JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL.4 NO. 1 July 2022

DOI :https://doi.org/10.36378/juatika.v4i2.2240
eissn 2656-1727
pissn 2684-785X
Hal : 194 – 206

Analysis of Soil Quality Index type of land use on dry land in Blang Bintang sub-district, Aceh Besar Regency

Umar Husein Abdullah[1)*], Endiyani Endiyani[1)], Sri Agustina[1)],
Irhami Irhami[1)], Chairil Anwar[2)], Irmayanti Irmayanti[3)]
[1]Department of Agroindustry, Politeknik Indonesia Venezuela, Jl. Bandara Sultan Iskandar Muda No. 12, Aceh Besar, 23372, Indonesia,
[2]Department of Livestock Product Technology, Politeknik Indonesia Venezuela, Jl. Bandara Sultan Iskandar Muda No. 12, Aceh Besar, 23372, Indonesia.
[3]Department of Agricultural Industrial Engineering, Faculty of Agricultural Technology, Serambi Mekkah University, Jl. T. Imum Lueng Bata, Banda Aceh, 23345, Indonesia
*email: umarah_1977@yahoo.co.id

ABSTRACT

This study aimed at examining the analysis of the soil quality index of dry land use on dry land in Blang Bintang District, Aceh Besar District. This research was conducted using a descriptive method based on the results of surveys and field observations as well as laboratory analysis. General biophysical conditions of the area and physical and chemical characteristics of the soil obtained from observations and indicators of soil quality through soil analysis in the laboratory. Soil sampling points were determined using the purposive sampling method, namely the points that have been determined on selected dry land in Blang Bintang District, Regency of Aceh Besar. The moderate soil quality index in the upland land use type is one of the reasons for the sampling of the Inceptisol soil type in the Blang Bintang sub-district, which has less fertile soil characteristics. Upland land use is the percentage of sand (57%) which is greater than the percentage of dust (36%) and clay (6%). This can be seen in the low content of C-organic (1.19), H2O, K-dd, P-available and N-total and high volume weight (1.34).

Keywords*: Soil qulity index, dry land, Tegalan*

1. INTRODUCTION

The potential of dry land for agricultural development in Indonesia is very large, it is estimated at 76 million hectares located in the lowlands to highlands with wet and dry climates. Of the dry land area in Indonesia which reaches 144.47 million ha, about 99.65 million ha (68.98%) is potential land for agriculture, while the remaining 44.82 million ha is not potential for agriculture, most of which are in forest areas. (Heryani, N., & Rejekiningrum, P., 2019). Soil degradation has an impact on decreasing soil quality and is followed by a decrease in agricultural land productivity (Lal, 2015). This condition can occur and be accelerated if land management is not done properly so that it can trigger excessive erosion (Kairis et al., 2013). Low soil quality is characterized by low soil organic matter content, high soil density, low porosity and slow infiltration rate (Schoenholtz et al., 2000). Efforts to improve soil quality must start with increasing soil organic matter content. An increase in soil organic matter content will trigger the activity of organisms in the soil, and can improve the porosity and stability of soil aggregates (Cardoso et al., 2013).

High soil fertility indicates high soil quality. Soil quality is the capacity of the soil to maintain plant productivity, maintain and maintain water availability and support human activities. Good soil quality will support the function of the soil as a medium for plant growth, regulate and share water flow and support a good environment (Akbar et al., 2022). Several studies have shown that the chemical, physical and biological characteristics of one land use type differ from other land use types. It is like the characteristics of forest land are different from the characteristics of dry land or other types of use. This happens because of differences in nutrient sources on these lands. These differences are often studied so that it can be known what actions will be taken for the management of these lands (Syahrul et al., 2021). Feng et al (2019), stated that total N, available P, pH, soil texture, soil depth are important factors that affect the soil quality index.

Soil quality is the ability of a soil to play a role in maintaining plant productivity, maintaining and maintaining the availability of water and supporting human activities (Minarsih and Hanudin, 2020). According to Padmawati et al. (2017), assessment of soil quality is measured based on indicators of changes in soil function in response to soil management. Several indicators are assessed in the process of evaluating soil quality, namely indicators that describe important soil processes based on the physical, chemical and biological properties of the soil. The level of soil quality in a plot of land is assessed based on the soil quality index (IKT) (Partoyo, 2005). Soil quality assessment can serve as a tool for agricultural managers and for other policy makers to gain a better understanding of agricultural systems that can affect soil resources. (Dong et al., 2013). Maintained soil quality will affect humans economically by selling crops, soil resistance to erosion, minimized human health from the influence of heavy metals (Wander et al., 2002; Kurniawan et al., 2021).

