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THE PERMEABILITY ON SEVERAL TYPES OF DRY LAND USE IN ACEH BESAR REGENCY

Umar Husein Abdullah[1)], Chairil Anwar[2)], Endiyani[1)], Sri Agustina[1)], Irhami[1)], Yusran Akbar[1)]

[1]Department of Agroindustry, Politeknik Indonesia Venezuela, Jl. Bandara Sultan Iskandar Muda No. 12, Aceh Besar, 23372, Indonesia, email:
[2]Department of Livestock Product Technology, Politeknik Indonesia Venezuela, Jl. Bandara Sultan Iskandar Muda No. 12, Aceh Besar, 23372, Indonesia.
umarah_1977@yahoo.co.id

ABSTRACT

The variation in soil permeability levels as a result of several types of land use on dry land in Aceh Besar district is not widely known. Therefore, a study of the ability of soil to pass water (soil permeability) as a result of various land use patterns is very important to conduct research in order to maintain a sustainable environment. The metode of research used is directly survey method. The Field survey carried out by taking soil samples that were taken in a composite manner in the processing layer (0-20 cm) and intact. The variables measured include: permeability, soil organic fraction. Intact soil sampling is carried out using a ring or tube to determine soil permeability based on the constan head method. Meanwhile, composite soil samples, which are samples collected from several observation points mixed evenly into a homogeneous sample, those were used to variable soil organic fraction content using the pipette method. Permeability in the type of land use forest shrubs, mixed gardens, moor and teak forests were classified into the medium class. The order of increasing permeability starts from the type of land use for forest shrubs, mixed gardens, moorlands, teak forests and rainfed rice fields. Permeability rates didn't have correlation with organic matter content in several types of dry land use in Aceh Besar district. By increasing sand content, the pores between particles increase, the capillary action weakens, and water easily evaporates through the macro pores, or directly penetrate deep into the soil for vegetation use By increasing clay content, the effect of soil on local rainfall redistribution on vegetation growth changes from decreasing to increasing whereas sand, on the other hand, those was based on a limited distribution of soil types only with high clay content.
Keywords: permeability of soil, organic matter, dry land, top soil, moor

INTRODUCTION

Soil is a hollow permeable material which is interconnected and causes fluid flow from high energy to low energy locations. Precise soil permeability measurement / evaluation is required to calculate seepage under hydraulic structures and water quantity during draining operations. Soil permeability is influenced by several factors, including cavity ratio, inter-granular pore distribution, and degree of saturation (Elhakim, 2016). Soil comes from the weathering of rocks mixed with the remains of organic material from organisms (vegetation or animals) which live on it or in it. In addition, there are other components on the ground, namely air and water. Soil supports many forms of life, especially plant growth as a prime example. Soil functions as a place for plants to grow that catch sunlight (Bintoro et al., 2017).

The potency of land is determined by land use for land management, especially in the highlands and forests. The differences of land use determine the quality of soil physical and chemical properties. Soil quality assessment refers to the physical soil, those one of which is assessed as the amount of organic C as a function of soil organic matter content and soil physical quality based on texture. (Sand report). The proportion of manure and soil), weight and material.

The soil permeability. Inceptisol land is one of the most popular land contracts in Indonesia. West Java needs around 2,119 million hectares. Inceptisolan has a low organic matter content, but can spread to agricultural land. In Indonesia, the organic C content of agricultural land is 73% lower (> 2). The low organic content is a result of high temperatures and rapid decomposition. Organic matter can improve soil structure, become a source of nutrients and increase the soil's ability to retain moisture. Organic matter also affects the physical properties of the soil, especially the formation of structure and aggregate stability. In addition, the amount of organic matter affects the accumulation process in the soil (Dewi et al., 2020).

