Assessment of soil degradation in Pitu District, Ngawi Regency

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Received 16 September 2019, Accepted 10 December 2019

Abstract: This study aimed to determine the status of soil damage in Pitu District, Ngawi Regency. The study was conducted in a descriptive exploratory with survey methods. Determination of site sampling was done by purposive sampling, based on distribution or division and land use categories from the results of map overlays. Assessment of soil degradation potency was based on land units from the uniformity of the soil, rainfall, slope, and land use map. Land units resulting from overlay were scored based on the results of multiplication of weights and soil, slope, rainfall, and land use ratings. Total score indicates soil Degradation Potency (SDP). Assessment of soil degradation status was done through matching and scoring. Field observation results were matched with the standard criteria of soil degradation from Indonesian Government Regulation No. 150 of 2000. Each parameter was scored, then the total score was used to determine soil degradation status. Soil degradation potency in Pitu District, Ngawi Regency is PR II (Low) at LMU (Land Map Units) 1, 3, 4, 5, and 8, and PR III (Moderate) at LMU 2, 6, 7, 9, and 10. Soil degradation status in Pitu District, Ngawi Regency is slightly degraded at all LMU, with limiting factors, namely texture, bulk density, total porosity, and permeability.

Keywords: soil degradation potency, soil degradation status

Introduction

Soil degradation is a major threat to the food security of the poor in various countries. Soil degradation is considered as one of the main causes of stagnating plant productivity. Continuing soil degradation remains a serious threat to food security (Bindraban et al., 2012). Soil degradation contributes greatly to increasing poverty (Suradisistra et al., 2010). Soil degradation has the potential to cause land conversion, which in turn will have an increasingly uneven distribution of income for farmers (Barokah et al., 2012). Soil degradation is a temporary or permanent decline in land productivity caused by human activities and natural factors (United Nation Environmental Program, 1992). Soil degradation also means changing the nature of the soil that exceeds the standard criteria for soil degradation (Indonesian Ministry of Environment Regulation No. 7 of 2006).

The causes of soil degradation due to human factors include land use that is not following its capabilities, environmental pollution, land conversion and over-exploitation of land. The causes of degradation from natural factors include global warming, natural disasters, and other natural phenomena. Land management carried out by farmers is one of the main causes of soil degradation (Winarno, 2009). Soil degradation that occurs continuously without any prevention or improvement efforts will cause the land to become critical.

According to the Indonesian Ministry of Environment and Forestry (2018), land which is categorized as critical land will lose its function as
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water retention, nutrient cycling, microclimate regulator, and carbon retention. Critical land is land that functions less well, as a medium for crop production or uncultivated crops (Undang-Undang No.37 of 2014). According to CNN Indonesia (2018), the area of critical land in Indonesia reaches 14 million hectares.

Pitu District is located in Ngawi Regency, East Java. Some land in the Pitu District has been degraded due to poor land management, and material C (soil and limestone) mining activities. Poor land management has the potential to reduce soil quality. Soil mining is carried out on fertile agricultural land by open mining. This activity removes the topsoil and leaves infertile soil. Intake of limestone can cause landslides (Ngawi Regency Environmental Services, 2008). Soil degradation results in hydrological imbalances in the watershed. One result of the hydrological imbalance in the watershed is drought (Miardini and Susanti, 2016). Some villages in the Pitu District are affected by drought during the dry season.

The availability of information on the status of soil degradation is still limited to a broad scale, such as the provincial or district scale. The availability of information at the Sub-district scale will assist in the preparation of corrective and preventive measures for soil degradation according to specific locations. Availability of soil degradation data can also be used as a reference for policymakers, in preparing plans and regulations to reduce the area of critical land. Soil degradation status data can be used as a reference for farmers to manage land to achieve optimal and sustainable productivity. Soil degradation mapping can be used as an evaluation and monitoring step of soil quality (Mujiyo et al., 2016).

Materials and Methods

Research design

The study was conducted in Pitu District, Ngawi Regency in August - October 2018. The study included descriptive exploratory survey method. Land units are obtained from overlay rainfall maps, soil type maps, slope maps, and land use maps. Determination of the location of sample points is done intentionally (purposive sampling) based on distribution or division and land use categories from the results of map overlays.