Soil quality is a general term that combines physical, chemical and biological parameters. These aspects of soil are interdependent and may respond differently to changes in land use, so individual parameters may be indicators of poor soil quality (Mukherjee and Lal, 2014, Davaria et al., 2020). Instead, a more holistic methodological approach should be used to assess change (Raiesi, 2017). Currently, comprehensive methods for evaluating soil quality include qualitative (eg visual), semi-quantitative (Doran and Parkin, 1994), and quantitative (Andrews et al., 2002, Davaria et al., 2020) methods. The difference between semi-quantitative and quantitative is how to get the minimum data set. The semi-quantitative method is to select the minimum data set from the total data set through expert opinion, and the quantitative method is to extract the minimum data set through statistical methods, for example, principal component analysis, multiple correlation, factor analysis (Andrews et al., 2002). Quantitative assessment of soil quality is usually achieved through laboratory analysis of physical, chemical, and biological parameters, in combination with a soil quality index. SQI can be determined through standard scoring function, nonlinear scoring function, or linear scoring function method (Li et al., 2020), where the SQI value represents soil quality. In general, SQI is easy to use and offers flexibility (Leite Chaves et al., 2017, Huang et al., 2021; Akbar et al., 2022).

Soil quality is the ability of soil to provide nutrients for plants, maintain and improve water and air in the soil, and support human needs. There are several reasons that lead to the decline in soil quality, including the change in land use type from forest to agricultural land and the consequences of intensive land use. Soil quality improvement due to various types of land use or crop rotation can be measured by changes in soil indicators and other parameters. The most popular indicators used to assess soil quality are soil organic carbon (SOC), total nitrogen (TN) and soil acidity (pH). Soil organic carbon It is very important for soil fertility and is a strong indicator of the biological health of the soil and its chemical, biological and physical processes. Total nitrogen is the main nutrient used for vegetation growth and is also used as a key soil quality assessment. Soil pH is the most important indicator in managing agricultural production. Most agricultural crops thrive in soils with a pH of 5.5 to 6.5 . (Pham et al., 2018).

Soil quality is a useful concept when assessing the sustainability of an agricultural business and demonstrates the ability of the soil to maintain plant and animal productivity, improve water and air quality, and to protect human health. SQI is a soil variable with the following characteristics: 1) well correlated with ecosystem processes; 2) the integration of physical, chemical and biological properties of the soil; 3) good sensitivity to human-induced soil changes; 4) simplicity of measurement and interpretation; and 5) reproducibility (Sione et ai., 2017).

Soil quality index (SQI) is a diagnostic procedure to evaluate soil function and overall health. SQI usually integrates physical, biological, and chemical properties into a single weighted number (Bastida et al., 2008). The selected soil properties must be relevant to the soil process, consistent, reproducible, and relatively easy and affordable for sampling (Bünemann et al., 2018, Moebius-Clune, 2017). The physical properties examined for the assessment of restoration success are related to soil structure, and include texture, specific gravity, water holding capacity, infiltration rate, penetration resistance, available water content, and aggregate stability (Bandyopadhyay and Maiti, 2019). Biological properties refer to macro and micro organisms in the soil, such as microbial biomass, respiration, community composition, and enzymatic activity (Muñoz-Rojas, 2018), as well as processes related to soil organic matter and activated carbon (Sheoran et al., 2010).). Soil chemical properties include pH, salinity, nutrient availability (for example, ammonium (NH4+), nitrite

(NO_3^-), phosphorus (P), and potassium (K)), cation exchange capacity, nutrient cycling, and heavy metal content (Dunger et al. Voigtländer, 2005, Gómez-Sagasti et al., 2012, Melgar-Ramírez et al., 2012, Sheoran et al., 2010; Levy et al., 2021)

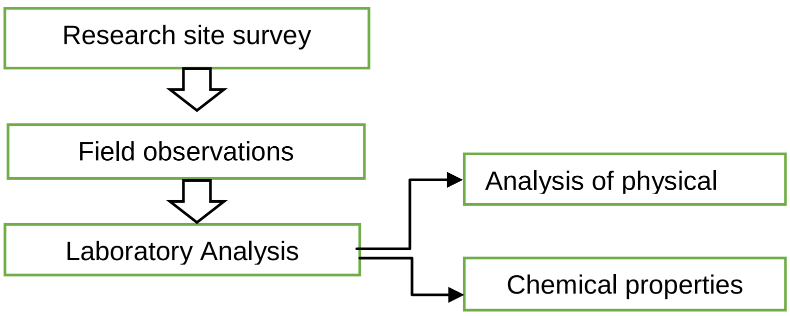
The type of land use is very important for all types of soil to maintain soil fertility. In the type of dry land use which is planted with seasonal crops, namely corn, soybeans, and cassava, almost all parts of the plant are carried away by the harvest, so that very little organic matter is returned to the soil and added from intensive tillage effect. Each soil has a different organic matter content according to the characteristics of the soil and the use of the land. Changes in vegetation or land use and soil management patterns cause changes in soil organic matter content (Yasin, 2007). Therefore, this study is to examine the analysis of the soil quality index on the type of dry land use in the Blang Bintang sub-district, Aceh Besar district.

2. MATERIAL AND METHODS

This research was conducted in Blang Bintang District, Aceh Besar District, Aceh Province which is geographically located between 5.20 - 5.80 North Latitude and 95080' - 950.88' East Longitude with an area of 2,969 km2 or 296,900 ha. This study focused on several field observation points in agricultural areas and other uses on several types of dry land use in Blang Bintang District, Aceh Besar District.