The control of land use measures are used to manage landslides on the side of the slopes by increasing soil surface strength, soil erosion resistance, controlling and maintaining rainfall (Feng et al., 2019), It can effectively improve soil ecosystems, increase soil nutrient content, improve soil physical structure, increase soil activity and biomass through litter and root input (Zhang, 2019). The Utilization of land use has been widely used to reduce soil erosion, soil degradation, as well as provide information on the mechanisms for the effect of land use on soil quality at various stages of recovery (Guo et al., 2018). Those can provide an understanding of the relationship between plant species and soil characteristics as well as selection of species most suitable for land use rehabilitation (Lin et al., 2015). The Previous research had shown that the effect of land rehabilitation on land properties is different from other types of land use. Hao et al., (2020) assessed the effect of vegetation restoration on soil infiltrability in heavily textured soils and it found that soil organic matter, aggregate stability, total soil porosity, and non-capillary porosity were significantly improved in the order of grass> shrub-planted > bare soil. In addition, the effect of vegetation on soil physical properties varies according to the year of land rehabilitation. The Different fundamental parameters such as soil bulk, total phosphorus, protease activity and soil shear strength are often used to evaluate the changing characteristics of soil quality under different land use treatments (Raiesi & Kabiri, 2016; Tang et al., 2019). The land use rehabilitation can also be evaluated by other parameters, including saturated hydraulic conductivity, aggregate stability, and macroporosity (Gu et al., 2019).

The process of water flow in the soil is an important aspect in relation to the agricultural sector. Several important processes, such as the entry of water into the soil, movement of water into the root zone, drainage, runoff and evaporation, are largely determined by the ability of the soil to channel water. Soil permeability is the ability of the soil to distribute water. Quantitatively, soil permeability / hydraulic conductivity is the speed at which a liquid moves in a porous medium, or it is interpreted as the velocity of water passing through the ground at a certain time expressed in centimeters per hour (Mulyono et al., 2019).

The amount of water available for land use types does not depend entirely on rainfall but on how much rainfall can be retained in the soil for vegetation use (Fatichi et al., 2016). Soil plays a central role in supporting vegetation growth as a domain in which atmospheric and hydrological processes are linked to the biosphere (Reynolds et al., 2004). In general, soil pores shrink along with increasing clay content, strengthening capillary action, and increasing groundwater retention capacity (Tian et al., 2017).

The quality of good water is necessary to maintain ecological and habitat stability, sustainable agricultural production and human health (Lu et al., 2015, Nguyen et al., 2015). However, maintaining water quality has become a major long-term challenge, due to the high pollution of water sources due to anthropogenic factors and pollution from non-water sources which is also influenced by climatic and environmental factors. The effects of land use on water quality have frequently been investigated, for example, in China by Shen et al. (2016). However, the relationship between several catchment characteristics (including climate, soil, topography, land use, and anthropological activities) and water quality has rarely been studied at various spatial and temporal scales (Giri and Qiu, 2016, Lintern et al., 2018, Zhang et al. ., 2020). The quality of water is fundamentally influenced by the characteristic different catchment, it is necessary to identify the main impacts among different attributes to facilitate sustainable watershed management.

The high organic matter content in the topsoil can trigger nitrification and denitrification processes under aerobic and anaerobic conditions, respectively (Pal et al., 2016). The groundwater permeability affects soil quality and moisture, consequently changing nutrients or organic inputs to groundwater and flow systems (Rodriguez-Galiano et al., 2014). Given that soil plays a complex role in the transformation of pollutants, emissions or transportation, it is important to understand how soil properties affect the quality of river water.

The soil are permeable materials because of the presence of interconnected voids which permit the flow of fluids from locations of high energy to locations of low energy. Proper measurement/evaluation of soil permeability is required for calculating the seepage under hydraulic structures and water quantities during dewatering activities. Soil permeability is affected by several factors including voids ratio, distribution of inter-granular pores, and degree of saturation. This discussion presented herein is limited to evaluating the coefficient of permeability of saturated soils. The coefficient of permeability exhibits a wide range of values up to 10 orders of magnitude from coarse to very fine grained soils. Furthermore, previous studies on the coefficient of permeability shows that the coefficient of permeability is highly variable within the same deposit with a coefficient of variation as high as 240% (Nagy et al., 2016).

Soft soil properties (e.g. permeability coefficient and compression modulus) exhibit clear characteristics of unevenness and anisotropy, which fundamentally depend on the discontinuity and uncertainty of soil microstructures (Pietruszczak and Oboudi, 2017, Marvila et al., 2019, Kostić et al., 2019, Zhang et al., 2016). The macroscopic mechanical behavior of soft soil is largely controlled by the soil microstructure. Therefore, a basic understanding of the soil microstructure is important for measuring the properties of soft soil (eg permeability). The main factors which affect soil permeability are the shape and size of soil particles, the coefficient of uniformity and viscosity of the fluid in the soil (Rahimi et al., 2015; Zhai and Rahardjo, 2015).