Soil analysis

Soil samples consist of disturbed and non-disturbed soils. Analysis of soil samples was carried out at the Soil Conservation and Physics Laboratory, Chemistry and Soil Fertility Laboratory and Soil Biology Laboratory, Agriculture Institute, Sebelas Maret University. The parameters analyzed refer to Indonesian Government Regulation No.150 of 2000 (Table 1).

Table 1. Parameter for soil degradation assessment.

| Parameter               | Measurement method                              |
|-------------------------|------------------------------------------------|
| Soil Depth              | Direct measurement                             |
| Gravel/Rock             | Direct measurement of balance stone and soil   |
| Composition of sand fraction | Pipette Method                        |
| Bulk Density            | Gravimetric                                    |
| Porosity                | Bulk Density : Specific Gravity                 |
| Permeability            | Falling Head Permeameter                       |
| pH                      | pH meter (1 : 2.5)                             |
| Electrical Conductivity | Electric resistance (1 : 2.5)                  |
| Redox potential         | Field observation with Electrical Conductivity meter |
| Number of microbes      | Standard Plate Count (SPC)                     |

Source: Indonesian Government Regulation No.150 of 2000.

Data analysis

Soil degradation potency

Mapping the soil degradation potency refers to Technical Guidelines for Preparation of Land
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Damage Status Maps for Biomass Production (Indonesian Ministry of Environment, 2009). Mapping of soil degradation potency based on land units from the uniformity of the soil, rainfall, slope, and land use map. Land units are made by an overlay. Land units resulting from overlay are scored based on the results of multiplication of weights and soil ratings (Table 2), slope (Table 3), rainfall (Table 4), and land use (Table 5). The scoring results are then classified to obtain a class of soil degradation potency (Table 6).

Table 2. Soil degradation potency based on soil types (Indonesian Ministry of Environment, 2009).

| Soil types         | Score | Status | Weight score (score x status) |
|--------------------|-------|--------|-------------------------------|
| Vertisols          | 2     | 1      | 2                             |
| Oxisols            | 2     | 2      | 4                             |
| Alfisols, Mollisols, Ultisols | 2 | 3 | 6 |
| Inceptisols, Entisols, Histisols | 2 | 4 | 8 |
| Spodosols, Andisols | 2   | 5     | 10                            |

Table 3. Soil degradation potency based on land slope (Indonesian Ministry of Environment, 2009).

| Slope (%) | Scores | Status | Weight score (score x status) |
|-----------|--------|--------|-------------------------------|
| 1-8       | 3      | 1      | 3                             |
| 9-15      | 3      | 2      | 6                             |
| 16-25     | 3      | 3      | 9                             |
| 26-40     | 3      | 4      | 12                            |
| >40       | 3      | 5      | 15                            |

Table 4. Soil degradation potency based on rainfall (Indonesian Ministry of Environment, 2009).

| Rainfall (mm/year) | Scores | Status | Weight score (score x status) |
|--------------------|--------|--------|-------------------------------|
| < 1.000            | 3      | 1      | 3                             |
| 1.000-2.000        | 3      | 2      | 6                             |
| 2.000-3.000        | 3      | 3      | 9                             |
| 3.000-4.000        | 3      | 4      | 12                            |
| > 4.000            | 3      | 5      | 15                            |

Table 5. Soil degradation potency based on land use (Indonesian Ministry of Environment, 2009).

| Land use                              | Scores | Status | Weight score (score x status) |
|---------------------------------------|--------|--------|-------------------------------|
| Natural forest, paddy field, pure fertile reed | 2 | 1 | 2 |
| Mix farm, shrub, savanna               | 2      | 2      | 4                             |
| Production forest                       | 2      | 3      | 6                             |
| Dry land                               | 2      | 4      | 8                             |
| Open field                             | 2      | 5      | 10                            |

Table 6. Soil degradation potency (SDP) class (Indonesian Ministry of Environment, 2009).

| Symbol | SDP | Total score |
|--------|-----|-------------|
| PR.I   | Very low | < 15        |
| PR.II  | Low   | 15 – 24     |
| PR.III | Moderate | 25 – 34     |
| PR.IV  | High  | 35 – 44     |
| PR.V   | Very high | 45 – 50    |

Soil degradation status

Soil degradation status is determined through two stages, namely matching and scoring. Matching is the comparison between the data parameter field observations and laboratory analysis with standard criteria of soil degradation from Indonesian Government Regulation No. 150 of 2000 (Table 7).