The equipment used in the field are gps, soil drill, sample ring, pH meter, meter, plastic, rubber, knife, hoe, and Abney level. While the equipment used in the laboratory for soil analysis are analytical balance, pH meter, oven, shaker, hot plate, hogonizer, distillation unit, burette, beaker, spectrophotometer and AAS (Atamic Absorption Spectrophotometer). The materials used in this study include: soil taken from the top layer (0 - 20 cm) for evaluation of soil fertility status. Other materials include regional maps, google maps, maps of soil types, maps of observation points and various chemicals that will be used during soil surveys in the field such as 10% H_2O_2, 10 N HCl, distilled water and materials for laboratory analysis.

This research was carried out using a descriptive method based on the results of surveys and field observations (field study) and laboratory analysis. Field surveys were carried out to obtain primary data in the form of general biophysical conditions of the area and physical and chemical characteristics of the soil obtained from observations and soil quality indicators. through soil analysis in the laboratory.



Picture 1. Flowchart of the process of conducting soil quality index research

Soil sampling points were determined using the purposive sampling method, namely points that have been determined in selected dry land areas in Blang Bintang District, Aceh Besar District. Soil sampling for analysis of chemical properties is carried out by drilling. Soil drilling is carried out to determine the level of thickness of the soil solum. Sampling is only focused on the top soil layer with a thickness of 0 - 20 cm. In dry vegetation (LUT) 5 - 6 sample points were taken which were then analyzed in the laboratory. From the data from the soil analysis, the fertility status of each type of land use will be determined. Field observations and sampling were carried out at each observation point (LUT) in the Blang Bintang sub-district, Aceh Besar district. Soil samples were taken at a slope of 0 to 15% (flat to slightly steep) representing Entisol and Inceptisol soil types.

Soil sample analysis was carried out in the laboratory to obtain information on the chemical and physical properties of the soil at the research site. The variables analyzed included: pH (H2O), C-Organic, N-Total, P-available, K-switched. For data on the value of cation exchange capacity (CEC) and base saturation (KB) are used as data to support soil classification. Meanwhile, the analysis of the physical properties of the soil from a single undisturbed soil sample were: size fraction (texture), volume weight and porosity as well as soil respiration. Aspects and methods of analysis of chemical properties, soil physics and root depth can be described in Table 1

Table 1. Physical, Chemical and Biological Properties of Soil analyzed in the Laboratory

No	Aspect Analysis		Analysis Method
1	Texture (Three Fractions)	%	Stokes' Law of Pipette Method
2	Reaction (pH) of soil: pH (H2O)		electrometric
3	C-Organic	%	Walkey dan Black
4	N-total	%	Kjeldahl
5	P-available	ppm	Bray dan Olsen
6.	K-dd	cmol kg^{-1}	Extraction 1 N NH_4COOH
7.	Root depth	cm	Drilling (earth drill)
8.	Volume weight (*Bulk density*)	g m^{-3}	Ring sample (*core method*)
9.	Porosity	%	Total saturation
10.	Soil Respiration	mg $C\text{-}CO_2$ g^{-1} hari $^{-1}$	Verstraete modification method

Source: Soil and Plant Laboratory and Biology Laboratory, Faculty of Agriculture, Syiah Kuala University (2015)

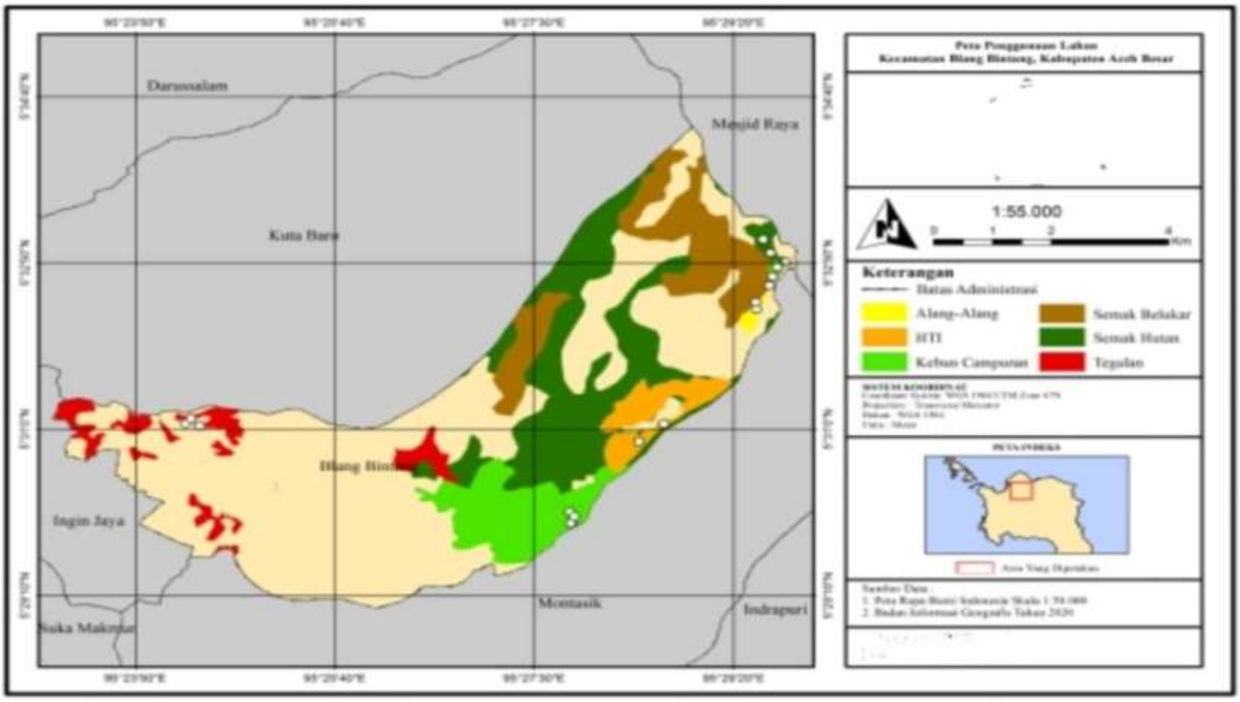
Analysis of the soil quality index applied the Mausbach and Seybold (1998) method modified by Partoyo (2005). Determination of the soil quality index is based on the nine criteria of soil properties in table two above. . The criteria for soil quality according to Partoyo are presented in table 4 below.