The plains of Indonesia cover 191.1 million hectares, most of which consist of 1.45 billion hectares of dry land and 46.6 million hectares of wetlands. From 1.45 billion hectares of dry land, it can be further differentiated into dry land with a wet climate of 133.7 million hectares and 10.8 million hectares of dry climate. In a humid climate, most of the dry areas, namely 104.6 million hectares and 29.1 million hectares, are non-acid dry areas (Sufardi et al., 2016).

Dry land in Indonesia has a very high potential for agricultural development. However, generally the productivity is still quite low, except for annual crops. Even though it has high land potential, the use of dry land in Indonesia, especially in the agricultural sector, is still very low. This is caused by several constraints and obstacles.In general, dry land has a steep slope, and shallow depths / solum, mostly in mountainous (> 30% slope) and hilly (slope 15-30%) areas, with an area of 51.30 million ha and 36.90 respectively. million ha.

The use of dry land as an agricultural sector is also faced with several problems, one of which is the low level of soil fertility. This is due to several constraints that inhibit plant growth, such as low organic matter content, minimal presence of organisms in the soil, and high soil acidity. Apart from low soil fertility, dry land with steep slopes is very sensitive to erosion, especially when cultivated for seasonal food crops. Limited water on dry land also means that farming cannot be carried out throughout the year. Water that is distributed through rainfall on dry land cannot be utilized properly because of the lack of the ability of the soil to bind water and restrain the surface runoff.

Dry land is land that is not submerged at any time of the year. In general, mainland Aceh, especially the Aceh market, has relatively high potential, however the optimal utilization of the land for business development is still low. This is due to several obstacles, including the lack of data and information on soil quality for various types of land in the arid Aceh market area. Therefore, efforts to increase land productivity to support food development are still minimal (Sufardi et al., 2016).

The use of land is very important for the type of soil to maintain fertility. In mixed gardens, due to the diversity of mixed garden vegetation, organic C content (2.17%) and (2.10%) and wetlands (1.92%) affect almost all parts of the plant. It is grown seasonally with crops such as corn, beans and cassava seeds. In other words, a small amount of organic matter is added to the soil, adding to the effect of cultivation by a large amount. Each soil has different organic matter depending on the properties and uses of the soil. Changes in soil organic matter content are caused by changes in vegetation or land use and soil management patterns. (Sufardi et al., 2016).

Therefore, this study wanted to examine how much variation in the level of soil permeability in several types of land use on dry land in Aceh Besar district. Therefore, studies on the ability of the soil to carry water (soil permeability) as a result of various land use patterns are very important for research in order to maintain a sustainable environment.

MATERIALS AND METHODS

The research sample was taken randomly and deliberately, which was limited to the type of land use for teak forests, mixed gardens, moorlands, shrub forests and rainfed dry land in Aceh Besar district. Samples were taken based on a digitized map obtained from an overlay of land use maps, maps of slope, soil type maps and administrative maps of Aceh Besar district. For the maps of the slope is limited to a slope of 25% where this was did on order to make the samples were taken are deemed still be used in cultivation and environmental conservation efforts.

This research was carried out by the method through direct survey to the research site. Having conducting field surveys on soil samples, a combined method was used on the crop layer (0-20 cm) in accordance with the technical guidelines for responsible soil monitoring. The parameters measured were permeability, soil organic fraction. Whole soil samples were taken with rings or tubes to determine soil permeability using the Sar-e-Konstan method. Soil permeability was measured by the following procedure. (B) After the saturation process was complete, attach the top of the ring containing the soil sample to the white ring. During the bonding process, soil samples remain submerged in water. (C) Soil samples were sent to the meter. Keeping the water level in the soil sample constant allows water to enter the equipment. (D) Measure the amount of water flowing through the soil mass after 6 hours with primary and secondary measurements at 1 hour intervals.