Table 7. Standard criteria for soil degradation.

| Parameter                  | Critical Limit |
|----------------------------|----------------|
| Soil depth                 | < 20 cm        |
| Gravel/rock                | > 40 %         |
| Composition of sand fraction | < 18% colloid; > 80% quartz sand |
| Bulk density               | > 1.4 g/cm³    |
| Porosity                   | < 30%; > 70%   |
| Permeability               | < 0.7 cm/hour; >8.0 cm/hour |
| pH                         | < 4.5; > 8.5   |
| Electrical                 | > 4.0 mS/cm    |
| Conductivity               |                |
| Redox potential            | < 200 mV       |
| Number of microbes         | < 10^7 cfu/g soil |

Source: Indonesian Government Regulation No. 150 (2000).
Determination of the status of soil degradation is done by calculating the relative frequency (%) of each parameter of soil degradation and gives a score for each parameter based on its relative frequency value with a range of values from 0 to 4. Determination of soil degradation status based on soil degradation score is presented in Table 8.

Table 8. Soil degradation status based on the total of soil degradation score.

| Total Score | Soil Degradation Status       |
|-------------|-------------------------------|
| 0           | Not degraded                  |
| 1-14        | Slightly degraded             |
| 15-24       | Moderately degraded           |
| 25-34       | Heavily degraded              |
| 35-40       | Very heavily degraded         |

Source: Indonesian Ministry of Environment (2009).

Results and Discussion

Soil degradation potency

Soil degradation potency in Pitu District, Ngawi Regency consists of two criteria, namely PR. II (Low) at LMU (Land Map Unit) 1, 3, 4, 5, and 8 and for PR. III (Moderate) at LMU 2, 6, 7, 9, and 10 (Table 9). The map of potential soil damage in the District of Pitu, Ngawi Regency is shown in Figure 1.

LMU 3, 4, and 8 are dominated by Vertisol, so they have low soil degradation potential. Vertisol is dominated by clay. Soil with clay texture has solid aggregate, so it has low eroded potential. Soil type is related to soil properties. Soil properties such as texture, organic matter content and calcium content will influence the level of soil degradation through their effect on surface flow (Vaezi et al., 2010). The higher surface flow will increase the potential of erosion. LMU 1, 3, 4, and 5 have flat slopes. Soil with flat slopes has low eroded potential. The slope is directly related to soil erosion. Arsyad (2010) states that the steeper a slope is, the more land is sprinkled by collisions of raindrops so that it can increase erosion. LMU 1, 3, 5, and 8 with mix farm land use have low land degradation potential. Mix farm land use usually consists of annual crops (deep roots) and perennial crops (shallow roots). Mix farm land use also has high plant density, so that the soil surface is covered with plants to minimize runoff. The diversity of the root system is able to hold the soil from erosion. Fang et al. (2012) state that the type of land use greatly influences the amount of surface runoff which then impacts the amount of soil erosion.
Table 9. Soil degradation potency in Pitu District, Ngawi Regency.