Table 2. Soil quality criteria based on soil quality index values (IKT)

No Grade	IKT Value	Soil Quality Criteria
1	0,80– 1,00	Very good (SB)
2	0,60– 0,79	Good (B)
3	0,40– 0,59	Medium (S)
4	0,20– 0,39	Low (R)
5	0,00– 0,19	Very Low(SR)

Sourcer:Partoyo(2005)

The map of the research location to determine the soil quality index on the type of dry land use in the Blang Bintang sub-district, Aceh Besar district can be seen in Figure 1.



Picture 1. map of research locations on dry land use types in Blang Bintang sub-district, Aceh Besar district

3. RESULTS AND DISCUSSION

Soil quality index (IKT) can be known from the results of field observations and laboratory analysis. Based on the results of observations and descriptions of soil profiles in several locations, the survey was made to represent several dry land vegetation in Blang Bintang sub-district, Aceh Besar district.

Table 3. Average modification of soil indicators, weight index and boundaries of the grading function (Moor)

Soil Function	Weight I	Soil Indicator	Weight II	Weight III	Weight Index	Rating Function				Value	Score	IKT
						Lower Limit		Upper Limit				
						X_1	Y_1	X_2	Y_2			
Preserving biological activity	0.4	*Rooting Medium*	0.33									
		Rooting Depth (cm)		0.60	0.0792	5.00	0.00	180.00	1.00	99.9	0.5423	0.0429
		Volume weight of soil (g cm^{-3})		0.40	0.0528	2.10	0.00	0.50	1.00	1.34	0.4750	0.0251
		Humidity	0.33									
		Total porosity (%)		0.20	0.0264	20.00	0.00	80.00	1.00	61.6	0.6933	0.0183
		C-organic (%)		0.40	0.0528	0.20	0.00	3.00	1.00	1.19	0.3536	0.0187
		Dust Clay (%)		0.40	0.0530	0.00	0.00	100.00	1.00	43	0.4300	0.0228
		Harrasment	0.33									
		pH		0.10	0.0130	4.00	0.00	8.00	1.00	6.88	0.7200	0.0094
		P-available (mg kg^{-1})		0.20	0.0260	2.50	0.00	50.00	1.00	66.18	1.3406	0.0349
		K-dd (cmol kg^{-1})		0.20	0.0260	0.01	0.00	1.00	1.00	1.03	1.0303	0.0268
		C-organic (%)		0.30	0.0400	0.20	0.00	3.00	1.00	1.19	0.3536	0.0141
		N-total (%)		0.20	0.0260	0.20	0.00	2.50	1.00	0.13	-0.0304	-0.0008
		Total A										**0.2121**
Arrangement & Distribution of water	0.3	Dush-Clay (%)	0.60		0.1800	0.00	0.00	100.00	1.00	43	0.4300	0.0774
		Porosity total (%)	0.20		0.0600	20.00	0.00	80.00	1.00	61.6	0.6933	0.0416
		Volume weight of soil (g cm^{-3})	0.20		0.0600	2.10	0.00	0.50	1.00	1.34	0.4750	0.0285
		Total B										**0.1475**
Filter & Buffer	0.3	Dush-Clay (%)	0.60		0.1800	0.00	0.00	100.00	1.00	43	0.4300	0.0774
		Porosity total (%)	0.10		0.0300	20.00	0.00	80.00	1.00	61.6	0.6933	0.0208
		Mikrobiological Process	0.30									
		C-organic (%)		0.33	0.0297	0.20	0.00	3.00	1.00	1.19	0.3536	0.0105
		N-total (%)		0.33	0.0297	0.20	0.00	5.20	1.00	0.13	-0.0140	-0.0004
		Total C										**0.1083**
Total IKT Sampel 2 (A+B+C)												**0.4679**
Criteria												Medium

