH – Journal of Soil Science and Agroclimatology, 13 (1) , 2016, 25-30

RESEARCH ARTICLE

MAPPING OF SOIL DEGRADATION POTENCY IN PADDY FIELD WONOGIRI, INDONESIA

Mujiyo[1], Rahayu[1], Reni Ustiatik[2] and Dhika Sri Anggrahini[2]

[1]Department of Soil Science, Faculty of Agriculture, Sebelas Maret University, Indonesia
[2]Department of Agrotechnology, Faculty of Agriculture, Sebelas Maret University, Indonesia
Submitted : 2016-05-27 Accepted : 2016-11-03

ABSTRACT

Sustainability of paddy field becomes the main concern as the media of biomass production, thus it is needed a datum and information about land characteristics to find out its degradation. Mapping of soil degradation potency in paddy field is an identification of initial soil condition to discover the land degradation potency. Mapping was done by overlaying map of soil, slope, rainfall and land use with standard procedures to obtain its value and status of soil degradation potency. Area mapping is an effective land for biomass production (natural forest, mixed farm, savanna, paddy field, shrub and dry field) with approximately 43,291.00 hectares (ha) in Sidoharjo, Girimarto, Jatipurno, Jatisrono, Jatiroto, Tirtomoyo, Nguntoronadi and Ngadirojo District. The result shows that soil degradation potency (SDP) in Districts of Sidoharjo, Girimarto, Jatipurno, Jatisrono, Jatiroto, Tirtomoyo, Nguntoronadi and Ngadirojo are very low, low (DP II) 20,702.47 ha (47.82%), moderate (DP III) 15,823.80 ha (36,55%) and high (DP IV) 6,764.73 ha (15.63%). Paddy field covered 22,036.26 ha or about 50.90% of all area as effective biomass production, its SDP considers as low (DP II) 16,021.04 ha (37.01%) and moderate (DP III) 6,015.22 ha (13,89%). Paddy field has a low SDP because it is commonly lies on flat area and conservation method by the farmer is maintaining the paddy bund and terrace. This study needs an advanced study to identify actual SDP through detail verification in the field, and also support by soil sample analysis in the laboratory.

Keywords: paddy soil, soil degradation, soil degradation mapping, soil quality, paddy soil mapping

Permalink/DOI : http://dx.doi.org/10.15608/stjssa.v13i1.481

INTRODUCTION

Paddy field is a fundamental land use because it produces rice yield for almost Indonesia community. Approximately 90% of national rice production is produced in paddy field farming (Irawan et al., 2003). Rice becomes Indonesia community main food, thus production policy becomes the main concern for agricultural development (Ashari, 2003). Hence paddy field sustainability becomes the main priority for Indonesian agriculture policy.

Paddy field has been dealing with many obstacles in quality and quantity. Soil fertility of paddy soil has been declining due to erosion and low organic matter (Sanchez, 1976; Karama, 2001; Syamsiyah and Mujiyo, 2006), plant pest and diseases restrained, disruptive environmental contamination and high input dependence affect to production quality. Land use changes from paddy field to non paddy field will affect to quantity of grain production. The rate of paddy field changes during 2000 to 2002 in Java Island is about 56,000 ha/year, and in outer Java Island is 132,000 ha/year (Irawan, 2005). Paddy field in Kebakkramat District, Karanganyar Regency in 2000 is initially about 2,571.89 ha, and then in 2008 decreases down to 2.128,11 ha (Mujiyo, 2009).

Land quality monitoring and evaluation, includes paddy field, are needed to obtain a

** Coresponding Author :*
Email : mujiyo_wa@yahoo.com (Mujiyo)

recommendation for maintaining agricultural production sustainability. Rules of Republic Indonesia No. 32 in 2009 describes that the decreasing of environmental quality has been threatened human life sustainability and other organism thus it is required to protect and to manage living environment actually and consistently by all stakeholders. An information provider of land degradation status and/or biomass production land has been appointed as a standard service in the living environment such as district/city area (Regulation of The Minister of Environment No. 20 in 2008).

An identification of initial soil condition in order to determine the land degradation potency (SDP) is one kind of mapping. Therefore the results are expected to be an information source for land and/or soil degradation status.