| LMU | Soil Type | Score | Slope (%) | Score | Rainfall (mm/year) | Score | Land Use                     | Score | Total Score | Symbol | SDP   |
|-----|-----------|-------|-----------|-------|--------------------|-------|-----------------------------|-------|-------------|--------|-------|
| 1   | Inceptisol| 8     | 1-8       | 3     | 2000-2500          | 9     | Mix farm                    | 4     | 24          | PR.II  | Low   |
| 2   | Inceptisol| 8     | 1-8       | 3     | 2000-2500          | 9     | Dry land (annual crop)      | 8     | 28          | PR.III | Moderate |
| 3   | Vertisol  | 2     | 1-8       | 3     | 2000-2500          | 9     | Mix farm                    | 4     | 18          | PR.II  | Low   |
| 4   | Vertisol  | 2     | 1-8       | 3     | 2000-2500          | 9     | Dry land (annual crop)      | 8     | 22          | PR.II  | Low   |
| 5   | Inceptisol| 8     | 1-8       | 3     | 2000-2500          | 9     | Mix farm                    | 4     | 24          | PR.II  | Low   |
| 6   | Inceptisol| 8     | 9-15      | 6     | 2000-2500          | 9     | Mix farm                    | 4     | 27          | PR.III | Moderate |
| 7   | Inceptisol| 8     | 9-15      | 6     | 2000-2500          | 9     | Dry land (annual crop)      | 8     | 31          | PR.III | Moderate |
| 8   | Vertisol  | 2     | 9-15      | 6     | 2000-2500          | 9     | Mix farm                    | 4     | 21          | PR.II  | Low   |
| 9   | Vertisol  | 2     | 9-15      | 6     | 2000-2500          | 9     | Dry land (annual crop)      | 8     | 25          | PR.III | Moderate |
| 10  | Inceptisol| 8     | 9-15      | 6     | 2000-2500          | 9     | Mix farm                    | 4     | 27          | PR.III | Moderate |
**Soil degradation status**

Soil degradation status in Pitu District, Ngawi Regency shows all LMU (Land Map Units) including slightly degraded with several different limiting factors (Tables 10 and 11, Figure 3). LMU 1, 8, and 9 have limiting factors such as bulk density, total porosity and permeability with a total land area of 225.9 ha. LMU 3 has limiting factors for bulk density and porosity with an area of 13.2 ha. LMU 4 has a limiting factor namely permeability with a land area of 31.5 ha and LMU 2, 5, 6, 7, and 10 have limiting factors namely texture, bulk density, total porosity, and permeability with an area of 2634.2 ha. Parameters that related to soil degradation in Pitu District are texture, bulk density, total porosity, and permeability. All LMUs have slow permeability. Slow permeability can increase surface runoff and soil erosion. Slow permeability can be related to soil texture and land management. Almost all sampling sites have clayey texture and are managed under no-tillage. Soil with clayey texture and that is managed under no-tillage has high bulk density and low soil permeability (Nunes et al., 2014; Martin and Rahmat, 2017). Soil with clayey texture that is managed under no-tillage has potentially caused soil compaction. Soil compaction inhibits root development (Lipiec et al., 2012) and reduces crop yield (Chen and Weil, 2011). High bulk density can inhibit root development and water movement in the soil. Soil with bulk density above 1.4 g/cm$^3$ is difficult to be penetrated by roots. Higher bulk density means that the soil is denser, so the soil porosity is low (Arabia et al., 2012). Low soil porosity causes disruption of water movement in the soil, which can cause flooding, increase surface run-off and soil erosion.