One of the reasons for the moderate soil quality index on the type of dry land use is the sampling of the Inceptisol soil type in the Blang Bintang sub-district, which has less fertile soil characteristics. Inceptisols are known to have low essential nutrient levels, especially nitrogen (N)., phosphorus (P), and potassium (K). Intensive soil management can cause soil damage in terms of properties, physics, chemistry, and soil biology. Damage to soil chemical properties can occur due to the acidification process caused by the continuous use of large amounts of artificial nitrogen fertilizers (Sufardi 2012). Physical soil damage can be in the form of damage to soil structure that causes compaction (soil compaction) due to the use of inappropriate agricultural mechanization tools. or continuous use of chemical fertilizers. Biological damage is characterized by population shrinkage or reduced biodiversity of soil organisms which is usually the result of damage to physical and/or chemical properties (Akbar et al., 2022; Sufardi et al 2017).

In the type of dry land use, the percentage of sand (57%) is greater than the percentage of dust (36%) and clay

(6%). The results of the research by Bakri et al (2016) who get the percentage of 69.5% sand, 15.2% silt and 15.3% clay which belong to the sandy clay class. Sandy loam conditions on dry land indicate that this soil is not strong enough to bind water and nutrients. So that the substances needed for plants are easily washed out and cannot be utilized by these plants.

The C-organic content (1.19) is classified as low and the volume weight on dry land (1.34) is very high, causing the soil quality index for the dry land use type to be in the medium category in Blang Bintang sub-district, Aceh Besar district. The application of organic matter into the soil can increase the amount of soil pore space and form a crumb soil structure so that it will reduce the density of the soil. The average soil density at the study site was 1.24 g cm-3 , this figure has slightly exceeded the critical value for healthy agricultural soils, which is less than 1.2 g cm-3 for loamy soils (Brouwer and Jenkins, 2004). 2015). The value of soil density greater than 1.2 g cm-3 means that the soil has undergone a compaction process (Saputra et al., 2018). The low content of organic C in the research location can be caused by the lack of awareness of farmers about the importance of adding organic fertilizer during the process. land management. The addition of organic matter into the soil can add nutrients to plants, increase the cation exchange capacity of the soil and be able to create fertile soil suitable for plant growth (Fayez et al., 2017). crop yields are burned. Utilization of crop residues and crop rotation systems maintain soil organic matter (Parmata, 2011; Bakri et al., 2016). Likewise, it can be seen that pH H2O, K-dd, P-available and N-total a low level indicates that the type of dry land use is in the medium category so that it is somewhat less fertile.

4. CONCLUSIONS

The soil quality index on the type of upland land use in Blang Bintang sub-district, Aceh Besar district, is in the medium category. This can be seen by the low organic C content, high volume weight, pH H2O, K-dd, available P and N -low totals. In the type of dry land use, special treatment is needed in the form of adding organic matter to the soil by means of fertilization.

ACKNOWLEDGEMENTS

Researchers give appreciation and many thanks to all parties who have supported the implementation of this research activity and to journal committees who have accepted this research in reputable journals.

REFERENCES

A. Soleimani, S.M. Hosseini, A.R.M. Bava ni, M. Jafari, R. Francaviglia. 2019. Influence of land use and land cover change on soil organic carbon and microbial activity in the forests of northern IranCatena, 177 (2019), pp. 227-237, 10.1016/j.catena.2019.02.018.

A.M. Gelaw, B.R. Singh, R. Lal. 2014. Soil organic carbon and total nitrogen stocks under different land uses in a semi-arid watershed in Tigray, Northern EthiopiaAgricEcosyst. Environ, 188 (2014), pp. 256-263, 10.1016/j.agee.2014.02.035.

Akbar, Y., Endiyani, E., Agustina, S., Irhami, I., Rezvani, I., & Irmayanti, I. (2022). Analysis of Soil Quality Index of mixed garden land use type on dry land in Blang Bintang sub-district, Aceh Besar district. *JURNAL AGRONOMI TANAMAN TROPIKA (JUATIKA)*, *4*(1), 155-165.

Arifin, Z. 2011. Analisis Nilai Indeks Kualitas Tanah Entisol pada

Penggunaan Lahan yang Berbeda. Fakultas Pertanian UNRAM. Jogjakarta.Vol. 21 No.1.

Bakri, I., Thaha, A. R., & Isrun, I. (2016).Status Beberapa Sifat Kimia Tanah Pada Berbagai Penggunaan Lahan Di Das Poboya Kecamatan Palu Selatan. *AGROTEKBIS: E-JURNAL ILMU PERTANIAN*, *4*(5), 512-520.

Brouwer, D. and Jenkins, A. 2015.Managing for Healthy Soil: AgGuide – A Practical Handbook. NSW Agriculture, Tocal - New South Wales.

Cardoso, E.J.B.N., Vasconcellos, R.L.F., Bini, D., Miyauchi, M.Y.H., dos Santos, C.A., Alves, P.R.L., de Paula, A.M., Nakatani, A.S., Pereira, J.M. and Nogueira, M.A. 2013. Soil Health: looking for suitable indicator. What should be considered to assess the effects of use and management on soil health?. *Scientia Agricola* 70: 274-298.