RESULTS AND DISCUSSION

The types of soil in this study area have an Incepticol ordersandy clay texture, lumpy structure, slightly sticky, contains a lot of organic matter, no lime content, fine to slightly coarse roots. The large amount of organic matter content makes it possible to increase the infiltration rate. This was a study of research that had been done previously by Sufardi et al 2016.

Table 1. The Average Organic Matter and Soil Permeability of Various Land Use

No.	Land Use Type	Organic Ingredients	Permeability (cm / hour)	Sample Points
1	Teak forest	1.12	3.37	3
2	Mixed Garden	2.44	2.98	8
3	Moor	1.34	3.35	5
4	Bush Forest	1.23	2.23	5
5	Rainfed Rice Fields	1, 03	4.54	3

Source: Laboratory Analysis and Field Survey

Table 2. The Soil Permeability Classification (Rusdi, M., et al., 2015)

No.	Class	Permeability
1	Very slow	<0.0125
2	Slow	0.0125-0.5
3	Slightly Slow	0.5-0.2
4	Moderate	2,0-6,25
5	Rather fast	6.25-12.5
6	Fast	12.5-25.5
7	Very fast	> 25, 5

It can be seen in Tables 1 and 2 above that the permeability in the type of land use for shrubs, mixed gardens, moorlands and teak forests is classified into the medium class. The order of increasing permeability starts from the type of land use for forest shrubs, mixed gardens, moorlands, teak forests and rainfed rice fields. This is due to the existence of cultivation efforts in managing the soil (such as the use of rainfed rice fields), the size of the canopy, and the distance to the roots that causes the infiltration rate of water into the soil to accelerate. In upland land use type, soil permeability is higher in dry soil than in other soils. Permeability refers to the ability of porous soil to release liquid (rainwater) horizontally or vertically. Soil permeability (cm / hour) is a function of various physical properties of the soil. Soil permeability is influenced by pore size, porosity, texture, composition and overall distribution that occurs during the flow process. The higher permeability of the soil, the better soil passes through the water.

The main problem in forest shrub land is generally its low organic matter content. Consistent organic matter is also a source of nutrients and the physical and chemical formation of the soil that improves irrigation units, biological processes affect biological processes in the soil. Forest shrubs have a major obstacle, namely low levels of organic matter in the soil. Forest shrub land use is a type of shrub that has been dominated by native tree stands (forest plants). Soil organic matter content is largely determined by the balance between the factors that influence its formation and also the factors that affect the weathering process. Forming factors include the quantity and quality of the organic material source, while the weathering factor is determined by conditions that affect the rate of oxidation of the organic matter.

The Mixed garden or *agroforestry* is a land use system (agriculture) that combines trees and crops to increase economic and economic benefits. The International Council for Forestry and Forestry Research (ICRAF) is sustainable by increasing the productivity of crops (including arboreal plants) and forest products and by applying culturally appropriate management techniques to increase overall productivity. The system is defined as follows: The quiet commercial use of forest has many benefits, including increasing soil fertility.

The forestry agroforestry model states that regenerative systems can change the function of forest ecosystems as regulated nutrient cycles, so that they can have two benefits at once: production (economy) and the environment. This can have a positive impact on other aspects of the environment. Plant annual crops. Tigran is a land area that relies on rainwater irrigation. This land is generally planted as seasonal or annual crops that are not related to rice and exported from the community to the mainland. Growing plants in the highlands requires consideration of the type and model of plants. According to this land use model, the area of dry land use appears to be much larger than the area of wetland / rice fields used, however the majority of all food crop sectors still come from discussions on the use of paddy fields.

Table 3. The Pearson correlation analysis and Sig. (2-tailed)

Correlations			
		B. Organic	Permeability
Organic Ingredients	Pearson Correlation	1	-0.35
	Sig. (2-tailed)		0.55
	N	5	5
Permeability	Pearson Correlation	-0.35	1
	Sig. (2-tailed)	0.55	
	N	5	5

Source: Processing data statistics 24

Based on the sig value. The 2-tailed from the out put table above between organic matter (x) and permeability (y) is 0.55> 0.05 or close to 0, which means that there is no correlation between organic matter and soil permeability. Based on the calculated r value for the relationship between organic matter (x) and permeability (y) is -0.35 <0.87 (r table), which means there is no correlation between organic matter and soil permeability. In the dry land use type, mixed garden, rainfed rice field, teak forest and shrub forest, the soil permeability value does not affect soil organic matter.