### Table 10. Result of field observation for soil degradation assessment.

| LMU | Parameter | **1 (cm)** | **2 (%)** | **3 (%)** | **4 (g/cm$^3$)** | **5 (%)** | **6 (cm/hour)** | **7 (mS/cm)** | **8 (mV)** | **9 (cfu/g soils)** |
|-----|-----------|------------|-----------|-----------|-----------------|-----------|-----------------|--------------|------------|-------------------|
| 1   |           | 100        | 5         | 40.14     | 43.21           | 1.53      | 27.8            | 0.00         | 6.82       | 0.796             |
|     |           | 100        | 8         | 45.24     | 42.02           | 1.70      | 14.42           | 0.73         | 7.50       | 0.384             |
|     |           | 100        | 5         | 47.70     | 33.39           | 0.96      | 47.13           | 0.00         | 7.61       | 0.429             |
| 2   |           | 90         | 10        | 12.98     | 71.64           | 1.65      | 12.91           | 0.89         | 7.36       | 1.663             |
|     |           | 100        | 5         | 14.97     | 64.07           | 1.4       | 13.92           | 0.00         | 7.27       | 0.181             |
|     |           | 100        | 5         | 10.21     | 73.48           | 1.77      | 2.42            | 0.80         | 7.09       | 0.211             |
| 3   |           | 80         | 5         | 81.33     | 12.42           | 1.47      | 22.71           | 0.72         | 7.07       | 0.455             |
|     |           | 80         | 8         | 67.68     | 12.49           | 1.41      | 27.57           | 0.83         | 7.09       | 0.368             |
|     |           | 90         | 5         | 82.04     | 12.21           | 1.47      | 27.89           | 0.94         | 7.19       | 0.509             |
| 4   |           | 100        | 5         | 48.50     | 26.79           | 1.29      | 52.46           | 1.90         | 7.90       | 0.203             |
|     |           | 100        | 5         | 46.82     | 36.59           | 1.20      | 51.55           | 1.39         | 6.52       | 1.117             |
|     |           | 80         | 5         | 51.31     | 33.25           | 0.96      | 51.63           | 0.00         | 7.02       | 0.678             |
| 5   |           | 90         | 8         | 5.81      | 78.69           | 1.02      | 37.74           | 0.31         | 7.78       | 0.224             |
|     |           | 90         | 10        | 10.48     | 70.13           | 1.43      | 24.51           | 0.00         | 7.61       | 0.377             |
|     |           | 90         | 8         | 18.57     | 66.76           | 1.58      | 17.77           | 0.28         | 7.71       | 0.455             |
| 6   |           | 110        | 15        | 16.84     | 53.39           | 1.56      | 26.16           | 0.60         | 7.71       | 0.295             |
|     |           | 100        | 10        | 21.71     | 56.83           | 1.66      | 29.63           | 0.90         | 7.79       | 0.243             |
|     |           | 110        | 10        | 24.39     | 54.95           | 1.11      | 49.93           | 1.19         | 7.71       | 0.391             |
| 7   |           | 110        | 10        | 20.51     | 67.81           | 1.95      | 3.70            | 1.90         | 8.13       | 0.313             |
|     |           | 110        | 8         | 10.35     | 71.07           | 1.97      | 3.14            | 1.39         | 7.80       | 0.317             |
|     |           | 110        | 8         | 15.19     | 66.44           | 1.96      | 2.34            | 0.00         | 8.01       | 0.333             |
| 8   |           | 110        | 5         | 53.17     | 36.30           | 2.07      | 2.96            | 0.13         | 7.09       | 1.231             |
|     |           | 110        | 5         | 56.32     | 34.04           | 1.75      | 5.60            | 0.80         | 6.97       | 1.275             |
|     |           | 100        | 5         | 53.65     | 35.17           | 1.99      | 9.20            | 0.00         | 7.80       | 1.021             |
| 9   |           | 90         | 5         | 62.27     | 9.72            | 1.22      | 31.52           | 0.06         | 7.80       | 0.347             |
|     |           | 110        | 8         | 43.72     | 15.17           | 1.46      | 27.13           | 0.08         | 7.87       | 0.372             |
|     |           | 110        | 5         | 44.15     | 20.88           | 1.41      | 29.78           | 0.00         | 7.08       | 0.438             |
| 10  |           | 100        | 12        | 13.03     | 50.49           | 1.57      | 6.40            | 0.47         | 8.15       | 0.232             |
|     |           | 80         | 12        | 18.64     | 48.81           | 1.60      | 5.56            | 0.00         | 7.79       | 0.216             |
|     |           | 80         | 15        | 9.17      | 55.67           | 1.37      | 12.56           | 0.92         | 8.16       | 0.301             |

Remarks: 1 = Soil depth; 2 = Gravel/rock; 3 = Composition of soil fraction (clay and sand); 4 = Bulk density; 5 = Porosity; 6 = Permeability; 7 = pH; 8 = Electrical conductivity; 9 = Redox potential; 10 = Number of microbes.