Chaves, H. M. L., Lozada, C. M. C., & Gaspar, R. O. (2017).Soil quality index of an Oxisol under different land uses in the Brazilian savannah. *Geoderma Regional*, *10*, 183-190.

Davari, M., Gholami, L., Nabiollahi, K., Homaee, M., Jafari, H. J. (2020). Deforestation and cultivation of sparse forest impacts on soil quality (case study: West Iran, Baneh). *Soil and Tillage Research* 198, 104504.

Dong, C.Y., Yan, W.H., Min, Z.J., Lu, X., Shu, Z.B., Chun, Z.Y. and Qin, C.X. 2013. Minimum data set for assessing soil quality in farmland of Northeast China. Pedosphere 23(5): 564-576.

Doran, J. W., & Parkin, TB. (1994). Defining and Assessing Soil Quality, *In Defining Soil Quality for a Sustainable Environment*.JW.Doran, DC. Coleman, DF. Bezdicek,&BA. Stewart (eds). SSSA Spec. Pub. No. 35*. Soil Sci. Soc. Am., Am. Soc. Agron*.,Madison, WI, 3-21.

E. Bakhshandeh, M. Hossieni, M. Zeraatp isheh, R. Francaviglia. 2019. Land use change effects on soil quality and biological fertility: a case study in northern Iran.

E. Sakin. 2014. Organic carbon organic matter and bulk density relationships in arid- semi arid soils in Southeast Anatolia region Afr. J. Biotechnol., 11 (6) (2014), pp. 13731377,10.5897/AJB11.2297

E.K. Bünemann, G. Bongiorno, Z. Bai, R. E. Creamer, G. De Deyn, R. de Goede,L. Fleskens, V. Geissen, T.W . Kuyper, P. Mäder, M. Pulleman, W. Sukkel, J.W. van Groenigen, L. Brussaard. 2018. Soil quality – A critical review Eur. J. Soil Sci., 95 (2019), Article 103119, 10.1016/j.ejsobi.2019.103119.

F. Bastida, A. Zsolnay, T. Hernández, C. García. 2008. Past, present and future of soil quality indices: A biological perspective.Geoderma.10.1016/j.geoderma.2008.08.007.

F. Raiesi. 2017. A minimum data set and soil quality index to quantify the effect of land use conversion on soil quality and degradation in native rangelands of upland arid and semiarid regions Ecol. Ind., 75 (2017),pp. 307320, 10.1016/ j.ecolind.2016.12.049.

Fayez, R. 2017. A minimum data set and soil quality index to quantify the effect of land use conversion on soil quality and degradation in native rangelands of upland arid and semiarid regions. (75): 307-320.

Feng, S. Y., Wen, H., Ni, S. M., Wang, J. G., &Cai, C. F. (2019). Degradation characteristics of soil-quality-related physical and chemical properties affected by collapsing gully, the case of subtropical hilly region, China. Sustainability, 11(12).

H.M. Leite Chaves, C.M. Concha Lozada, R.O. Gaspar. 2017. Soil quality index of an Oxisol under different land uses in the Brazilian savannah Geoderma Reg., 10 (2017), pp. 183-190, 10.1016/j.geodrs.2017.07.007.

Heryani, N., & Rejekiningrum, P. (2019).Pengembangan pertanian lahan kering iklim kering melalui implementasi panca kelola lahan. *Jurnal Sumberdaya Lahan*, *13*(2), 63-71.

Huang, W., Zong, M., Fan, Z., Feng, Y., Li, S., Duan, C., & Li, H. 2021.Determining the impacts of deforestation and corn cultivation on soil quality in tropical acidic red soils using a soil quality index. *Ecological Indicators*, *125*, 107580.

Huang, X., Wang, D., Qiao, N., Geng, Q., Liu, Y., Song, H., ... & Wang, G. (2021). Effects of mowing and fertilization on soil quality in a semiarid grassland of North China. *Land Degradation & Development*, *32*(4), 1656-1666.

J. Six, K. Paustian. 2014. Aggregate-associated soil organic matter as an ecosystem property and a measurement tool Soil Biol. Biochem., 68 (2014), pp. A4-A9, 10.1016/j.soilbio.2013.06.014.

Kairis, O., Karavitis, C., Kounalaki, A., Salvati, L., and Kosmas, C. 2013. The Effect of management practices on soil erosion and land desertification in an olive grove. *Soil Use andManagement* 29: 597-606; doi:10.1111/sum/12074.

Kurniawan, M. F., Rayes, M. L., & Agustina, C. (2021).Analisis kualitas tanah pada lahan tegalan berpasir di DAS Mikro Supiturung, Kabupaten Kediri, JawaTimur. *Jurnal Tanah dan Sumberdaya Lahan*, *8*(2), 527-537

L.C. Barbosa, P.S.G. Magalhães, R.O. Bordonal, M.R. Cherubin, G.A.F. Castioni, S. Tenelli, H.C.J. Franco, J.L.N. Carvalho. 2019. Soil physical quality associated with tillage practices during sugarcane planting in south-central BrazilSoil Tillage Res., 195 (2019),Article 104383, 10.1016/j.still.2019.104383.