MATERIAL AND METHODS

Area mapping includes 8 districts out of 25 districts in Wonogiri Regency distributed in Sidoharjo, Girimarto, Jatipurno, Jatisrono, Jatiroto, Tirtomoyo, Nguntoronadi and Ngadirojo. SDP mapping follows the basic procedure of Regulation of The Government of Indonesia Number 150 on Soil Degradation Control for Biomass Production and Regulation of the Minister of Environment No. 7 of 2006 on Procedures Measurement Criteria of Soil Degradation for Biomass Production.

The SDP made by overlaying thematic map scale 1:50.000; map of soil, map of slope, map of rainfall and map of land use to obtain land unit. Each land unit is scored based on the multiplying weight from soil type status (Table 1), land slope (Table 2), rainfall (Table 3) and land use (Table 4). The final score is classified to obtain SDP class (Table 5).

Table 1. Assessment of soil degradation potency (SDP) based on soil types (Indonesia Natural Resources Ministry, 2006)

Soil types	SDP	Scores	Status	Weight score (score x status)
Vertisols	Very low	2	1	2
Oxisols	Low	2	2	4
Alfisols, Mollisols, Ultisols	Moderate	2	3	6
Inceptisols, Entisols, Histosols	High	2	4	8
Spodosols, Andisols	Very high	2	5	10

Table 2. Assessment of soil degradation potency (SDP) based on land slope (Indonesia Natural Resources Ministry, 2006)

Slope (%)	SDP	Scores	Status	Weight score (score x status)
1 – 8	Very low	3	1	3
9 – 15	Low	3	2	6
16 – 25	Moderate	3	3	9
26 – 40	High	3	4	12
> 40	Very high	3	5	15

Table 3. Assessment of soil degradation potency (SDP) based on rainfall (Indonesia Natural Resources Ministry, 2006)

Rainfall (mm/year)	SDP	Scores	Status	Weight score (score x status)
< 1,000	Very low	3	1	3
1,000 – 2,000	Low	3	2	6
2,000 – 3,000	Moderate	3	3	9
3,000 – 4,000	High	3	4	12
> 4,000	Very high	3	5	15

Table 4. Assessment of soil degradation potency (SDP) based on land use (Indonesia Natural Resources Ministry, 2006)

Soil types	SDP	Scores	Status	Weight score (score x status)
Natural forest, paddy field, pure fertile reed	Very low	2	1	2
Mix farm, shrub, savanna	Low	2	2	4
Production forest, dry land	Moderate	2	3	6
Dry land (annual crop)	High	2	4	8
Open field	Very high	2	5	10

Table 5. Soil degradation potency (SDP) class based on final scores (Indonesia Natural Resources Ministry, 2006)

Symbol	SDP	Weighting score (final score)
DP I	Very low	< 15
DP II	Low	15 – 24
DP III	Moderate	25 – 34
DP IV	High	35 – 44
DP V	Very high	45 – 50

All mappings and calculating process are performed by ArcView GIS 3.3 (ESRI, 1992-2000).

Paddy soil degradation potency was determined by calculating proportion area and each class percentage of degradation potency to overall land use types. Land use types in this study are the effective area for biomass production such as natural forest, mix farms, paddy field, shrubs and dry field.

RESULT AND DISCUSSIONS

Soil type in the middle of area mapping is Alfisols and degradation potency status (DPS) is 3 (moderate). In the north and south area is Inceptisols and DPS is 4 (high). Land slope varies between 0 – 40%, for the middle area is 0 – 15%, it has status between 1 – 3 (low-moderate), and in the north a nd south area land slope is 15 – 40% thus it has status between 3 – 5 (moderate-high). Rainfall in the most areas is 2,000 – 3,000 mm/year and it has status 3 (moderate), meanwhile in the north-end is 3,000 – 4,000 mm/year and it has rating 4 (high). Land use which effective for biomass production is natural forest 450.45 ha, status 1 (very low), mix farms 10,442.03 ha has status 2 (low), savanna 60.71 ha has status 2 (low), paddy soil 22,036.26 ha has status 1 (very low), shrubs 794.73 ha has status 2 (low) and dry land 9,506.82 ha has status 4 (high).