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Table 11. Assessment of soil degradation in Pitu District, Ngawi Regency.

| LMU | Parameter | Total Score | Soil Degradation Status | Limiting Factor |
|-----|-----------|-------------|--------------------------|-----------------|
|     | 1 | 2 | 3.1 | 3.2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |         |        |
| 1   | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 9 | Slightly degraded | Bulk density, permeability, and total porosity |
|     | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 9 | Slightly degraded | Bulk density, permeability, and total porosity |
|     | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 9 | Slightly degraded | Bulk density, permeability, and total porosity |
| 2   | 0 | 0 | 4 | 0 | 4 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 14 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 4 | 0 | 4 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 14 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 4 | 0 | 4 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 14 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
| 3   | 0 | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 8 | 8 | Slightly degraded | Bulk density and total porosity |
|     | 0 | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 8 | Slightly degraded | Bulk density and total porosity |
|     | 0 | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 8 | Slightly degraded | Bulk density and total porosity |
| 4   | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | Slightly degraded | Permeability |
|     | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | Slightly degraded | Permeability |
|     | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | Slightly degraded | Permeability |
| 5   | 0 | 0 | 3 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 13 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 3 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 13 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 3 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 13 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
| 6   | 0 | 0 | 2 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 10 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 2 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 10 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 2 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 10 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
| 7   | 0 | 0 | 3 | 0 | 4 | 4 | 2 | 0 | 0 | 0 | 0 | 13 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 3 | 0 | 4 | 4 | 2 | 0 | 0 | 0 | 0 | 13 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 3 | 0 | 4 | 4 | 2 | 0 | 0 | 0 | 0 | 13 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
| 8   | 0 | 0 | 0 | 0 | 4 | 4 | 3 | 0 | 0 | 0 | 0 | 11 | Slightly degraded | Bulk density, permeability, and total porosity |
|     | 0 | 0 | 0 | 0 | 4 | 4 | 3 | 0 | 0 | 0 | 0 | 11 | Slightly degraded | Bulk density, permeability, and total porosity |
|     | 0 | 0 | 0 | 0 | 4 | 4 | 3 | 0 | 0 | 0 | 0 | 11 | Slightly degraded | Bulk density, permeability, and total porosity |
| 9   | 0 | 0 | 0 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 10 | Slightly degraded | Bulk density, permeability, and total porosity |
|     | 0 | 0 | 0 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 10 | Slightly degraded | Bulk density, permeability, and total porosity |
|     | 0 | 0 | 0 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 10 | Slightly degraded | Bulk density, permeability, and total porosity |
| 10  | 0 | 0 | 4 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 14 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 4 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 14 | Slightly degraded | Texture, bulk density, permeability, and total porosity |
|     | 0 | 0 | 4 | 0 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 14 | Slightly degraded | Texture, bulk density, permeability, and total porosity |

Remarks: 1 = Soil depth; 2 = Gravel/rock; 3 = Composition of soil fraction (clay and sand); 4 = Bulk density; 5 = Porosity; 6 = Permeability; 7 = pH; 8 = Electricity conductivity; 9 = Redox potential; 10 = Number of microbes

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Improvement efforts need to be carried out to reduce the area of degraded land. Improvement efforts are focused on factors related to land degradation at the study site. Factors related to soil degradation in Pitu District are soil physical parameters. Provision organic fertilizer can help to improve soil physical quality. Murphy (2015) states that organic fertilizers can improve soil physical properties at a depth of 10-20 cm. Organic matter can improve soil physical properties such as increasing aggregate stability, increasing soil porosity and permeability (Soelaeman and Haryati, 2012; Prasetyo et al., 2014; Sanjaya et al., 2016; Surya, 2017). According to Minardi et al. (2012), provision of organic material is also able to increase soil fertility in degraded land.

**Conclusion**

Soil degradation potency in Pitu District, Ngawi Regency, including PR. II (Low) at LMU (Land Map Units) 1, 3, 4, 5, and 8 and PR. III (Moderate) at LMU 2, 6, 7, 9, and 10. Soil degradation status in Pitu District Ngawi Regency for all LMU including slightly degraded. Limiting factors determining soil degradation include permeability, bulk density, porosity, and texture. Provision organic fertilizer can be an effort to improve soil physical parameters and reduce soil degradation in Pitu District, Ngawi Regency.

**Acknowledgements**

The authors express the gratitude to Dinas Lingkungan Hidup Kabupaten Ngawi and research assistant for helping this research. The authors also express the gratitude to Universitas Sebelas Maret for facilitating this research publication through the scheme of PPK-GR UNS of PNBP 2019.

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