L.L. Guo, Z. Sun, O. Zhu, D.R. Han, F.D. Li. 2017. A comparison of soil quality evaluation methods for Fluvisol along the lower Yellow RiverCatena, 152 (2017), pp. 135-143, 10.1016/j.catena.2017.01.015.

Lal, R. 2015. Restoring soil quality to mitigate soil degradation.*Sustainability* 7: 5875-5895; doi: 10.3390/su7055875.

Levi, N., Hillel, N., Zaady, E., Rotem, G., Ziv, Y., Karnieli, A., & Paz-Kagan, T. 2021. Soil quality index for assessing phosphate mining restoration in a hyper-arid environment. *Ecological Indicators*, *125*, 107571.

Li, C., Yuan, P., Wang, J., Xiao, Q., Liu, Q., Sun, Z., ... & Cao, C. (2020). Soil quality indicatorsof integrated rice-crayfish farming in the Jianghan Plain, China using a minimum data set. *Soil and Tillage Research*, *204*, 104732.

M. Bayranvand, Y. Kooch, A. Rey. 2017. Earthworm population and microbial activity temporal dynamics in a Caspian Hyrcanian mixed forest Eur. J. For. Res., 136 (2017), pp. 447-456, 10.1007/s10342-017-1044-5.

M. Davaria, L. Gholamia, K. Nabiollahia, M. Homaeeb, H.J. Jafaric. 2020. Deforestation and cultivation of sparse forest impacts on soil quality (case study: West Iran, Baneh)Soil Tillage Res., 198 (2020), Article 104504, 10.1016/j.still.2019.104504.

M.T. Gómez-Sagasti, I. Alkorta, J.M. Becerril, L. Epelde, M. Anza, C. Garbisu. 2012. Microbial monitoring of the recovery of soil quality during heavy metal phytoremediation.Water.Air. Soil Pollut., 223 (2012), pp. 3249-3262, 10.1007/s11270-012-1106-8.

Mausbach,M.J.,AndC.A.Seybold. 1998. Assessmentof SoilQuality.InSoil Quality andAgricultural Sustainability.AnnArborPress.Chelsea. Michigan.

Minarsih, S. Dan Hanudin, E. 2020. Kualitas Tanah pada Beberapa Tipe Penggunaan Lahan.Prosiding Seminar Nasional Pertanian Peternakan Terpadu 3. Universitas Muhammadiyah Purworejo. 14 Maret 2020.

Moebius-Clune,B.N., 2017. Comprehensive Assessment of Soil Health.

Muñoz-Rojas, M., 2018. Soil quality indicators: critical tools in ecosystem restoration. Curr.Opin. Environ. Sci. Heal. https://doi.org/10.1016/j.coesh.2018.04.007.

P. Li, M.C. Wu, G.D. Kang, B.J. Zhu, H.X. Li, F. Hu, J.G. Jiao. 2020. Soil quality response to organic amendments on dryland red soil in subtropical China Geoderma, 373 (2020), Article 114416, 10.1016/j.geoderma.2020.114416.

Padmawati, N.A., Arthagama, I.M. dan Susila, K.D. 2017. Evaluasi kualitas tanah di lahan sawah Simantri dan Non Simantri di Subak Riang Desa Riang Gede. Agroekoteknologi Tropika 6(2): 185-193.

Partoyo.2005.AnalisisIndeksKualitasTanahPertaniandi Lahan PasirPantai SamasYogyakarta.*JurnalIlmu Pertanian*12:140-151.

Petunjuk Teknis Pengamatan Tanah. 2004. Balai Penelitian Tanah. Pusat Penelitian dan Pengembangan Tanah dan Agroklimat. Balai Penelitian dan Pengembangan Pertanian. Departemen Pertanian.

Pham, T. G., Nguyen, H. T. and Kappas, M. 2018. Assessment of soil quality indicators under different agricultural land uses and topographic aspects in Central Vietnam. *International Soil and Water Conservation Research,* 6**,** 280-288.

R. Marzaioli, R. D'Ascoli, R.A. De Pascale, F.A. Rutigliano. 2010. Soil quality in a Mediterranean area of Southern Italy as related to different land use types.

R. MelgarRamírez, V. González, J.A. Sánchez, I. García. 2012. Effects of application of organic and inorganic wastes for restoration of sulphur-mine soil.Water. Air. Soil Pollut., 223 (2012), pp. 6123-6131, 10.1007/s11270-012- 1345-8.

Raiesi, F. (2017). A minimum data set and soil quality index to quantify the effect of land use conversion on soil quality and degradation in native rangelands of upland arid and semiarid regions. *Ecological Indicators*, *75*, 307-320.

Sione, S. M. J., Wilson, M. G., Lado, M., & González, A. P. (2017).Evaluation of soil degradation produced by rice crop systems in a Vertisol, using a soil quality index. *Catena*, *150*, 79-86.

S. Bandyopadhyay, S.K. Maiti. 2019. Evaluation of ecological restoration success in mining-degraded lands.Environ. Qual. Manag., 29 (2019), pp. 89-100.