Map of SDP (Figure 1) shows that most areas of 20,702.47 ha (47.82%) has a low SDP (DP II; score = 15 – 24) and 15,823.80 ha (36.55%) has a moderate SDP (DP III; score = 25 – 34). Meanwhile, only a few area of 6,764.73 ha (15.63%) has high SDP (DP IV; score = 35 – 44). Very low and very high soil degradation potency did not occur in the study area.

Low up to moderate of SDP occureds in the middle-north of Sidoharjo, south of Girimarto, south of Jatipurno, Jatisrono, north of Jatiroto, north of Nguntoronadi, and Ngadirojo. Moderate to high of SDP occurs in the north-south of Girimarto, north of Jatipurno, south of Jatiroto, Tirtomoyo, middle-south of Nguntoronadi and south of Sidoharjo.

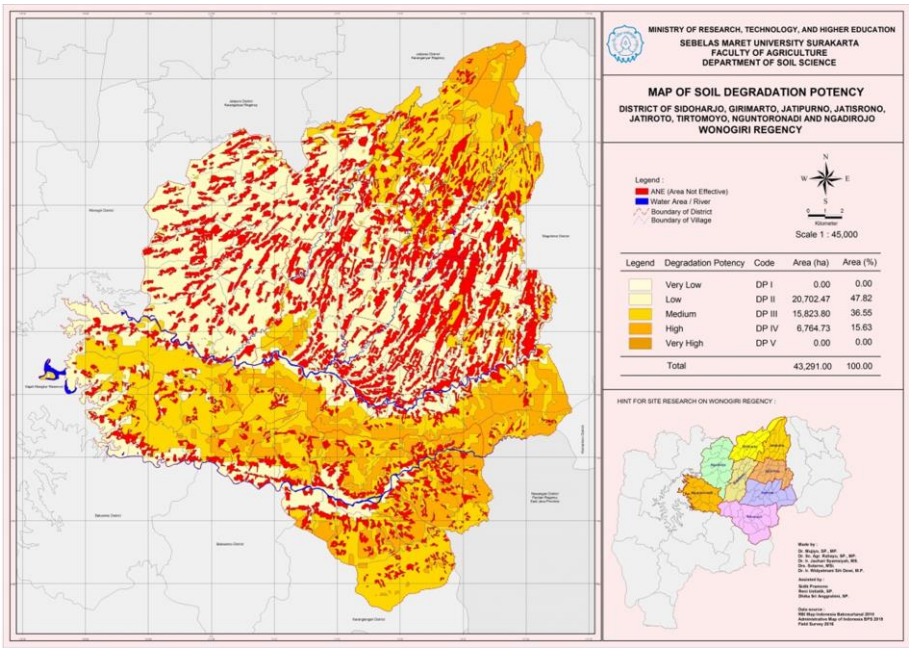

Figure 1. Map of Soil Degradation Potency in Sidoharjo, Girimarto, Jatipurno Jatisrono, Jatiroto, Tirtomoyo, Nguntoronadi and Ngadirojo Regency