Slow or fast soil permeability can be affected by the degree of soil porosity. This is because the higher the porosity, the better the soil will absorb. So water and some substances can move faster. In general, permeability increases with soil porosity. Likewise, the wetter the soil, the more permeable it will be. In dry soil, some of the pores are filled with air which blocks the flow of water. Penetration is usually measured as the velocity of water passing through the ground over a period of time, usually expressed in inches per hour. The rate of penetration into the soil was very slow, from 0.20 to 0.80 ml DT-1. Soils with a very high clay content are associated with very little ventilation and very low permeability. Increasing soil weight will increase soil density, hinder ventilation and drainage, and cause root growth to be abnormal. Soil density can indicate the presence of soil layers, cultivation, content of organic matter, minerals, porosity, resistance to water retention, drainage properties and ease of penetration into the soil. It is rooted in the ground. Regarding changes in the location and composition of the pores, the weight of the soil volume can change from layer to layer over time (Bintoro, A. et al., 2017).

The Factors which is affecting permeability 1. Soil tissue: Soil tissue is the proportion of sand, loam and soil dust. The texture has a strong effect on transparency. For sand texture, sand has large pores which make it more permeable. So water and some substances can move faster. 2. Soil composition. The soil structure is where primary grain is collected into secondary grain and separated from naturally distributed agriculture. Soils that are structurally stable have low permeability due to small pores. The soil is irregular, but its permeability increases due to large pores (decreases with age). Porosity depends on the particle size, particle size and pore size which are influenced by soil composition. The smaller the particle size, the less permeable it is. 4. Viscosity of the liquid. Viscosity is the thickness of a liquid. The higher the viscosity, the less permeable the soil will be. 5. Gravity: Gravity affects the ability of the soil to hold water. The greater the gravity, the higher the permeability. 6. Specific gravity. The higher the Bj, the higher the soil density, in order to make the transmission speed becomes slower or slower.

The factors which are influenced by permeability. 1. Infiltration. Osmosis is the ability to conduct soil particles. The higher the permeability. 2. Erosion. Soil Erosion Due to the transfer of soil mass, erosion is low when the penetration rate is high. 3. Replacement. During draining, excess water is removed from the soil profile as quickly as possible. The degree of drainage is determined by the extent to which can easily be removed from the soil. Water that enters the ground can wash the surface of the soil. In highly porous soils, water moves freely, accelerating the process of water loss. Therefore, it has high drainage and high permeability. The conductivity is obtained when calculating soil moisture saturation (unit value) to indicate whether the permeability is fast or not. 5.Conductivity, high conductivity, high portability. Effluent is surface water flowing from the ground. Therefore, the higher the flow rate, the lower the permeability. 6. Filtration. Filtration is the movement of water in the ground. Less washing on high quality soil. Therefore, less filtration results in lower permeability.

The contribution of soil texture to soil capacity to redistribute local rainfall for vegetation growth can be explained as follows: by increasing sand content, the pores between particles increase, capillary action weakens, and water easily evaporates through macro pores, or directly penetrate deep into the soil for vegetation use (Jotisankasa and Sirirattanachat, 2017). However, it can be concluded that with increasing clay content, the effect of the soil on local rainfall redistribution on vegetation growth changes from decreasing to increasing whereas sand, on the other hand, is only based on a limited distribution of soil types with high clay content. Therefore, this conclusion cannot be extrapolated if the soil type contains a relatively high clay content. On a global scale, due to poor soil permeability under soil conditions with high clay content, a significant amount of rainfall is lost to surface runoff, increasing the level of unused water consumption (McColl et al., 2017).

CONCLUSIONS

Permeability in the type of land use for shrubs, mixed gardens, moorlands and teak forests which is classified into the medium class. The order of increasing permeability starts from the type of land use for forest shrubs, mixed gardens, moorlands, teak forests and rainfed rice fields. This is due to the existence of cultivation efforts in managing the soil (such as the use of rainfed rice fields), the size of the canopy, and the distance to the roots that causes the infiltration rate of water into the soil to accelerate. Permeability rates do not correlate with the content of organic matter in several types of dry land use in Aceh Besar district.

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