S.M. Zuber, G.D. Behnke, E.D. Nafziger, M.B. Villamil. 2017. Multivariate assessment of soil quality indicators for crop rotation and tillage in Illinois Soil Tillage

Res., 174 (2017), pp. 147-155, 10.1016/j.still.2017.07.007.

S.S. Andrews, D.L. Karlen, J.P. Mitchell. 2002. A comparison of soil quality indexing methods for vegetable production systems in Northern California Agric. Ecosyst. Environ., 90 (1) (2002), pp. 25-45, 10.1016/S0167-8809(01)00174-8.

S.Y. Korkanç. 2014. Effects of afforestation on soil organic carbon and other soil properties Catena, 123 (2014), pp. 62-69, 10.1016/j.catena.2014.07.009.

Saputra, D. D., Putrantyo, A. R., & Kusuma, Z. (2018).Hubungan kandungan bahan organik tanah dengan berat isi, porositas dan laju infiltrasi pada perkebunan salak di Kecamatan Purwosari, Kabupaten Pasuruan. *Jurnal Tanah dan Sumberdaya Lahan*, *5*(1), 647-654.

Schoenholtz, S.H., Vam Miegroet, H. and J.A. 2000. A review of chemical and physical properties as indicators of forest soil quality: challenges and opportunities. *Forest Ecology andManagement* 138: 335-356.Soil Biol. Biochem., 120 (2018), pp. 105-125, 10.1016/j.soilbio.2018.01.030.

Sufardi, I. S. 2012.Perubahan sifat fisika Inceptisol akibat perbedaan jenis dan dosis pupuk organik. *Lentera: Jurnal Ilmiah Sains dan Teknologi*, *12*(1), 150369.

Sufardi, M. Lukman, dan Muyassir. 2017. Pertukaran Kation pada Beberapa Jenis Tanah diLahan Kering Kabupaten Aceh Besar Provinsi Aceh (Indonesia).Prosiding SeminarNasional Pascasarjana (SNP) Unsyiah. Banda Aceh. Hal: 45 - 53.

Susan S. Andrews, Douglas L. Karlen, Cynthia A. Cambrella. 2004. The Soil management assessment framework. Soil science of society AmerikaJ ournal. https:// doi. org/ 10.2136 /sssaj2004.1945.

Syahrul, S., Thaha, A. R., & Toana, M. R. C. (2021).Analisis Beberapa Sifat Kimia Tanah Pada Berbagai Tipe Penggunaan Lahan Di Desa Tolai Barat Kecamatan Torue Kabupaten Parigi Moutong. *AGROTEKBIS: E-JURNAL ILMU PERTANIAN*, *9*(5), 1287-1297.

T. Wang, F.F. Kang, X.Q. Cheng, H.R. Han, W.J. Ji. 2016. Soil organic carbon and total nitrogen stocks under different land uses in a hilly ecological restoration area of North China Soil Tillage Res., 163 (2016), pp. 176-184, 10.1016/j.still.2016.05.015.

USDA. 2007. National Nutrient Database for Standard Reference. http://www.nal.usda.gov/foodcomp/search.

V. Sheoran, A.S. Sheoran, P. Poonia. 2010. Soil reclamation of abandoned mine land by revegetation: a review.Int. J. Soil, Sediment Water, 3 (2010), p. 13

W. Dunger, K. Voigtländer. 2005. Assessment of biological soil quality in wooded reclaimed mine sites.Geoderma. (2005), pp. 32-44, 10.1016/j.geoderma.2004.12.028.

Wander , M.M., Walter, G.L., Nissen, T.M., Billero, G.A., Andrews, S. S. and Cavanaught-Grant, D.A. 2002. Soil quality: science and process. Agronomy Journal 94: 23-32.

Willy, D. K., Muyanga, M., Mbuvi, J. & Jayne, T. 2019. The effect of land use change on soil fertility parameters in densely populated areas of Kenya. *Geoderma,* 343**,** 254 - 262.

X.G. Wang, M.H. Zhou, T. Li, Y. Ke, B. Zhu. 2017. Land use change effects on ecosystem carbon budget in the Sichuan Basin of Southwest China: Conversion of cropland to forest ecosystem Sci. Total Environ., 609 (2017), pp. 556-562, 10.1016/j.scitotenv.2017.07.167.

Y. Hu, Y. Li, Y.L. Hou. 2018. The variation of soil organic carbon fractions and soil enzyme activity of different land use types in Minjiang River valley Ecol. Environ. Sci., 27 (9) (2018), pp. 1617-1624, 10.16258/j.cnki.1674-5906.2018.09.005.

Y.B. Qi, T. Chen, J. Pu, F.Q. Yang, M.K. Shukla, Q.R. Chang. 2018. Response of soil physical, chemical and microbial biomass properties to land use changes in fixed desertified land Catena, 160 (2018), pp. 339-344, 10.1016/j.catena.2017.10.007.

Yasin, S. 2007. Degradasi Lahan pada Kebun Campuran dan Tegalan.Jurusan Tanah Fakultas Pertanian Unand Padang.