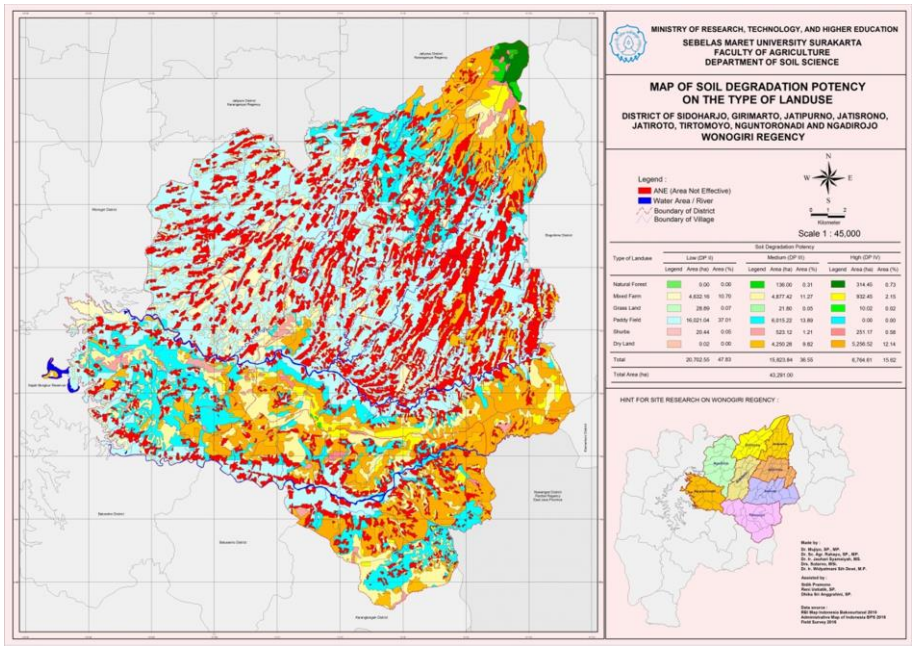

Figure 2. Map of Soil Degradation Potency based on Land Use

The main factor causing the middle area belongeds to low-moderate of SDP is having slope (0 – 15%) and land use (paddy field). Meanwhile, main factor causing the middle area belonged to moderate-high of SDP is due toslope (15 – 40%) and land use (mix farms, dry field, and shrubs). Rainfall affected to SPD diverse, rainfall in the north-end is 3,000 – 4,000 mm/year, thus, it caused SDP average higher than other area.

Paddy field dominated low to moderate of SDP and covering about 50.90% of all area as effective biomass production. Figure 2 shows that paddy field has a low SDP (DP II)

covering about 16,021.04 ha (37.01%) and moderate (DP III) showing 6,015.22 ha (13.89%). Paddy field is generally a land use with low SDP because it lies on flat area and conservation method by the farmer maintaining the paddy bund and terrace.

Farmer maintained paddy bund at the initial planting season or preparation stage before paddy planting. Paddy bund maintaining is a hereditary tradition that has done through *Tamping* (build the dike on Javanese ethnic in Indonesian Ethnic) and *Mopok* (rebuild the dike) to prevent water leakage. *Tamping* is taking soil from the inner side paddy bund then continue with *mopok* which is changing the taking area with wet soil then flattened by gentle foot step. Terrace shape maintained at the initial planting season has done through flattened land surface and rebuilt broken bund. Maintaining paddy bund and terrace is aimed that the water can stagnate evenly on the surface of the land, and so to prevent water leakage thus water can fill in the field for a long time and water can infiltrate into the soil thus runoff and soil erosion can be reduced.

Generally soil degradation related to soil quality, Marzaioli et al. (2010) said that soil quality related to land use due to land use management affect on soil physical, chemical and biological properties. Land use changes or deforestation lead to diminish soil quality. Thus, it may affect to severe degradation in soil quality. It can lead to land productivity degradation (Ayoubi et al. 2011). Extreme degradation leads to the soil has lost of its capability to support human community and ecosystems (European Environment Agency 1999; Bone et al. 2010).

CONCLUSION

Soil degradation potency (SDP) in Districts of Sidoharjo, Girimarto, Jatipurno, Jatisrono, Jatiroto, Tirtomoyo, Nguntoronadi and Ngadirojo are occurred low (DP II) with highest square of 20,702.47 ha (47.82%), moderate (DP III) 15,823.80 ha (36,55%), high (DP IV) with value of 6,764.73 ha (15.63%) and very high (DP V) 0.00 ha (0.00%). Paddy field covered about 22,036.26 ha or 50.90% of all area as effective as a biomass production, its SDP considered as low (DP II) 16,021.04 ha (37.01%) and moderate (DP III) 6,015.22 ha (13,89%). Paddy field has a low SDP because it commonly lies on flat area and conservation method by the farmer is maintaining the paddy bund and terrace. This study needs an advanced study to identify actual SDP through detail verification in the field, and also support by soil sample analysis in the laboratory.

ACKNOWLEDGEMENT

This study was supported by Sebelas Maret University under grant research for Hibah Pusat Keunggulan (PK-UNS) 2016. We would like to thank Mas Djati, Mas Hanjar, Mas Machmud and all farmers in Asosiasi Pertanian Organik “Wono Agung” Wonogiri (APOW) for their participation.

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